Elephants

Loxodonta africana and *Elephas maximus*

BIAZA

BRITISH & IRISH ASSOCIATION OF ZOOS & AQUARIUMS

Managment Guidelines for the **Welfare** of **Zoo Animals**

3rd Edition

Management Guidelines for the Welfare of Zoo Animals
Elephants *Loxodonta africana* and *Elephas maximus*

Third edition (2010)

Revised by Olivia Walter

First published 2002

Published and printed by the British & Irish Association of Zoos & Aquariums,
Regent's Park, London NW1 4RY, United Kingdom

ISSN 0963 - 1712

MANAGEMENT GUIDELINES FOR THE WELFARE OF ZOO ANIMALS

Elephants

3rd EDITION

Incorporating BIAZA's Policy Statement and Policy Document on the Management of Elephants

BIAZA

British and Irish Association of Zoos and Aquariums

Management Guidelines for the Welfare of Elephants

Document compiled by Olivia Walter, IZVG, for the

British and Irish Association of Zoos and Aquariums

www.biaza.org.uk

3rd Edition   January 2010

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SECTION 1: INTRODUCTION

1.1 The Purpose of the Document

The first edition of the Elephant Guidelines was published in October 2002. The document underwent its first review process (c.f. Section 3.19) during 2003 and 2004. The EAZA Elephant TAG adopted the Guidelines in 2003 and were subsequently reviewed for EAZA who produced an abridged version (**www.rotterdam/nl/zooinfo/**). The Elephant EEPs have made a few amendments to their recommendations (see Sections 3.6) for the second edition that was published in 2006, but none subsequently.

Several of the research recommendations have been carried out since the last edition, including a Defra/BIAZA/IFAW/RSPCA funded project carried out by the University of Bristol entitled 'The Welfare, Housing and Husbandry of Elephants in UK Zoos' (Harris *et al* 2008) and further analysis of the (Clubb and Mason 2002) data (Clubb *et al.* 2009; Clubb *et al* 2008) (see Section 3.17 Research). This third review is to update the guidelines to incorporating the research findings that have been recently published, publish the results of the audit against the 2nd edition of the guidelines and so acknowledge the changes that have occurred and identify new areas of research that have arisen.

All amendments in this third edition are incorporated in the text, and highlighted through footnotes.

This document incorporates BIAZA's Elephant Management Policy. In order to explain the purpose of the document it is necessary to provide answers to a number of key questions:

- Why are elephants kept in British and Irish zoos?
- How can we justify their continued presence in zoos?
- Who is the policy document for, and what does it set out to achieve?
- Who is responsible for implementation and review of the policy?

There have been elephants in captivity in western zoos for centuries. Originally imported as exotic showpieces in menageries, as the one exhibited in the Tower of London in 1256 [Menageries 1931 #30], they are now ambassadors for their species and form a basis for conservation breeding and conservation education activities.

Both African and Asian Elephant species are under extreme pressure from poaching, habitat-loss and human conflict in the wild, which has increased, in recent years. Zoos now have a legacy of long-lived individuals that they must care for and involve in genuine conservation-related activities. Justification for a continued presence of elephants in zoos can only be by demonstration of a conservation benefit to the species. This should also assist in achieving a shift in public understanding, attitudes and action towards field conservation. Part of the justification of keeping elephants in zoos must be the recognition of a clear accountability, on the part of zoos, to care for the animals under **optimal** standards of welfare which relate, as far as is possible, to natural behaviours and which follow the five principles as set out in the Secretary of State's Standards of Modern Zoo Practice (DETR (DEFRA) 2000) under the (Zoo Licensing Act 2002).

This document sets out current best practice and principles that should be followed by responsible zoos. As such its primary target group is zoo managers and zookeepers, who together bear responsibility for humane care and conservation benefit. The document spans broad imperatives and detailed procedures and will certainly need regular updating as knowledge of elephants' biology, behaviour and needs is advanced. The secondary target group concerns all people who ask, perfectly legitimately, the questions listed above. Zoos can act as excellent vehicles for conservation but will only succeed, in the longer term, if they enlist public understanding, sympathy and support. This can only be achieved by transparency of action and good communication.

1.2 Additional Reasons for Management Guidelines

1. There is not a comprehensive widely used manual in existence. People looking after elephants have differing methods according to home-grown traditions and practices. There is a need to bring together combined experience and offer suggested best practices.
2. Elephants are long-lived and highly intelligent animals with a complex social life. Often their needs are not fully provided for when they are held in a captive environment. There is understandable public concern about whether keeping elephants in captivity is justifiable, particularly on grounds of welfare and care. These concerns are legitimate and must be addressed in a positive and constructive fashion that will improve conditions for elephants.
3. Elephants are already in captivity, not including those remaining as semi-domesticated working animals in countries in Asia. It is not intended to debate the philosophical and rights issues of whether elephants should be in captivity, they are. However it is intended to stress that since elephants are in captivity there is a fundamental duty of care on the part of the people who manage, control and own them. A collection of standards and best practices makes it easier for people to attain the highest possible levels of care, both physiological and psychological.
4. The presence of elephants in zoos and safari parks must be set in the context of the threats to overall survival of extant species of elephant. The shrinkage of habitable range, poaching for ivory, elephant-human conflict, emergence of shared/communicable diseases with domestic livestock all contribute to an ongoing decline in wild populations. Population modelling and projections indicate that the solution, simply in population numbers terms, is most unlikely to be from captive breeding. Even if sustainable captive breeding established surplus numbers, the behavioural conditioning, securing of habitat and management of disease risks all mitigate realistic plans for reintroduction. Nevertheless it is vital to achieve normal breeding in zoos in order to avoid temptations to import

wild-caught animals, and, arguably, to retain such an effective 'ambassador' species on which to base educational conservation messages and thereby enlist real support for direct conservation and change the attitudes of people into future generations.

5. Elephants are large and intelligent animals. There is a tradition of close contact between the elephants and their carers. Bull elephants manifest a condition known as *musth* when their testosterone levels are very high and their behaviour becomes extremely unpredictable and dangerous. In addition many elephants have, unfortunately had what can only be described as at best a 'mixed' experience of interaction with humans. At worst some animals have been subjected to debasement and outright brutality. There are clear risks to people in working with, and being close to, elephants. Human mortality records in zoos over many decades bear witness to this fact and, sadly, new fatalities continue to be added. A major benefit of reviewing and collating best practice in elephant management is to make the occupation of the elephant carer safer, whilst retaining the best aspects of human and animal bonding and care that undeniably do exist.

ASSUMPTIONS

Elephants are worthy of our respect as another long-lived, intelligent species. If we cannot look after them properly then we should not even attempt to.

African and Asian species of elephant have sufficiently similar natural behaviours and biology that, unless specific distinctions are drawn, in general they can managed and cared for in a similar manner. Larger samples sizes from questionnaires may show up some of these differences which are relevant to captive management. Some current differences may be due to age structure of the two populations. It has been suggested, that African elephants are more difficult to train (Mellen and Ellis 1996), although this view is not widely accepted (De Leon 1981).

Given that welfare is both difficult to define and measure we must accept that definitive welfare measures for zoos elephants will be difficult to attain, particularly given the number of elephants in captivity. In the absence of sufficient data we are obliged to give the animals the benefit of the doubt in terms of management recommendations. That is to say rather than waiting for evidence which states that a variable correlates welfare, where common sense suggests that such a variable is likely to correlate with welfare, we will assume it does until evidence is available to contradict this and management recommendations should reflect this[1].

1.3 BIAZA's Elephant Policy Statement

This document incorporates BIAZA's Elephant Management Policy. Some of the management guidelines are mandatory and some guidance. Those that are mandatory are high-lighted in boxes and include the word 'must'. All

[1] The paragraph has been added to explain basis of assumptions.

Standard Operating Procedures (SOPs) are mandatory. Areas covered by SOPs are:

- Elephant training issues
  - Shackling
  - Voice control
  - Use of the ankus or hook
  - Use of the electric goad or hotshot
  - Use of elephants in demonstrations
- Staff training
- Health and safety and risk assessments

BIAZA, through its membership of responsible zoos and the executive management, will follow through the implementation of this policy and guidelines and ensure that it is reviewed and revised annually.

Zoos must continually assess their performance against BIAZA's Elephant Management Policy and the Secretary of State's Standards of Modern Zoo Practice (SSSMZP), with their defined standards and procedures, in order to demonstrate legal compliance and address legitimate public concerns.

ELEPHANT MANAGEMENT POLICY STATEMENT

***Elephants must only be kept in zoos as part of an overriding conservation mission so that they are in actively managed breeding programmes. These follow the same guidelines as for other EEP programmes, i.e. the captive population is managed to maintain an agreed level of genetic diversity and size commensurate with that required to sustain a captive population for a minimum period of 100 years. This may mean that non-breeding elephants are kept at some zoos to ensure maximization of the capacity for elephant breeding zoos and control of the breeding population*[1].**

Their presence must enable progressive educational activities and demonstrate links with field conservation projects and benign scientific research, leading to continuous improvements in breeding and welfare standards.

Zoos must exercise a duty of care so that standards of husbandry practices, housing, health and welfare management are humane and appropriate to the intelligence, social behaviour, longevity and size of elephants. All zoos should aim to continuously improve welfare standards.

Zoos must meet their moral and legal responsibility to ensure the safety of visitors and staff.

[1] This paragraph was expanded in the 2nd edition to provide a clearer meaning for managed population.

SECTION 2: BIOLOGY AND FIELD DATA

A: BIOLOGY

2.1 Taxonomy

Order	Probosicidea
Family	Elephantidae
Genera	*Loxodonta* (African elephant)
	Elephas (Asian elephant)
Species	*Loxodonta africana* (African bush elephants)
	Loxodonta cyclotis (African forest elephant)
	Elephas maximus (Asian elephants)

SPECIES AND SUBSPECIES

Detailed information on elephant taxonomy and morphology can be found in texts such as Nowak, (1991) (Sukumar 2003) Taxonomists have studied and revised the classification of elephants for many years and numerous subspecies have been described of which most represent no more than the normal variations to be expected in an animal with such a wide distribution. For the purpose of this publication what is considered the basic and most relevant information is provided.

FIG. 1: AFRICAN BUSH ELEPHANT *LOXODONTA AFRICANA*

Loxodonta: in historical times the African elephant occurred throughout Africa from the Mediterranean Sea to the Cape of Good Hope, except in parts of the Sahara and some other desert regions (Nowak 1991). The forest elephants of the Congo Basin and West Africa are so unlike the other African elephants that they have been considered a separate species *L. cyclotis* from the bush elephant, *L. a. Africana* (Barriel *et al* 1999) (Day 2000) (Grubb *et al* 2000) (Roca *et al* 2001) (Tangley 1997). There are reports of another species of small elephant *L. pumilo*, in dense lowland forest from Sierra Leone to Democratic Republic of Congo, but most consider this to be small forest elephants (Nowak 1991) (Haltenorth and Diller 1977). This was confirmed in 2003 by a study of mitochondrial markers that indicated that all forest elephants come from the same gene pool (Debruyne *et al.* 2003) and size differences are as a result of isolation and remoteness between populations and climatic variations.

FIG. 2: ASIAN ELEPHANT *ELEPHAS MAXIMUS*

Elephas: the genus probably occurred in historical time from Syria and Iraq to Indochina and the Malay Peninsula, to China as far as the Yangtze River and Sri Lanka, Sumatra and possibly Java. However there have been suggestions that the elephants of ancient Syria were in fact *Loxodonta*. The Asian elephant has been divided into a number of subspecies and the validity of many is doubtful. The elephant of Sri Lanka *Elephas maximus maximus* is the type specimen. Asian elephants are commonly assigned three subspecies (Eisenberg 1981); *E. m. maximus*, *E. m. indicus,* the continental form and *E. m. sumatranus* of Sumatra (Santiapillai and Jackson 1990) (Eisenberg 1981). However recent sequencing work using mitochondrial DNA (Fleischer *et al* 2001) suggests that there are two clades, A and B, with clade A originating in Indonesia and Malaysia, suggesting that these are an ESU (evolutionary significant unit). Clade A has been distributed by the human trade in elephants among Myanmar, India and Sri Lanka, resulting in mixes of Clad A in with B. This work does not support an ESU status for Sri Lankan elephants.

However the Sumatran subspecies is diagnosable and it is suggested that they be managed as a separate unit. *E. m. sumatranus* also has physical differences. They tend to be paler and smaller, with larger ears and one extra pair of ribs (20) (Shoshani 1991a). More recently there is a suggestion that the Bornean elephant may also be significantly different from mainland forms (Sukumar 2003)[1]

PHYLOGENY

The order contains one living family, Elephantidae, with two living genera. Elephants are members of the broad evolutionary line leading to ungulates or hoofed mammals. Early proto-ungulates showed extensive radiation in the Eocene. These fossils show development towards the ungulate condition but the limbs remained primitive and the nails had not evolved in to proper hooves. These lines died out leaving the remnants of three: the sirenians (sea cows), hyraxes and elephants. Numerous primitive features shared by these groups show their common ancestry (Eltringham 1982). There are various classifications of extinct proboscids, (Eltringham 1982) (Carrington 1962) (Nowak 1991) (Shoshani 1991b); this section is intended simply as a guide to the radiation which resulted in the extant elephants.

RELATIONSHIP BETWEEN EXTANT FORMS

The earliest definite proboscidean genus *Moeritherium* of the Gomphotheriidae arose in Africa in the late Eocene. *Moeritherium* was about the size of a large pig. It survived into the lower Oligocene. From this evolved the three families: Elephantidae (living) and extinct Mastodontidae and Stegodontidae. The first known members of the Elephantidae are from late Miocene or early Pliocene deposits in Africa. Table I. shows the distribution of proboscids from Eocene to Recent. Whereas *Loxodonta* was confined to Africa, species of *Elephas* ranged over Africa, Europe and Asia but became restricted to Asia by the late Pleistocene. Three species of *Loxodonta* and eleven of *Elephas* have been recognised (Eltringham 1982). Remains of a pygmy species of *Elephas* have been found on some Mediterranean islands; E. maximus is thought to have evolved some 0.2 million years ago.

The mammoths of the genus *Mammuthus* originated in Africa, probably from the *Loxodonta* lineage, but passed into North America along the land bridge, splitting into two branches, one mainly European and the other American. The woolly mammoth (*M. primigenius*) is thought to have become extinct some 10,000 to 20,000 years ago.

TABLE I. EVOLUTION OF THE PROBOSCIDS

ERA	**PERIOD**	**MAJOR DIVISION**	**ELEPHANT EVOLUTION**

[1] Taxonomic notes updated and referenced

CAINOZOIC	QUATERNARY	HOLOCENE (recent) *10,000 yrs since start*	*Elephas* *Loxodonta* *Mammuthus (?)*
CAINOZOIC	QUATERNARY	PLEISTOCENE *1 mill. yrs. since start*	Elephantids (Eur, As, N.A.) Mastodontids (N.A.) Dinotheres (Eur, As, Af) Stegodontids (Eur, As)
CAINOZOIC	TERTIARY	PLIOCENE *13 mill. yrs. since start*	Elephantidae arose. *Primelephas* (most primitive from which others may have evolved), *Loxodonta*, *Elephas* and *Mammuthus*. Dinotheres (Eur, As, Af) Mastodontids (Eur, As, N.A) Stegodontids (As)
CAINOZOIC	TERTIARY	MIOCENE *27 mill. yrs. since start*	Dinotheres (Eur, As,Af), Mastodontids (Eur, As, Af, N.A.) Stegodontids (As)
CAINOZOIC	TERTIARY	OLIGOCENE *37 mill. yrs. since start*	Moeritherium , Phiomia , Palaeomastodon Mastodontids
CAINOZOIC	TERTIARY	EOCENE *52 mill. yrs. since start*	Earliest proboscidean genus Moeritherium (Gomphotheriidae) in Egypt

2.2 Morphology

TABLE II. MORPHOLOGICAL DATA

SPECIES	WEIGHT (Kg)	HEIGHT (at shoulder, cm)	LENGTH (head and body, cm)
L. a. africana			
Male	4,000-6,000	280-400	500-650

Female	2,400-3,500	240-300	450-600
L. a. cyclotis			
Male	2,800-3,200	240-280	400-450
Female	1,800-2,500	210-240	350-400
E. maximus			
Male	5,400	240-300	550-640
Female	2,720	210-240	

Data presented in Table II. are taken from: (Eltringham 1982) (Eisenberg 1981) (Nowak 1991), and are very much average measurements. The African elephant is the largest extant land mammal. Elephants continue to grow throughout life so that the biggest elephant in a group is likely to be the oldest. The most conspicuous external feature is the trunk which is really an elongated nose, a combination of the nose and upper lip, the nostrils being located at the tip. The finger-like extremities are used to pick up objects. The head is very large as are the ears (especially in *Loxodonta*); the neck is short, the body and limbs are long and the tail is of moderate length. Ears are used in communication and are also important in regulating body temperature. The feet are short and broad and columnar in shape. The weight rests on a pad of elastic tissue which acts as a cushion or shock absorber; there are five toes on each foot but the outer pair may be vestigial. Elephants have four nails (occasionally five) on the hindfoot and five on the forefoot although there is some variation in *Loxodonta.* The forefoot is circular in outline and the hind more elongated. The skin is sparsely haired and the sebaceous glands, which are associated with the hair follicles in most mammals, are not present in elephants; thus there is no natural method for softening and lubricating the skin. Females have two nipples just behind the front legs and the testes are retained permanently within the abdominal cavity of males.

The two upper incisors grow throughout life and form the tusks; the longest recorded pair, held in Bangkok, is 3m and 2.74 metres each. Tusks continue to grow throughout life, one third being embedded in the alveolar processes of the skull. Two thirds of the length is hollow and contains a pulp cavity. The molar or grinding teeth are unique. The total number is 24; six in each half jaw but no more than two teeth are in use at any one time. There is linear progression (a queue) with each tooth appearing at the back of the jaw and moving forwards as the preceding tooth is progressively worn down at the front (Kingdon 1997). Each tooth drops out as it reaches the front of the jaw (Eltringham 1982).

The trunk is an information receptor; the elephant uses it as an olfactory organ, picking up scents and smells, and also to explore food and other items. Objects can be seized and manipulated with extreme sensitivity. The trunk can be used both for gentle caresses and admonitory slaps to the young. It is not, however, used as a weapon, a charging elephant will fold its trunk back, using the forehead as a battering ram, its forefeet to kick or trample and the tusks to stab. The trunk can hold up to four litres of water and is also used to suck up mud and dust. The trunk is essential to the survival of the elephant. Smell is the most highly developed sense, eyesight is limited but hearing acute. Midway between the elephant's eye and ear is a slit-like orifice, the temporal gland, which lies just beneath the skin. These glands emit a dark strong smelling oily substance, especially from bulls when on musth (see Section 2.9. on Sexual Behaviour).

The differences between African and Asian elephants are well described (Eltringham 1982) (Carrington 1962) (Nowak 1991) (Barnes 1984) (Shoshani 1991a). The main differences (see Fig. 1.) are: the Asian is smaller, has a convex back and much smaller ears, it also has twin mounds on the forehead, whereas the African has a single dome. The trunk has two lips or 'fingers' in the African and one in the Asian. There are also differences in the surfaces of the molar teeth. Tusks are very short or even absent in female Asian elephants (termed 'tushes'). Occasional male Asian elephants do not grow tusks; these are known in India as makanas. Full details of feet and foot structure can be found in (Csuti *et al* 2001). References are very inconsistent about the number of toenails in the two genera (Eltringham 1982). Basically these vary; in Asian elephants they can have five on both fore and hind, five on the fore and four on the hind, three on the fore and five on the hind or five on the fore and three on the hind. African elephants may have five or four on the fore feet and four or three on the hind (Clive Barwick, pers. comm.) Both genera have 56 chromosomes (Hungerford *et al* 1966)

Laws showed that elephants could be aged using teeth. He then related age, as determined by teeth, to body growth and constructed a graph of average shoulder height to age (Douglas-Hamilton and Douglas-Hamilton 1975). Similar methodology has been used for Asiatic elephants (Kurt 1974). Douglas-Hamilton designed a method of photographing elephants which allowed determination of shoulder height. Body measurements can be used to determine weight, shoulder height and foot-pad circumference can be used but the most accurate predictor was found to be heart girth (i.e. girth at the position of the heart) (Hile *et al* 1997). However this measure would be difficult to obtain in a wild animal. Good data are available on the relationship between shoulder height and weight in African elephants (Laws and Parker 1968) Length of footprint is also significantly correlated to shoulder height and length of hind footprint can therefore be used to determine height and therefore age (Western *et al* 1983). In Asiatic elephants the circumference of the forefoot, which is larger than the hindfoot, is exactly half the shoulder height distance (Kurt 1974). However, these ratios are not always as accurate for captive zoo elephants which are frequently overweight (see Section 3).

2.3 Physiology

A comprehensive account of the elephant's physiology is outside of the scope of this document. However, due to their immediate relevance to the veterinary management of elephants, a few points deserve emphasis.

The normal body temperature of the elephant is between 36 and 37°C. Temperatures of 38°C or above indicate a fever. As long as acclimatisation is achieved progressively, elephants will adapt to a wide range of environmental temperatures. A large mass:surface area ratio helps the elephant to tolerate ambient temperatures of 4°C or even lower, provided sufficient protection is afforded from wind. However, elephants have a limited ability to lose heat, and very high ambient temperatures and/or exposure to direct sunlight can be problematic. Sweat glands are present throughout the skin, but are few in number except for immediately above the toenails - thus the elephant relies on heat loss through the ears, sheltering from the hot sun and evaporative losses following bathing to avoid hypothermia. It is essential to provide shade and water to bathe in at all times in hot climates.

The digestive system of the elephant is similar to that of the domestic horse. It has a simple stomach and cellulose digestion takes place through microbial fermentation in the large caecum and colon (and see section 2.7). The liver is large, and there is no gall bladder. The presence of moderate amounts of sand and stone in the intestinal tract is probably normal. Elephants defecate up to 20 times daily, with 4 – 6 boluses per defecation. Schmidt (1986) remarks that elephants fed primarily on hay will have large roughly spherical faecal boluses, composed of what looks like finely chopped hay and have 12-20 defecations per day, of 4-6 boluses per defecation (and see Section 2.7).

The resting heart rate of a standing adult elephant is between 30 and 40 beats per minute (bpm) increasing by up to 25% when the animal lies in lateral recumbency. (Healthy elephants in captivity can stand for long periods and generally do not lie down for any length of time during the day). Lateral recumbency also leads to increases in arterial blood pressure and a decrease in arterial partial pressure of oxygen (PaO_2) (Honeyman *et al* 1992), thus the recumbent elephant may be at risk of developing hypoxemia and hypertension. However, elephant blood has a greater affinity for oxygen than that of other mammals.

Elephants are basically nose breathers – in other words, 70 % of their air intake is via the trunk. The lungs are attached to the chest wall by fibrous connective tissue which effectively eliminates any pleural space. This has been taken by some to indicate that elephants rely more on diaphragmatic movement for respiration than on costal movements (Todd 1913). Respiratory rates of adult elephants are generally between 4–6 per minute, rising noticeably when excited. Sternal recumbency can be dangerous especially in tired animals (Namboodiri 1997).

Features of the elephant's reproductive tract that are unusual include the internal testes of males and the very long urogenital canal extending from the urethral and vaginal openings to the vulva in females. This canal measures approximately one metre in adult cows (and see section 3.6).

Superficial veins are only seen on the surface of the ears, anterior surface of proximal forelimbs and medial aspect of the distal portion of rear limbs. There is no lacrimal apparatus; the harderian gland and the interior surface of the nictitating membrane supplies all moisture and lubrication for eyes.

2.4 Longevity

Longevity has been recorded as 60 years in the wild (Barnes 1984) and 45 and 57 years for captive African and Asian respectively (Eisenberg 1981). However, the oldest captive elephant recorded was probably Jesse at Sydney Zoo who lived 69 years (Crandall 1964). It is generally accepted that life expectancy in the wild is from 50-70 years, but normally not beyond 65 (Nowak 1991) (Kingdon 1997).

The life expectancies of wild and working Asiatic elephants have been shown to be similar, with all animals dying by age 70. However that of zoo and circus elephants in Europe was much shorter with most animals dead by age 40 (Kurt 1974) and only 1% of animals live beyond 50 (Schmid 1998b).

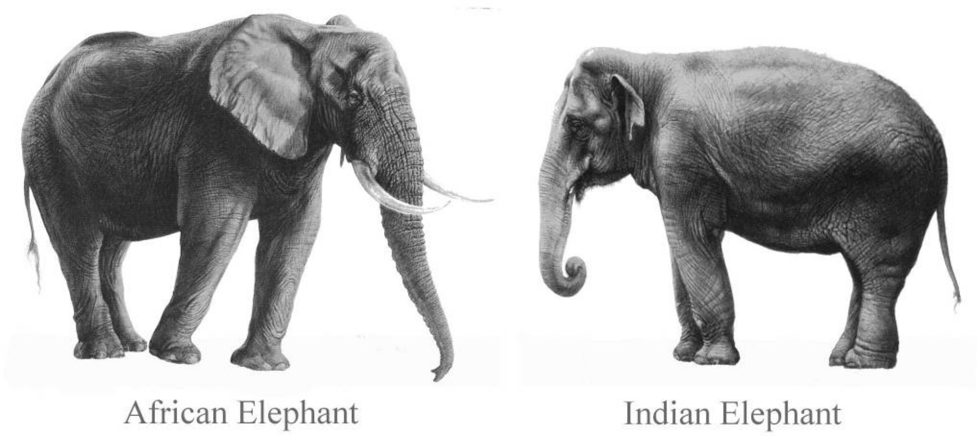


FIG. 3. AFRICAN AND ASIAN ELEPHANT PROFILES

B: FIELD DATA

2.5 Zoogeography / Ecology

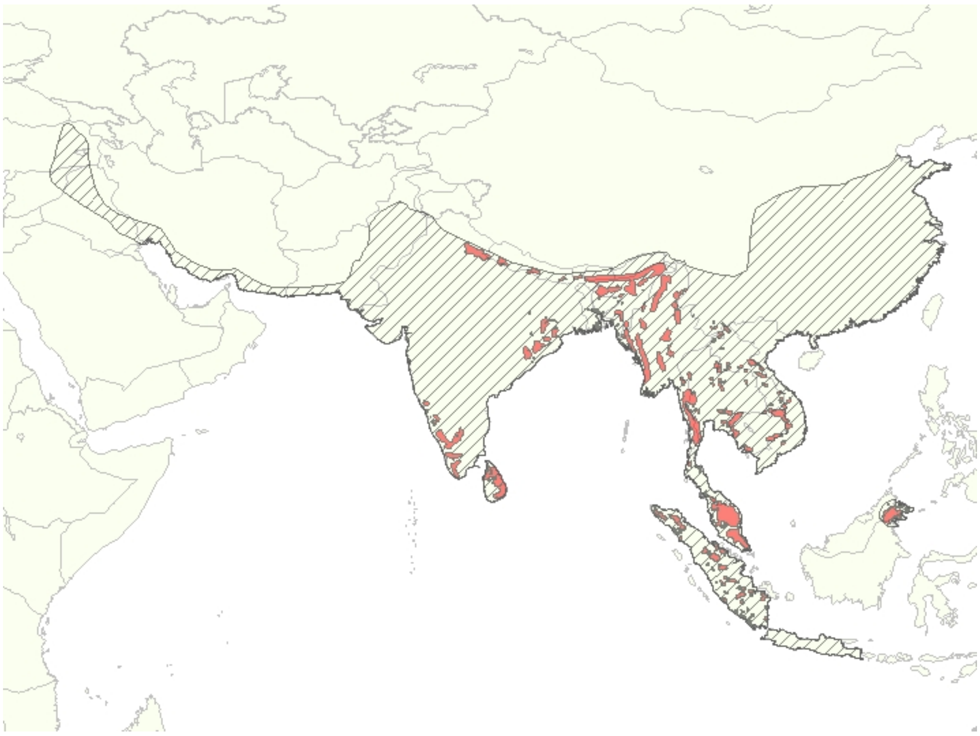
POPULATION, HABITAT AND DISTRIBUTION

Elephas

The wild population of Asian elephants is now very fragmented (Fig.2.). Prior to habitat modification the range extended from the Tigris-Euphrates in the west through Asia south of the Himalayas to Indochina and most of southern China (Fig.2). The species is in grave danger and the surviving population of between 41,000 and 52,000 (Sukumar 2003)is only a tenth of the population of African elephants. The important factors in Asia are reduction of habitat and pressures from man; about 20% of the world's human population lives in the present range of the Asian elephant. A comprehensive survey of the Asian elephant was carried out in the 1970s (Olivier 1978). Elephants currently occur in 13 countries, shown in Table III (WCMC and WWF International 2001) (Santiapillai and Jackson 1990). Elephants require a large range and are therefore one of the first species to suffer the consequences of habitat fragmentation. Populations continue to decline; from 1990 to 2001 number have decreased by more than 90% in Vietnam, near to 90% in Cambodia, by more than 50% in Laos and 25% in Burma (Myanmar).

All Asian elephants are forest animals, which require a shady environment, thus the conservation of forest is crucial to the conservation of elephants. The major population is in India, however the extensive forest, where elephant once roamed widely, now cover less than 20% of the country and about half of that is suitable for elephants. A network of protected areas connected by corridors has been proposed as a conservation strategy in India (Johnsingh and Williams 1999) but this has yet to implemented effectively, with developmental activities rendering most corridors un-usable by elephants. Burma (Myanmar) has one of the largest remaining captive populations of Asian elephants in the world; about 50% of timber is still extracted using elephants. These animals do not constitute a self-perpetuating population and so must be augmented by capturing wild animals. It is possible that the current rate of capture may be above the maximum sustainable yield. In Sumatra resettlement of people from the overcrowded islands of Java, Madura and Bali have created many new areas of elephant-human conflict. This and logging of the commercially valuable timber species is increasing fragmentation of elephant habitat. In Vietnam the devastation of forest between 1961 and 1973 by bombs, napalm, herbicides and defoliants constituted a man-made eco-catastrophe. Since the war forests have continued to decline as a result of logging, shifting cultivation and fuel wood collection. The Action Plan (Santiapillai and Jackson 1990) recommends a collaborative conservation programme with Vietnam, Laos and Cambodia.

FIG. 4. MAP SHOWING CURRENT AND FORMER DISTRIBUTION OF ASIAN ELEPHANT



(FOR MOST UP TO DATE MAP SEE WWW.IUCNREDLIST.ORG/DETAILS/7140/0/RANGEMAP)

TABLE. III. POPULATION ESTIMATES OF ASIAN ELEPHANT

Country	Numbers	
	Minimum	**Maximum**
Bangladesh	195	239
Bhutan	60	100
Myanmar (Burma)	4,639	5,000
Cambodia	200	500 – 2,000
China	250	300
India	19,090	29,450
Indonesia		
Kalimantan	200	500
Sumatra	2,800	4,800
Laos	950	1,300
Malaysia		
Peninsular	800	1,200
Sabah	800	2,000
Nepal	41	60

Sri Lanka	3,160	4,405
Thailand	1,300	2,000
Vietnam	109	144
Total	**34,594**	**50,998**

Loxodonta

The range of the African elephant has also been reduced and fragmented. Formally the genus occurred over most of the continent apart from the driest regions of the Sahara. Fig. 3 shows the present distribution. Table IV is taken from the African Elephant Database (Barnes *et al* 1999) and shows the definite and additional estimated numbers in each country – giving a maximum

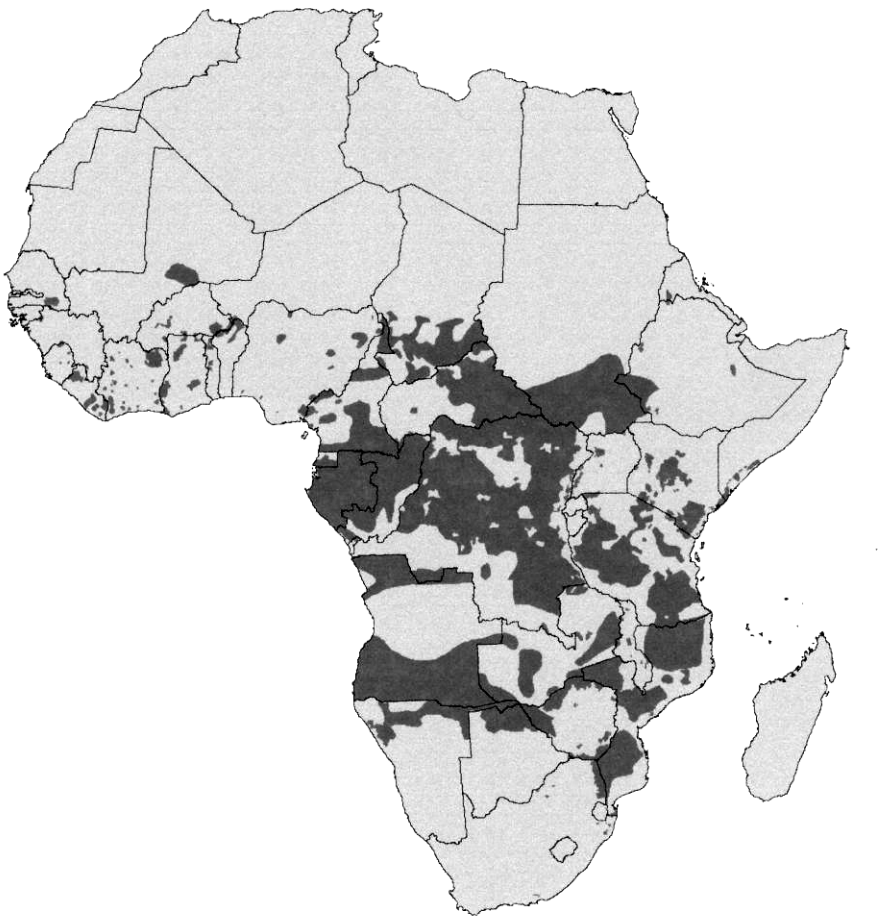


FIG. 5. CURRENT DISTRIBUTION OF THE AFRICAN ELEPHANT.

possible population of just over 500,000 animals[1]. Of these it is thought that some 350,000 may be bush or savannah elephants and 150,000 forest elephants (Barrett *et al* 2001). However the monitoring of forest elephant populations is difficult and incomplete (Walsh and White 1999) (and see Section 2.6 on censusing).

TABLE IV. AFRICAN ELEPHANT NUMBERS

REGION	COUNTRY	NUMBER OF ELEPHANTS				
		DEFINITE	PROBABLE	POSSIBLE	SPECULATIVE	TOTAL
SOUTHERN AFRICA	Angola	818	801	851	60	2,530
	Botswana	133,829	20,829	20,829	0	175,487
	Malawi	185	323	632	1,587	2,727
	Mozambique	14,079	2,396	2,633	6,980	26,088
	Namibia	12,531	3,276	3,296	0	19,103
	South Africa	17,847	0	638	22	18,507
	Swaziland	31	0	0	0	31
	Zambia	16,562	5,948	5,908	813	29,231
	Zimbabwe	84,416	7,033	7,367	291	99,107
	TOTAL*	**297,718**	**23,186**	**24,734**	**9,753**	**355,391**
CENTRAL AFRICA	Cameroon	179	*726*	4,965	9,517	15,387
	Central African Republic	109	1,689	1,036	500	18,721
	Chad	3,885	0	2,000	550	6,435
	Congo	402	16,947	4,024	729	22,102
	Democratic Republic of Congo	2,447	7,955	8,855	4,457	23,714
	Equatorial Guinea	0	0	700	630	1,330
	Gabon	1,523	23,457	27,911	17,746	70,637
	TOTAL*	**10,383**	**48,936**	**43,098**	**34,129**	**97,757**
EASTERN AFRICA	Eritrea	96	0	8	0	104
	Ethiopia	634	0	920	206	1,760
	Kenya	23,353	1,316	4,946	206	31,636
	Rwanda	34	0	37	46	117
	Somalia	0	0	0	70	70
	Sudan	20	0	280	0	300
	Tanzania	108,816	27,937	29,350	900	167003
	Uganda	2,337	1,985	1,937	300	6,559
	TOTAL*	**137,485**	**29,043**	**35,124**	**3,543**	**205,195**
WEST AFRICA	Benin	1,223	0	0	0	1,223
	Burkina Faso	4,154	320	520	0	4,994
	Ghana	789	387	241	12	1429
	Guinea	135	79	79	57	350
	Guinea Bissau	0	0	7	13	20
	Liberia	0	0	0	1,676	1,676
	Mali	357	0	141	156	654
	Niger	85	0	17	0	102
	Nigeria	348	0	105	375	828
	Senegal	1	0	0	9	10

[1] the latest edition, 2002 has an estimated total population of 402 thousand animals, see http://iucn.org/themes/ssc/sgs/afesg/aed/aesr2002.html

Sierra Leone	0	0	80	135	215
Togo	4	0	61	0	65
TOTAL*	**7,487**	**735**	**1,129**	**29,393**	**38,744**
TOTAL* CONTINENTAL ESTIMATES	***453,073***	***101,900***	***104,085***	***76,818***	***735,876***

* Note that totals for the Definite, Probably and Possible categories are derived by pooling the variances of individual estimates, as described under Data Types and Categorization section. As a result, totals do not necessarily match the simple sum of the entries within a given category

The most critical problems facing elephant conservation are lack of financial resources and growing human populations. Expanding agricultural activities are increasingly causing degradation and destruction of elephant habitat. This is most evident in West Africa which has the most fragmented elephant ranges. Over 40% of elephant range is in central Africa but only 10% of the area is protected. This is forest habitat and the region supports the main population of *L. a. cyclotis.* Southern Africa has the largest number of bush elephants, in mainly savannah habitat. Forest elephants only occur in forests but the bush elephant ranges from lowland and montane forest, upland moors, swamps floodplains all types of woodland, scattered tree savannahs and range into subdesert.

2.6 Conservation and Protection

The red list (IUCN 2009) assigns the category and criteria NT (down graded from EN A1b(IUCN 2003)) to the African elephant. In 1989 the African elephant was listed as Appendix I on CITES and this effectively placed a complete ban on the international trade in ivory and ivory products. However the species was downlisted again to Appendix II in some southern African countries in 1997. This was and is somewhat controversial (Sharp 1997) (Payne *et al* 1999). The African elephant is currently (i.e. 2004) listed as CITES Appendix I except for certain countries in southern African (Botswana, Namibia, RSA and Zimbabwe) where it is Appendix II with certain restrictions including quotas and permit controls see (CITES 2000). The sale of elephant products from the Southern African countries will continue to be a controversial issue, as is the methodology needed for successful monitoring.

The Asian elephant is also categorised as Endangered with the criterion A2c (IUCN 2009), i.e. due to population reduction. The species is CITES Appendix I throughout its range.

CITES has two monitoring systems for elephant trade (and see **www.traffic.org**): MIKE (Monitoring Illegal Killing of Elephants) is the approved instrument for tracking the situation across Africa and Asia and ETIS (Elephant Trade Information System) is the designated system to monitor illegal trade in ivory and elephant products. ETIS was designed by TRAFFIC.

CENSUSING ELEPHANTS IN THE WILD

Part of elephant conservation is the monitoring of populations in the field (Kangwana 1996). Aerial surveys are commonly employed to count elephants in open habitats. These methods are not suitable for censoring forest dwelling elephants and dung counts have been used for this sort of survey (Barnes 2001). This method has been shown to be relatively reliable and in many cases more precise than aerial surveys. However, the rate of decay of dung can vary in different areas, in some cases by as much as 50% (Nchanji and Plumtre 2001) and this factor has to be taken into account when calculating populations using this method; the method is also very time-consuming and labour-intensive. Elephants have also been counted using transect line techniques, however dung counts are reckoned to be the most accurate (Barnes 2001). A study in Tamilnadu in India compared direct-count transect methods with dung counts (Varman *et al* 1995). This found that although direct counts were faster they tended to overestimate elephant numbers; direct counts are very difficult to conduct in forest habitats. A good summary of the methodology using dung counts is given in Davies (2002).

ELEPHANT POACHING

Poaching for ivory is a problem for both African and Asian elephants, but probably greater for the African owing to the fact that females also have tusks. Ivory has been a valued substance from time immemorial and humans have been making and trading in ivory artefacts from some 10,000 years. As males tend to be poached more than females this can have a long term effect on the sex ratio of populations. Tuskers in southern India have been particularly badly hit (Sukumar *et al* 1998) and only abut 7.5% of bulls in Sri Lanka are tuskers (Santiapillai *et al* 1999). A survey carried out in Asian countries in 1999 (Stiles and Martin 2001) found worked ivory for sale throughout Asia. In Thailand more items were found for sale than in four African countries (which included Egypt) and imported African elephant ivory was also found. In Nepal, India and Sri Lanka, where there is a total ban, very little worked ivory was on display in shops (Stiles and Martin 2001). The ivory trade is thought to be the major cause of the drop in population of African elephants from an estimated 1.3 million in 1979 to around 626,000 in 1989 (Douglas-Hamilton 1987). Milner-Gulland (1994) examined rates of decline of the African elephants which indicated that the rapid decline since 1950, particularly from 1970, was due to the increase in poaching for the Far Eastern ivory markets. This increase started to drop around 1987. Egypt is considered the major African country selling illegal ivory, much of it poached in central and West Africa (Martin 2000). A survey carried out in Africa showed that the prices for ivory decreased as a result of the ban but there is still significant trade throughout the continent (Stiles and Martin 2001). Although elephant hides are traded TRAFFIC research has failed to uncover any linkages between elephant poaching and the trade in hides (**www.traffic.org**).

Elephant culling has effects on social organization and behaviour due to the fact that animals with larger tusks are selected first. It has been estimated that 336-388 tuskers have been poached over a 20 year period from the Periyar

Reserve of southern India (Sukumar *et al* 1998). This has resulted in a depletion of the male population and a drop in fecundity of females. It also appeared that a proportion of females, older than 15, were non-reproductive. Similar evidence from Africa shows populations with skewed sex ratios (50 females to one male) and the proportion of females showing signs of pregnancy and accompanied by recent offspring being reduced (Dobson and Poole 1998). Evidence from Queen Elizabeth Park in Uganda suggested that social structure was breaking down caused by stress due to factors like excessive poaching. Heavily poached populations characteristically have small family units comprising too many calves of similar ages. It is thought that some of these calves may have joined unrelated females (Nyakaana *et al* 2001). Work on mitochondrial DNA on this population showed that animals in these groups were derived from different maternal lineages, indicating a disruption of the normal social behaviour. It is also thought that family units coalesce as a response to poaching (Eltringham 1982). Culling is routinely carried out in the Kruger National Park, RSA (van Aarde *et al* 1999) where analysis has shown that once elephant densities reached a certain level the population declines naturally. Thus there is some evidence for natural biological control on populations; also data from elsewhere support the theory that age of sexual maturity i.e. first breading increases with density of elephants (Dunham 1988).

MINIMUM VIABLE POPULATION SIZE

Habitat fragmentation, as previously mentioned, is one of the major causes of the decline in wild populations and a major threat for the future. Attempts have therefore been made to assess minimal viable population sizes (MVP). A population and habitat viability analysis (PHVA) was carried out on the elephants of Sumatra in 1993 (Tilson *et al* 1994). This suggested that populations of less than 25 individuals were at high risk of extinction and a population of 40 – 50 animals in secure habitat would have a high chance of persistence, with no harvesting (i.e. removal of animals). To sustain harvesting a population of 100 would be necessary. The time frame for this analysis was 100 years and it has been suggested that this is too short a time frame to use for analysis of populations with long generations such as elephant (Armbruster *et al* 1999) and that a MVP of over 100 animals would be more realistic. Analysis on size of reserves in Africa was carried out by Armbruster and Lande (1993), which indicated that the minimum was 1,000 miles^2 needed to maintain populations for 1,000 years. Using the 100 year time span Sukumar (1993) arrives at a MVP for elephants in south India at 100 - 200 animals allowing for greater poaching of males. Whitehouse and Graham (2002) examined elephants populations in the Addo Elephant National Park (AENP) which had been fenced since 1954 (103 km^2, in size). They found an above average adult male mortality due to intra-specific fighting, suggesting that the park was not sufficiently large to accommodate the social needs of the male population.

SUSTAINABLE USE OF ELEPHANT POPULATIONS

Ecologically sustainable socioeconomic activities are those that are both ecologically and socioeconomically sustainable. The southern African countries, as previously mentioned, argue for a sustainable controlled trade in elephant products i.e. using elephants at a rate which is within their capacity for renewal. An example of this is CAMPFIRE (Communal Area Management Programme for Indigenous Resources) in Zimbabwe (Kock 1996). This initiative includes hunting for sport and trophies, and capture and live sales of animals. This is carried out within a communal resource management regime which guarantees that it is the local communities that benefit from revenue obtained from the wildlife resource. Zimbabwe therefore argued that the 1989 CITES ivory trade ban adversely affected the success of community-based resource programmes. It is also argued that it should be possible to sell ivory legally, that has been obtained from elephants shot due to problem animal control measures. It has been estimated that sport hunting of 200-300 elephants in Zambia would bring in more financial revenue that all international donations for conservation (Bowles 1996). For sustainable utilisation to work strict control measures must be enforced. However, it appears that elephant populations do require to be controlled in some southern African countries. Apart from culling, one option currently being examined, is the use of contraceptives to increase interbirth intervals and possible methods of doing this are being tested (Whyte *et al* 1998), but they can produce behavioural and physiological side-effects in individual elephants.

HUMAN-ELEPHANT CONFLICT

Definitions of the term vary (Inskip & Zimmerman 2009) but a broad definition of human-elephant conflict (HEC) is "any human-elephant interaction which results in negative effects on human social, economic or cultural life, on elephant conservation or on the environment" (Parker *et al* 2007).

HEC is a major intercontinental conservation problem (Hoare 1999). Both of the two recognized species (*Loxodonta africana* and *Elephas maximus*) are involved in HEC which occurs across much of their range (Sitati & Walpole 2006) at almost any interface where humans and elephants coincide (Hoare 2000). However there are some cultural differences across Africa and Asia that affect the approaches used to resolve conflict events, for example in some Asian countries elephants are removed from the wild and utilized as domesticated animals (Hart et al 2000).

The status of elephant populations in their range countries varies widely, and is primarily determined by local habitat conditions and rates of human-caused mortality (Hoare 1999). However it is widely accepted that conflicts between humans and elephants are increasing (Naughton et al. 1999). This appears to be because increasing human populations and expanding agriculture are causing humans and elephants to compete directly for land that is becoming increasingly scarce (Parker et al. 2007). In Assam, for example, major unsustainable extraction of forest products and encroachment of forests for agriculture in recent years has fragmented habitats, the most visible and immediate effect of which has been direct conflict between elephants and people (Kushwaha & Hazarika 2004). War and political instability have also caused localised increases in human-elephant conflict, particularly Africa, as people have moved into previously unoccupied elephant range areas

Conflicts between elephants and people can result in crop and property damage, economic losses, human injuries and fatalities, retaliatory killing of elephants leading to poor elephant welfare conditions and excessive mortalities and the more indirect impact such as stress, impaired freedom of movement and the knock-on effects in terms of healthcare or education (Hoare 2000; Dublin & Hoare 2004; Parker and Osbourne 2006; Parker et al. 2007). Consequently in many areas HEC has also become a serious local political issue (Hoare 1999) which can undermine regional conservation and welfare initiatives (Naughton 1999; WSPA 2009).

The impact of human-elephant conflict each year is considerable, both to subsistence-level agriculture and commercial crops in Africa and Asia. Elephants in Sumatra destroy millions of dollars of agricultural crops annually including date palms and sugarcane. In India several hundred people lose their lives to elephants each year (Osborn and Rasmussen 1995). Local communities generally endure the primary economic and social cost of conserving conflict species (Osborn & Parker 2003)(Osborn and Parker 2003; WSPA 2009). Typically their antipathy towards elephants extends beyond that expressed for any other wildlife even though in most cases, the regional economic impact of elephants on livelihoods is negligible relative to other vertebrate and invertebrate pests (Naughton et al. 1999). An indicator of the severity that human-elephant conflict can reach is seen in the response of several affected communities in Asia, many of which, despite revering elephants in their culture (e.g. Ganesha in Hinduism) have taken to poisoning and electrocuting elephants in desperate attempts to protect their lives and livelihoods (Gureja et al. 2002).

Human-elephant conflict tends to follow spatial and temporal patterns, although the exact nature of these will vary dependent upon situation. The majority of crop depredation tends to occur in late evening or at night (e.g. Sitati at al. 2003; Venkataraman et al. 2005; Jackson et al. 2008). This trend means that conflict also tends to be greater in areas on the boundary of refuge/protected areas (e.g. Nyhus et al. 2000). Conflict can also follow temporal patterns which relate to migration patterns (Parker et al. 2007) and the agricultural calendar (e.g. Jackson et al. 2008). Crop depredation for example is more likely as crops mature and property damage, particular to food stores, will likely increase after harvests.

There are also regional differences in the demographics of elephants involved in human-elephant conflict encounters. In several regions male bulls are the main culprits for crop depredation (e.g. Jackson et al. 2008), hypothesised by some to be a high risk – high gain foraging strategy improving reproductive success through a higher quality diet. In other areas however entire herds seem to be involved in conflict (Parker et al. 2007). While there may be habitual raiding, it is extremely difficult to collect data on this (Parker et al. 2007).

Approaches to Human-Elephant Conflict Management

The expertise to reduce these conflicts is growing and becoming increasingly available, but it requires a sharing of knowledge and willingness by governments and affected people to provide funding and/or resources for proposed solutions and/or altering customary behaviors (Johnsingh and Williams 1999; WSPA 2009). Government agencies can reduce economic losses and earn the respect and trust of people by recognizing HEC as a legitimate problem (WSPA 2009). Unfortunately currently few countries have clear and unambiguous national policies toward problem animal control and the level of commitment to HEC mitigation varies among the regions (Parker et al. 2007).

HEC are complex, humans and elephants meet and mix in numerous ways with varying consequences (Hoare 1995) and no single factor or condition explains human-elephant conflict at a given site (Naughton et al 1999). Therefore each situation requires careful analysis and an interdisciplinary, science-based approach that involves strategies to influence the behavior of both affected people and elephants (WSPA 2009).

In response to the increasing threat of human-elephant conflict to the survival of elephant populations both the Asia Elephant Specialist Group (AsESG) and African Elephant Specialist Group (AfESG) of the IUCN SSC have dedicated sub-groups for this issue. The Human-Elephant Conflict Working Group (HECWG) of the AfESG (previously the Human-Elephant Conflict Taskforce) essentially plays a role of 'technical facilitation' revolving around:

- Helping to reduce HEC by developing mutually beneficial strategies for elephant conservation and improvement of human livelihoods.
- Providing technical advice and expertise to elephant range state governments or other conservation support agencies on the management of HEC
- Linking people with an interest in, and co-ordinating activities with respect to HEC
- Fulfilling a catalytic role in getting HEC related studies underway

The AfESG web site (IUCN 2001) contains information and a number of resources to assist with the management of human-elephant conflict. The AsESG (**www.asesg.org**) held a Human-Elephant conflict task force meeting in 2009 and a strategic conservation planning workshop for Asian Elephants in 2008 which will lead to new publications and guidelines.

Mitigation methods are generally more effective when used in combination and the appropriate methods to use will be site specific depending upon many factors such as the local geography, elephant behaviour and available materials. Elephants can also become habituated to certain mitigation methods so they will need to be changed or improved over time. In many areas, particularly where the local authorities' capacity to tackle human-elephant conflict is limited, a community based approach to mitigation can be more effective. By pooling their resources and sharing responsibility for activities to mitigate HEC, local communities can, at least in theory, combat the human-elephant conflict menace much more effectively than relying exclusively on the often ill-equipped and under-funded wildlife agencies to deal with it. To make mitigation methods accessible they should ideally be affordable, locally available, adaptive, and effective and communities should take responsibility for maintenance and upkeep.

HECWG recommend human-elephant conflict management authorities to adopt a dual strategy involving both the animals and the 'public relations' associated with their presence. There are strong indications that officially centralized approaches to problem elephant management are less likely to succeed than ones where some decision making is devolved to a local level. The HECWG also states that it may be better to pursue the longer term policy options of managing the problem elephant component of a population in situ (e.g. land use planning, community conservation initiatives, etc.) rather than destroy a valuable resource (by frequently killing selected animals) or risk exporting the problem to another site (e.g. through translocation of individual animals. Guidelines for the in situ Translocation of the African Elephant for Conservation purposes can be found on the AfESG website **http://www.african-elephant.org/tools/trnsgden.html**).

A brief summary listing some of the main methods currently being utilized is provided below.

Elephant-focused methods for resolving conflicts

Physical Barriers—Physical barriers have been utilized in attempts to prevent HEC (Thouless and Sakwa 1995). They work on the principle of physically excluding elephants from attractants (such as crops, water pumps and storage facilities etc.). Traditionally farmers attempt to construct barriers around their fields and homesteads to deter elephants (e.g. logs and sticks may also be piled up around the edges of fields) (Parker et al. 2007). More conventionally, electric fences (in a variety of designs) have been used to protect, enclose, or deflect elephants away from specific areas (e.g. O'Connell et al. 2000). Additional, more experimental, barrier systems include strong non-electrified fences (Sitati and Walpole 2006), open trenches (Nyhus et al. 2000), covered trenches, bamboo spikes, sharp stones and barrier vegetation (Parker et al. 2007).

Elephant Deterrents— Some conflict species can be discouraged from approaching an attractant using acoustic or olfactory deterrents (WSPA 2009). Traditionally acoustic deterrents deter elephants by the shock value of an unexpected loud noise (Parker et al. 2007). However more experimental acoustic methods are currently being trialled that utilize specific noises that are known to scare elephants e.g. recordings of cattle noises or playbacks of elephant vocalizations (e.g. O'Connell et al. 2000). Olfactory deterrents are chemical compounds that animals taste or smell. They may take the form of an unpleasant or painful smell e.g. capsicum (chili) (e.g. Sitati and Walpole 2006), or as a targeted compound such as a hormone, which can create fear (Parker et al. 2007). Watchtowers and trip wires are used to provide an early warning system are commonly traditionally used in Asia, as are domestic elephants to drive the wild elephants back into the forests.

Aversive Behavioral Conditioning—Consistent aversive conditioning of wildlife to avoid contact with people, human developments, and human food sources may deter animals from approaching attractants, and increase their wariness of people (WSPA 2009). Aversive conditioning typically involves administering a repeated negative stimulus that is threatening, uncomfortable, and/or painful (WSPA 2009). Traditional methods include beating drums and tins, 'cracking' whips, yelling, whistling, firing catapults, throwing rocks and burning sticks (Parker et al. 2007). In addition fires may be lit on the boundaries of fields (Parker et al. 2007). On occasion plastic and rubber may also be burnt to create a noxious smoke (Parker et al. 2007). More conventionally disturbance shooting (the firing of gun shots over the heads of crop-raiding elephants) has been a longstanding deterrent (Parker et al. 2007).

Habitat Management— Elephants are attracted to human resources, especially when natural resources are in short supply due to natural environmental fluctuations or diminished habitat quality (Hoare 2000). Improvement to elephant habitat and the enhancement of key areas may reduce the attractiveness of natural and non-natural food sources near human habitations (Parker et al. 2007).

Elephant Population Management—Where non-lethal options are either ineffective or impractical, controlled culling or strictly regulated hunting have been used by some (African) governments with the objective of reducing elephant numbers without jeopardizing population viability (Barnes 1996). However, governments should carefully consider the negative potential ramifications of this approach in terms of (1) possible risks of over-harvest, especially where little scientific information exists about the elephant population, (2) negative responses of the public at large to what might be perceived as unnecessary killing and (3) the implications for wild elephant welfare (WSPA 2009).

Removal of Conflict Animals—In some cases it may be necessary to remove individual elephants from an area where they have been identified as persistent conflict animals (Parker et al. 2007). This can be accomplished by capturing them and releasing them in areas away from the conflict area, or by shooting them. Wildlife managers should consider the killing of problem elephants a last resort and should always strive to ensure that this is conducted as humanely as possible (WSPA 2009).

Human-focused methods for resolving conflicts

Education and Awareness—Educational and awareness efforts are required to change human behavior and to promote a better understanding of elephant ecology and the root causes of HEC (Tchamba 1996). Most studies of best practice advocate the need to empower local communities and encourage them to take responsibility for preventive action (e.g. O'Connell et al. 2000; Osborn & Parker 2003). The aim is to increase tolerance to both the elephants and conservation activities.

Land-Use Planning—Land-use planning approaches to HEC attempt to separate agricultural activities and elephants (Barnes 1996; Nyhus et al. 2000). This can be achieved through the identification and zonation of separate areas for farming and wildlife, or through the development of buffer zones at the edge of protected areas, or through the restriction of agricultural development in wildlife corridors (Parker et al. 2007). Protecting areas of land that connect forest patches and elephant populations is a method looked at in India. However, previous attempts at this have met with varied success (Johnsingh & Williams 1999).

Compensation Schemes— Losses caused by elephants can be directly compensated through in-kind or cash payments. The extent of damage in each incident is measured through an exhaustive assessment process (Zhang et al. 2003). Governments and people affected by conflict incidents should share the financial burden (WSPA 2009). However, those coordinated by the government have limited successes, largely due to the logistics of administration and the unsustainable financial burden of such schemes (Madhusudan 2003). When the burden rests entirely on affected individuals, their negative attitudes toward elephants may increase and ultimately hinder conservation and welfare efforts (Parker et al. 2007). Conversely, when the burden of HEC rests entirely on the government, people are often less motivated to employ individual measures to reduce conflicts in the first place (WSPA 2009).

Community Insurance Schemes—Community insurance uses revenues generated from wildlife to balance the losses of individuals within a conservancy (WSPA 2009). Payments are only made to registered conservancy members according to the conditions agreed by all conservancy members (Parker et al. 2007). Importantly, all conservancy members pay into the system and therefore have a stake in it (Parker et al. 2007). However, there is insufficient information and too few practical case studies to evaluate the effectiveness of such approaches.

Benefits from Wildlife—In Community-Based Conservation programmes the benefits generated from wildlife based activities such as tourism (Bauer 2003) and hunting (Barnes 1996) may be used to offset the costs of conflict. This process does not actually reduce the amount of conflict caused. Rather, it attempts to offset the damages by providing positive benefits to communities that suffer conflict (Parker et al. 2007). Benefits can take the form of community projects such as schools and clinics, cash payments to households, or capacity building and training (Parker et al. 2007. However, as with culling governments must carefully consider the negative potential ramifications of these approaches and avoid over exploitation (see elephant population management section above) (WSPA 2009).

Alternative Livelihoods—The exploration and development of sustainable alternative livelihood approaches may provide the ultimate solution to this conflict (Parker et al. 2007). For example, in some cases the utilization of unpalatable cash crops (e.g. chili which is less vulnerable to wildlife than other crops) have proved economically viable (e.g. Parker and Osborn 2006).

Evaluating the Effectiveness of Human-Elephant Conflict Resolution Strategies

A systematic approach to HEC monitoring is vital in order to assess the effectiveness of HEC strategies and mitigation efforts (WSPA 2009). It is also required in order to track patterns of HEC over time, to make comparisons between different geographical areas (Parker et al. 2007). Therefore the level and extent of HEC should be quantified both before and after implementation through an objective monitoring program (WSPA 2009). Monitoring should be conducted annually and should involve the collection and analysis of both quantitative (e.g. amount of crop damage caused by HEC) and qualitative data (e.g. attitudes of local people affected by HEC) (Hoare 1999). Advanced analysis can also be used to explore patterns in greater detail (Sitati et al. 2005).

The AfESG and AsESG both advocate the use of standardised data collection protocols for human-elephant conflict as an important management tool. Many projects have also effectively used Geographical Information Systems to monitor and analyse conflict patterns and elephant land use patterns to help better mange human-elephant conflict (eg. **www.assamhaathiproject.org**, **www.savetheelephants.org**).

Conclusions

HEC resolution strategies should strive to reduce conflicts to socially acceptable levels (Treves et al. 2006), while simultaneously ensuring that elephant populations remain sustainable over time (Hoare 2000). They should also be based on informed and responsible stewardship of shared habitat (Gadd 2005) and founded on ethical and humane approaches (WSPA 2009). Ultimately the best results for conflict mitigation may need to incorporate several long term measures such as land-use planning, which accommodates the needs of humans and elephants within a landscape (Parker et al. 2007). However, such interventions require political will and a large timeframe in which to be implemented (Johnsingh and Williams 1999; Parker et al. 2007). In the mean time researchers recommend that a combination of short term measures (e.g. deterrents) should be used to reduce the impact of human-elephant conflict upon rural communities (Osborn and Parker 2003; Sitati and Walpole 2006; Parker et al. 2007; WSPA 2009).

DOMESTICATION

Capture of wild elephants for domestic use has become a threat to some wild populations. It has been the custom to take wild elephants and train them rather than breed from captive animals. India has banned capture to conserve wild herds but hundreds are caught each year in Burma (Myanmar) where they are still used in the timber industry (Toke Gale 1974). A ban on logging in Thailand in 1989 caused a problem with unemployed working elephants, resulting in considerable welfare problems (Mahasavangkul 2001).

Working elephants are usually caught between the ages of 15 and 20 when they are large enough to work (Cheeran and Poole 1996). Traditional methods of capture training and taming may involve some cruelty (Fernando 1989) (Alwis 1991). Elephants in camps also have a poor record of breeding, probably because of lack of incentive as it is easier to capture older animals from the wild. Thus the capture of wild elephants for domestic use can create both conservation and welfare problems. (Also see Section 3.1, Elephants and Man).

DISEASE PROBLEMS IN THE WILD

No comprehensive accounts of the disease problems of wild elephants have been published, yet there are multiple papers describing the pathological and infectious diseases seen in wild populations. Disease was not thought to be a major factor affecting elephant populations, especially when compared to the problems of habitat destruction, elephant-man conflict, poaching, environmental changes or drought. However as populations of elephants further reduce in number, compounded by the conservation stressors already noted, diseases in wild populations are becoming a significant factor for the successful conservation of elephants. Comparison of wild population disease patterns is often used to justify some of the medical problems seen in captivity. In some respects this is a useful practice, noting the problems in wild elephants is essential, and using the knowledge gained from captive elephants to extrapolate to the wild populations when managing conservation programmes is essential. However in other respects this comparison is a meaningless enterprise; the wild, captive range country populations, and the captive elephant populations are separate populations, exposed to different environments, pathogens, physiological stressors and the epidemiological patterns are likely to be very different due to the nature of the environments and components that they are exposed to. The underlying pathophysiology however will be similar and the knowledge gained from captive elephants, and vice versa, is essential for the conservation of elephants overall.

Due to the differing nature of elephant populations it is more useful to look at populations as a whole, starting with the different species, but also the distinct populations such as that of camp verses wild, or wild island populations compared to mainland elephant populations. Diseases of Asian camp elephants do have an impact on the wild elephants, as they regularly interact, It is likely that, as more information becomes available, that the epidemiology of significant diseases is closely related between the two groups. A large proportion of the data on wild elephants is African elephant based, although the information for Asian elephants is increasing. There are several reasons for this, the main being the nature of African elephants, the long-term studies and the data from the cull programmes. Asian elephants, despite long-term studies, are very different in their natural history and the ability to detect them or rapidly find animals that have died is limited due to their habitat, and it is only recently that disease studies, including post-mortems, have really begun to be undertaken. The divisions in the elephant community, e.g. pro-captivity verses anti-captivity, results in different groups that have different agendas and the differences between the populations of elephants results in data that can be used for either side, depending on how it is utilised. Despite saying this there comes a point where disease in wild elephants as a whole needs to be considered which is the aim of this brief review. Disease management as a conservation tool is one of the tenements of the field of conservation medicine and cannot be ignored for any successful conservation programme.

Infectious diseases: known to affect wild elephants include anthrax (Lindeque & Turnbuall 1994) (Okewole *et al.* 1993) (Sukumar 2003) (Turnbull *et al.* 1991), encephalomyocarditis virus (Grobler *et al.* 1995), foot and mouth disease (FMD) (Hedger *et al.* 1972) (Howell *et al.* 1973), pasteurellosis (Kemf and Santiapillai 2000), elephant endotheliotrophic herpes virus (EEHV) (McCully *et al.* 1971) (Zachariah *et al* 2008), and cowdriosis (Okewole *et al.* 1993). The position regarding FMD is somewhat confusing. Clinical cases of FMD have been reported in captive Asian and African elephants, but African elephants are generally considered not susceptible under natural condition (Williams and Barker 2001). Reports of disease outbreaks in elephants include: cowdriosis (heartwater) a tick borne infection, reported in African elephants; haemorrhagic septicaemia, normally a cattle disease was responsible for the deaths of several animals in Sri Lanka's Uda Walawe National Park in May 1994; an outbreak of encephalomyocarditis reported in African elephant from the Kruger in 1993/4, Asian elephants are also susceptible but the mortality is probably not very high. Tuberculosis has yet to be described in wild elephants, although pathology that was consistent with tuberculosis was found in Uganda (Woodford 1982). It is likely that tuberculosis is present in wild populations; it is know to occur in home ranges of elephants, in captive elephants in range countries that interact with wild elephants, and in areas where human tuberculosis is rife (Dabgolla *et al.* 2002). Why it has not been found maybe down to the availability of tests or access to fresh post-mortem material (Mikota *et al* 2006) (Mikota and Fowler 2006). Another disease whose identification in wild elephants was limited to availability of testing is EEHV. This has now been identified in free ranging elephants in Kerala, India (Zachariah *et al* 2008) and Africa (McCully *et al.* 1971) as well as in captive elephants in range countries suggesting that there maybe a risk to wild populations (Reid *et al.* 2006). As the EEHV PCR becomes available in other range countries it is likely that we will find the virus in wild populations, especially considering the virus is 30 million years old.

Parasitic disease: significant parasite infestations in wild elephants are well documented, ranging from the common elephant louse (Haematomyzus elephantis) to nematodes, trematodes and bots. For a comprehensive list of the helminths and other parasites of elephants and their significance, see (Basson *et al* 1971) (Chowdhury and Aguirre 2001) (Mikota and Fowler 2006).

Other: dental disease has been described in free ranging African elephants ranging from tusk sulcus infection, failure of tusks to erupt, and pulpitis (Mikota and Fowler 2006). There have been reports of severe abscesses of molar teeth resulting in bony swellings of the jaws (Laws and Parker 1968). Foot pathology, including pododermatitis, has been reported in free ranging African elephants (Mikota and Fowler 2006). Flaccid trunk paralysis is well documented in Kruger National Park, the cause is unknown but toxicity is suspected from either plants or heavy metals (Kock *et al.* 1994). Poisoning, although not a disease, is a major problem as human-elephant conflict problems increase. Traumatic wounds do occur in individuals, either from conspecifics, humans, or other species. There are many other medical conditions in the literature available for interested readers.

2.7 Diet and Feeding Behaviour

The elephant is a hindgut fermentor, that is digestion and fermentation of plant cellulose takes place in the greatly expanded caecum and colon. They are generalist feeders and consume a large variety of plant species, ranging from grasses to trees. As they obtain food using the trunk they have a range from ground level to high up in trees, and can also knock over small trees and bushes. As with most non-ruminants, food passes through the gut quickly, estimated at some 11-46 hours (24 hrs average), although there will be differences with dietary type (Eltringham 1982) (Sukumar 1991). A wild elephant consumes about 4-8% of body weight per day; a mature bull requires about 300-400 kg (75 kg dry weight) per day and a mature cow 175 kg (42 kg dry wt.) or more (Estes 1991) (Sukumar 1991). Elephants may spend 16 hours a day feeding and eliminate 3-5 dung boluses every 1.4 hours (Estes 1991) or between seven and 29 defecations each day (averaging 12 per day) (Sukumar 1991).

There is seasonal variation in diet with animals eating more grasses and herbs in the rainy season and more woody plants in the dry season. Grass tends to have lower levels of protein in the dry season and elephants feeding solely on grasses may suffer nutritionally (Sukumar 1993), thus animals require a mix of grass and browse. The diet of the savannah elephant comprises about 45% of grasses whereas the forest elephant is highly frugivorous (White *et al* 1993) (Turkalo and Fay 1995). However both forms are opportunistic in their choice of food as the forest elephant in Bwindi forest favours bamboo shoots during the wet season (Babassa 2000). Elephants also play an important role as seed dispersal agents and some plant species will not germinate unless they have passed through the elephant's digestive system (Redmond 1996) (Sukumar 1991). Elephants also visit mineral licks where they will excavate pits and even caves with their tusks. Dierenfeld (1994) gives a good summary or elephant nutrition. Most of the food plants of elephants are low in chemical defences but they eat barks that are high in tannins and species that contain significant amounts of latex (Sukumar 1993). However detoxification could take place if only a small amount of a poisonous plant is eaten and it is possible that elephants employ this strategy. A condition of flaccid trunk paralysis noted in elephants in the southern shore area of Lake Kariba may have been caused by plant intoxication (Kock 1998), through the introduction of non-indigenous plant species.

Elephants require access to water for drinking and bathing but in arid areas may go for several days without drinking (Eltringham 1982), however an elephant would normally drink up to 100 litres at a time and 225 litres per day. If water is short elephants may dig holes in dry stream beds to get at sub-soil water.

2.8 Reproduction

SEXUAL MATURITY AND GESTATION

In the wild, first conception can occurs between 10-12 years and calving intervals range from three to nine years, with an average of four years (Lee 1991a). It is suggested (Laws and Parker 1968) from work in Murchison Falls that female elephants are ready to ovulate at 11 years on average but that full follicular maturation and ovulation can be inhibited by physiological, nutritive or social stresses. Work in Sri Lanka suggests that first parturition takes place at and around 10 years, making females mature at 8 years (Kurt 1974). From work in south India (Sukumar 1993) concludes that the earliest age of calving is between 12-13 but that the mean age at first calving is between 15–20 years. Basically reproductive rates are affected by several factors; quality and quantity of food supply (see next section), the presence and sex of a suckling calf and the age of the cow. A study in south India suggested a mean interval of 4.7 years with a range of 3-6.5 years (Sukumar 1993) and data from Amboseli on African elephants show a mean interval of 5 years (Moss 1983). However, captive elephants can commence reproductive cycles at younger ages (see Section 3.6).

Gestation is 20–22 months after which a single calf is born (Estes 1991). There is a low rate of twinning, around 2% (Douglas-Hamilton and Douglas-Hamilton 1975). For information on gestation periods in captive elephants see Section 3.6. Elephants are known to produce calves up to an advanced age but cows are reputed to exhibit menopause at the age of circa 55 years (Lee 1991a).

In the wild, bulls mature between 12-14 years. However puberty varies with environmental resources (Eltringham 1982) and whereas females produce their first calf some two or three years after their first ovulation males take some years to reach social maturity. Work on African elephants has shown that males are not able to compete successfully with oestrus females until about 25 years old (Poole 1989b).

SEASONALITY

The breeding season of elephants is not easily defined and months of conception vary from year to year. Elephants are not physiologically forced to breed seasonally. It appears that the better the rains the more likely cows are to conceive (Douglas-Hamilton and Douglas-Hamilton 1975). In both Murchison Falls and Tsavo conceptions were more likely to occur in wetter periods (Laws and Parker 1968). Most research in Asia has been carried out in Sri Lanka and south India where this observation has not been made (Nowak 1991) (Sukumar 1993) (McKay 1973) (Eisenberg and Lockhart 1972). However higher quality foods, usually available after rains, result in improved body condition and increase the likelihood of ovulation occurring (Lee 1991a) and it is likely that periods of nutritional stress decreases the likelihood of cows ovulating (Barnes 1984) and this may help explain the phenomenon that some years appear to have resulted in a very low number of conceptions (Sukumar 1993).

BIRTH AND DEVELOPMENT OF YOUNG

Average birth weight of new born African elephants is 120 kg (Laws and Parker 1968) and 91 kg in Asian (Lee 1991a). Females give birth within the family group and other females cluster around showing alloparenting behaviour. Two births in Amboseli have been described (Moss 1988), one to a primiparous female and the other to an older experienced female. The onset of birth was the appearance of a bulge below the tail. Birth is rapid. The primiparous female was agitated during the process and frequently scraped the ground with her forefeet. Other females may help remove the amniotic sac. Infants are unsteady on their feet, taking about 40 min to stand properly. The mother and other females use their forefeet and trunks to help infants stand; this unsteadiness remains for several weeks. Infants have to locate the teats between the mother's forelegs unaided and they suckle several times an hour for two to three minutes at a time. They gradually learn to use the trunk to collect food but are about four months old before they are really able to eat a significant amount of solid food. They also eat small quantities of older animals' dung which helps them acquire necessary microbes to aid digestion (Lee 1991a). Calves can be weaned at two years of age but usually suckle for four years or more. A female may allow an older calf to suckle at the same time as an infant (Douglas-Hamilton and Douglas-Hamilton 1975) but in Amboseli in two cases where an older sibling continued suckling, the calf died; the survival rate of twins was also low in Amboseli (Lee 1987). Cases of allosuckling have been observed but are very rare. The calf suckles and drinks using the mouth and has to learn how to use the trunk to feed and manipulate objects. The cow-calf bond is strong and it is thought that alliances of females in families may enhance calf survivorship (Lee 1987) and these alliances may have been perpetuated by the long term relationships between allomothers and calves. Males tend to leave the natal group at puberty but females remain for life, thus reciprocity in allomothering may play an important part in establishing the close relationships between females.

2.9 Behaviour and Social Organisation

Elephants have the greatest volume of cerebral cortex available for cognitive processing of terrestrial animal species (Hart *et al* 2001). This exceeds that of any primate species and therefore allows this long lived species to develop many skills and hold in memory information on conspecifics and the environment it inhabits.

ACTIVITY

Elephants spend about 16 hours a day feeding. They sleep four or five hours in 24, sometimes lying down thus, although primarily diurnal, they are active in the hours of darkness. Elephants perform remarkable movements and postures; they can roll, kneel, squat, sit on their haunches and climb up very steep slopes (Estes 1991). However they cannot run or jump but only walk at varying speeds.

SOCIAL ORGANISATION

The basic elephant social unit is a mother and her offspring. A family unit being a group of related females, consisting of a mother and young with her own mature daughters and offspring (Moss and Poole 1983). The matriarch, who will be the oldest, largest and possibly even post reproductive female, sets the activity, direction and rate of movement of the herd. The leadership and experience of the matriarch is thought to be of great importance and it has been suggested that there may be higher per capita reproductive success in groups led by older females due to their enhanced discriminatory abilities (McComb *et al* 2001). In Manyara the average size of a family unit was 10, these units grouped together to form larger kinship or 'bond' groups, which may consist of as many as 50 animals. When the number of elephants increases beyond a critical number a new matriarchy splits off but will remain as part of the same kinship or bond group. These kinship groups probably form part of a larger association, often termed 'clans', which would explain observations of gatherings of up to 100 animals or more (Eltringham 1982). The current suggestion for elephant social organisation is therefore a core group of a family unit, these units being further associated in bond groups. Bond groups are probably comprised of closely related individuals resulting from the fission of family groups. Bond groups come together in clans (of up to 55 animals in Amboseli), which combine to form sub-populations and thus the population of an area. Although most detailed work on social organisation is from African elephants, clans have also been identified in Asian elephants (Sukumar 1993) and families do split and come together (McKay 1973). Eisenberg suggests a range of 8-21 animals for bond groups in Sri Lanka, which may split into family units. A more recent study in Sri Lanka found bond groups of 22-58 animals which split into family groups comprised of between one and four reproducing females (Heine *et al* 2001). Data gathered by McKay in Sri Lanka shows a splitting of groups of females with young infants (a nursing unit) from groups with juveniles (a juvenile care unit), this seems to be because females with infants at heel associated more with other similar females; between these groups there is a degree of flexibility and interchange of individuals (Kurt 1974) (McKay 1973). In general herd sizes differ between populations, between wet and dry seasons, and between habitat types, e.g. desert elephants disperse over large areas in relatively small groups and probably rely on infrasound to communicate between groups (Lee 1991b).

The most detailed study of relatedness between animals in wild Asian elephants was carried out using mitochondrial DNA studies from dung of animals in Sri Lanka as well as direct observations (Fernando and Lande 2000). Four groups were observed in detail ranging in size from seven to 19 animals. There was a lower level of association between group members compared with African savannah animals and solitary ranging females were observed. The genetic analysis showed that all individuals within a social group shared the same mtDNA haplotype and that all these must have descended from a single female in the recent past. Groups with overlapping ranges maintained their maternal genetic identity, suggesting that females do not transfer between groups. However two groups which shared a haplotype had a greater overlap in their home ranges, but did not associate with each other. Smaller group sizes were found in the rain forest of Malaya and Sumatra (Eltringham 1982). Santiapillai and Supahman (1995) found group sizes of 4-8 animals in the forests of Way Kambas in Sumatra but larger aggregations of up to 45 animals were found in areas of grassland; however smaller groups were more common in the dry season. They compare this to group sizes observed by Oliver in Malaysia averaging five or six animals.

Less is known of the social organisation of African forest elephants but group size is much smaller, averaging 2.4 individuals. There, groups seem to consist of single mother family units (Turkalo and Fay 1995), with older males being solitary.

It appears therefore, from evidence to date, that elephants living in forest and woodland habitats may tend to split into smaller units more frequently than those in savannah and have less direct inter-group contact.

Male calves leave the family unit on reaching sexual maturity and join up with other males and may form bull herds which are very unstable in composition. Younger bulls may hang around the family units but older bulls spend little time with them and tend to be solitary. The home range of a cow herd is much larger than the area used by a given male, hence cow herds will pass through the home ranges of several different males. Data from Sri Lanka suggest that the nursing units may have smaller home ranges (Kurt 1974) (McKay 1973).

SEXUAL BEHAVIOUR

Female Asian elephants show a cycle length of 14-16 weeks and African females of 14 weeks (Oerke *et al* 2000). This is a relatively long oestrus cycle with a brief 1 week receptive period (Rasmussen and Schulte 1998). A considerable amount of research has taken place to obtain detailed information on the elephant ovarian cycle since early work in the 1980's (Plotka *et al* 1988) and this is reviewed (Hodges J.K. 1998). Female elephants advertise forthcoming ovulation to males by characteristic behaviour patterns which include: oestrus walk (head held high, eyes wide open and tail may be raised), chase, mounting and consort behaviour (Moss 1983); these patterns are shown for 2-6 days. Asian females also advertise a forthcoming ovulation by releasing (Z)-7-dodecenyl acetate in urine during the pre-ovulatory phase to signal to males of their readiness to mate (Rasmussen and Schulte 1998) (Rasmussen 2001), however this compound has not been found in African females (Riddle and Rasmussen 2001). Females also produce a unique vocalisation when in oestrus (Poole 1999) 'the oestrus call'. Thus females can communicate their reproductive state by olfactory, visual and auditory means.

Both Asian and African male elephants exhibit a condition known as musth. When in musth males have elevated levels of testosterone (Cooper *et al* 1990), aggression and reproductive activity (Poole and Moss 1981) (Poole *et al* 1984)

(Dickerman and Zachariah 1997) (Niemuller 1991). The discharge of fluid from the temporal gland increases and is continuous; the penis develops a greenish colouration and dribbles a mucous discharge; they also vocalize frequently. It has been shown that males emit volatile compounds from the temporal gland which may inform other bulls and cows of their condition (Rasmussen *et al* 1990) (Rasmussen 1997). There are many questions as to the function of musth (Wingate and Lasley 2001) and a suggestion that it may be a relatively recent phenomenon in the African species (Rasmussen *et al* 1990). In Amboseli no male under 24 years of age has been seen in musth and bouts of musth among individuals of the 25-35 age group are short and sporadic, while older males have longer bouts lasting several months (Poole 1989a). This work has also shown that the number of males in musth correlates closely with the number of oestrus females and is highest during the rainy season, when females are more likely to ovulate. Information from Sri Lanka (Kurt, pers com) and India (Desai and Johnsingh 1995) show that bulls over 20 years of age have longer musth periods and that bulls have individual periods of musth. Both Asian and African bulls settle into a regular cycle of musth with increasing age.

It has recently been demonstrated that the chemical composition of musth males changes with age in Asian elephants (Rasmussen *et al* 2002); youngest males (8-13 yrs) exhibited a honey like odour which changes to a more foul-smelling compound as animals mature (25-35 age group). Elephants can therefore distinguish between older and younger musth males.

It has been shown that females can distinguish, by olfaction, between musth and non-musth males and also that they are more responsive during the follicular stage of the oestrus cycle (Ganswindt *et al* 2005) (Schulte and Rasmussen 1999). Oestrus females enter into consortship with a musth male who guards her from copulatory attempts from lower ranking males. Females also prefer older musth males and males in musth rank above non-musth males in agonistic interactions (Poole 1989a). Thus in the Amboseli population, males did not complete successfully for females until they were 25 or older and large musth males of over 35 were more frequently seen guarding females mid-oestrus. Males may check the reproductive state of females by putting the trunk tip to the vulval opening and then inserting it in the mouth, the elephant equivalent of *flehmen*.

Copulation is rapid, the male mounts the female from the rear and mounting and copulation take on average 45 seconds (Estes 1991). Females may give a low frequency post-copulatory call (Poole 1989b).

COMMUNICATION

Elephants, being large brained highly social animals, have a complex repertoire of communication which includes touching, vocalising, olfaction and body postures. Elephants are tactile animals; family members lean on each other and frequently touch with the trunk. In a greeting ceremony the lower ranking animal inserts its trunk into the mouth of the other and trunks are held out to other animals as a greeting. The trunk is also the olfactory organ, picking up chemical signals from other elephants. Many postures are used in communication e.g. spreading the ears and holding them forward is normally a threat and various trunk movements may signify submissive behaviour (Langbauer 2000). Thus this combination of posture, vocalisations and olfaction provide sophisticated means of communication.

The infrasonic range of some elephant vocalisations, much of it below human hearing thresholds, was only recently discovered. Elephants make these calls in the larynx; there is a pharyngeal pouch between the tongue and above the epiglottis. The infrasonic calls have fundamental frequencies ranging from 14-34 Hz and sound pressure levels as high as 103 dB. Low frequency sounds are subject to little environmental attenuation, such that they can be audible to conspecifics several kilometres away, certainly as far as 2-4 km and perhaps further. Elephants make use of these calls for spatial coordination and in the search for mates (Langbauer 2000) (Poole *et al* 1988) (Langbauer *et al* 1991).

Elephants have four main sounds, (Estes 1991) but a great range of pitch and duration between each one. *Rumbling* is the main form of distance communication and covers a broad range of frequencies, many infrasonic. Quiet rumbles, audible to human ears, are uttered as a herd feeds. There are known to be over 27 different low-frequency rumbles (Poole 1999). Elephants *growl* when greeting and their voices are individually recognizable. An increase in volume becomes a *roar*, when elephants threaten predators or man. *Screaming* is used to intimidate opponents and is the adult equivalent of the juvenile distress call, the *squeal*. *Trumpeting* is the sound of excitement and is produced by blowing through the nostrils hard enough to cause the trunk to resonate, a long high amplitude squeak. It is usually combined with growling and screaming. Trumpeting ranges from an expression of alarm or a cry for help to a greeting.

The musth rumble is a rumble given only by males in musth and the oestrus call is a distinctive rumble given by females in oestrus, the latter being the same call that is given post copulation (Poole 1999). Males in musth are attracted by the oestrus call of females and females in oestrus by the call of musth males.

Recent work in Amboseli has shown that females can distinguish the infrasonic contact calls of female family and bond group members and estimated that the subjects would have to be familiar with the contact calls of 14 families (around 100 adult females) (McComb *et al* 2000).

Recently it has been postulated that the low frequency high amplitude vocalizations of elephants have a potential for long distance seismic transmission (Marchant 2001) (O'Connell-Rodwell *et al* 2000) (Hart *et al* 2001). Seismic waveforms from vocalisations are detectable up to distances of 16 km and up to 32 km for locomotion generated signals (e.g. foot stomp). This would explain phenomena like a thunderstorm in Angola triggering elephants in Namibia to move north and an elephant cull leaving a herd 50 km away tense and agitated (Marchant 2001). Histology of the trunk-tip suggests that it is specialised to pick up vibrations and it is possible that elephants can also pick up vibrations through the feet (Marchant 2001). However there is still some doubt as to the validity of these ideas although it remains a fascinating possibility (Langbauer 2000). Another possible communication channel is the recently discovered ear discharge from African elephants which may have a function in olfactory communication (Riddle *et al* 2000).

PLAY

Play in young includes head to head sparring and trunk wrestling, mounting, charging and rolling. Calves tend to play with others close to them in age and calves over six months of age may form play-groups (Eisenberg and Lockhart 1972). Females, particularly juveniles, frequently play with young calves.

PREDATOR PROTECTION

Although adult elephants are immune from most predators (except humans) elephant calves are subject to predation from lions, tigers and hyenas. Elephants exhibit group defence against potential predators, with young animals being protected by adults. The herd may form a cluster with adults facing the source of danger (Eisenberg and Lockhart 1972). Disturbed elephants may perform displacement behaviour in between threat displays. Cows with small calves are more likely to charge and calf distress is responded to by the mother and other members of the family. Adolescent and juvenile females play an important role in protecting calves; this has been shown to be important in calf survival as mortality in the first 24 months is higher in calves born into families with no allomothers (Lee 1987).

TOOL USE

Elephants exhibit tool use. In the wild this can range from using grass to rub on the body to scratching the body using a stick (Chevalier-Skolnikoff and Liska 1993). There are also reports of elephants using branches as fly switches (Hart and Hart 1994) and of modifying an unsuitable branch so that it became a useful switch (Hart *et al* 2001). This has been observed in both wild and captive animals. Elephants have been observed to use tools in various contexts which can be identified as: skin care, feeding and drinking, threat and aggression, rest and sleep and social interactions (Kurt and Hartl 1995) and types and variety in use increases with age.

SECTION 3: MANAGEMENT IN CAPTIVITY

3.1 Elephants and Man

Because of its long association with man, it seems appropriate to include something of the history of this relationship. The relationship extends to pre-history. Pictures of elephant and mammoths are found in ancient cave paintings of many cultures (Eltringham 1982). Hinduism has as a deity (of wisdom) Ganesha, who is depicted as elephant-headed. Indian chronicles mention the elephant 4000 years ago and it was used in the time of the Lord Buddha. A white elephant appeared to his mother Queen Maya to announce the birth of a royal world-ruler; the Buddha could be spoken of as the Great Elephant in one of his incarnations. In Siam (Thailand) the white elephant was thought to have a king's soul. The elephant has a long history of ceremonial use (Carrington 1962) and is still used as such in many Asian countries (Eltringham 1982)

It is thought that humans began domestication of Asian elephants some 4000-5000 years ago in the Indus valley (Carrington 1962). By 700 BC the elephant is mentioned as an animal that is captured and tamed (Fernando 1989). Aristotle also refers to capturing elephants in his *Historia Animalium* (4th century BC). Methods of capture are described well by (Carrington 1962) (Fernando 1989; Menageries 1831). Elephants were traded throughout Asia; animals from Sri Lanka were traded widely from the 3rd century, later by the Portuguese in the 17th century and the Dutch and British from the 18th century. Large numbers of animals were moved over national borders, between India and Sri Lanka, and Myanmar to Sri Lanka and Bengal. This all contributed to the mixing of genetic material among elephants in Asia (Fleischer *et al* 2001).

Elephants were used in warfare; Alexander the Great used them after encountering elephants in used in warfare in India. The most famous military use was in 218 BC when Hannibal crossed the Alps with elephants, perhaps of both African and Asian origin, fighting the Romans in the second Punic war. Kublai Khan had a large wooden castle borne on the backs of four elephants; within the 'castle' were cross-bow men and archers. Elephants have also been trained to assist in executions, and even perform them.

The most useful role that elephants have played in their relationship with man is as beasts of burden. Although not good at carrying heavy loads (up to about 300 kg) it is a magnificent hauler and can easily pull a two tonne log. It is for this reason that teams of elephants have been used for centuries in the logging industry, although their use has significantly declined with the advent of modern machinery. However, there is now a demand from the tourist industry in Asia, as they are an excellent means of taking tourists on safari trips around wildlife parks, a practice which may involve over-working of the animals at the height of the season.

Most use and training of elephants as working animals is and has been in Asia and the Asian elephant is frequently referred to as 'domesticated'. However, most of the animals have been wild caught and most breeding is from matings between domestic cows and wild bulls. Working elephants have not been the subject of sustained captive breeding, nor have they been selected for particular characteristics. It is therefore inaccurate to refer to the Asian elephant as a domesticated species. African elephants have a reputation of being more difficult to train than Asian (Mellen and Ellis 1996) however elephants have been trained to work in what is now the Democratic Republic of Congo since Belgium colonial times (Bridges 1947) (Hillman Smith 1992) (Wager 1954) (Caldwell 1927) and are still used in the Garamba National Park (Hillman Smith 1992).

Man has hunted the elephant since prehistoric times; it is known that stone-age man hunted the mammoth, mainly for use of meat and skin. More primitive methods involved pit traps, poisoned arrows, harpoons and even swords, but it was the advent of the rifle that heralded the start of the serious decline of elephant populations. Elephant carcasses are put to many uses: food, oil, hair is made into bracelets and the skin can be manufactured into many objects from shields to clothing and furniture. Elephants became extinct in Syria in the first millennium BC due to excessive hunting. From the first days of civilization ivory has been in great demand. It is mentioned in the Bible and was much treasured in ancient Greece and Rome, its consumption in Europe was enormous. The Menageries (1831) quote 364,784 lbs of ivory being imported into England in 1827, representing at the very minimum, the deaths of 3,040 elephants. More recent is the advent of sport hunting, with licences being sold to hunters (Redmond 1996) and this forms part of the ongoing debate over sustainable use of elephants in some African countries.

Not only has man hunted the elephant, he has used it as a means of transport to hunt other animals, notably in magnificent hunting expeditions by Indian princes, when hundreds of elephants could be used. All animals were targeted from antelope to leopard, buffalo and tiger, although the elephant was most frequently employed in India in tiger hunts [Menageries 1931 #30] and there are several accounts of tigers fighting back and attacking the transporting elephant.

Assurnasirpal II (King of Assyria) established a zoo in the ninth century BC with elephants he had captured in Syria; Alexander the Great kept elephants in the Macedonian court. However it was the Romans that started to use elephants in the amphitheatre as circus performers. They fought each other, bulls and even armed men. Elephant baiting was also a popular sport in India and other Asian countries as was elephant / tiger and lion fights (Carrington 1962; Menageries 1831). In Roman times they were also taught to perform and even to throw arrows and walk on tight-ropes. Both Caeser and Claudius are reputed to have brought elephants to England (Menageries 1831). The first elephant to reach England since Roman times was in the 13th century, as mentioned in the Introduction but it was not until the 16th century that elephants became more common in western Europe; notable animals were the one at Clerkenwell Green in London in the mid 17th century and the one burnt to death in Dublin around the same time. By the nineteenth century they were a familiar sight in zoos and, when the menagerie in the Tower was closed, an elephant from there was passed on to the newly formed collection in Regent's Park, which opened in 1829. The first Asian elephant was brought to North

America in 1796 and the first African in 1804 (Schulte 2000). In those times elephants moved frequently between zoos and circuses and were routinely trained to perform tricks, various characters having made the annuls of animal history (Eltringham 1982) (Carrington 1962; Menageries 1831). Zoos were very much consumers of elephants and an interesting account of the capture of African forest elephants for the Bronx Zoo in 1946 is given by William Bridges. This is of particular interest as the elephants came from the then Belgium Congo (now DRC) which was the only African country to train and domesticate elephants in recent times (Bridges 1947).

Currently captive management of elephants in India comes under four categories (Krishnamurthy 1998);

- In logging camps maintained by state forestry departments: working elephants, particularly logging. Some provide extensive environments for their animals and welfare is good and the animal's breed (Kurt 1995).
- In zoological parks: the Central Zoo Authority of India sets husbandry standards.
- In temples: these tend to be tethered and fed a monotonous diet and do not have regular health care.
- Under private ownership: this constitutes the majority of captive elephants and they may change hands frequently.

An elephant welfare association has recently formed in India and has published a handbook for mahouts and organises training programmes (Namboodiri 1997).

Until recently few elephants were bred in zoos, mainly because bulls were rarely kept. Elephants have been bred infrequently in circuses, the first recorded birth in the USA being in 1880. European zoos which bred elephants in the early years of the 20th century were Vienna (in 1906), Berlin and Copenhagen. By 1931 only nine animals had been born in European collections, three of those in Copenhagen (Crandall 1964). The first African birth was in Munich in 1943. The first accounts of handrearing were from Rome zoo in 1948 and 1950. Using data from the International Zoo Yearbook, in 1982, it was estimated that 150 collections exhibited 500 elephants and of these only 30 had been captive born in the previous 10 years of which 21 had survived; not a record for zoos to be proud of (Wait 1983). From the mid 1980s zoos started taking elephant breeding more seriously and information on this is provided in subsequent sections.

3.2 General Guidance on Health and Welfare in Captivity

Animal welfare is notoriously difficult to define (Broom 1996) (Fraser *et al* 1997) (Stafleu *et al* 1996) and to measure as it is often about states of mind such as 'suffering' or 'contentment' (Mason and Veasey 2009). It is also difficult to measure in that it is difficult to assess the relative qualitative and quantitative comparisons of two different environments (Mason and Mendl 1993). One definition commonly used is that of Broom where the welfare of an animal is defined as *its state as regards its attempts to cope with its environmen*t. This *state* includes its health, physical and mental states and biological fitness. Good animal welfare implies both fitness and a sense of well-being and the animal MUST be protected from unnecessary suffering. The captive environment may be markedly different from that in which the species evolved. For example in the wild elephants may spend up to 16 hours a day feeding, but in captivity this may be compressed to a much shorter time scale. This difference in feeding time between the captive and wild state requires a *coping* response. The degree of difference between the two regimes in terms of time budgeting could be considered to be an indicator of the extent to which an individual animal's welfare may be compromised.

Welfare can also be defined as a state in which an animal can fulfil its needs/wants (Stafleu *et al* 1996), these may be biological or physical, the fulfilment of which is necessary to cope with the environment and cognitive needs are sometimes included in this. However, only certain behaviour represents what can be described as a need, i.e. that which, when not expressed by the animal, results in suffering. For example foraging (i.e. feeding) behaviour can be considered as a need, in that it has a high survival value and is driven by an almost omnipresent stimulus to feed. Since different species allocate different amounts of time to feeding, the extent to which an animal suffers due to the non-performance of this behaviour will vary. This means that a snake, which hunts infrequently, if denied the opportunity to hunt, will suffer less than a pig denied the opportunity to forage (Appleby 1999). Thus animals like elephants, although they are provided with sufficient food in a nutritional sense, may not be provided with sufficient as regards time spent feeding (Shepherdson 1999). Anti-predator behaviour (e.g. escape responses), on the other hand, has a high survival value but is probably not a need as it is only expressed when the stimulus of a predator is present.

Welfare relates to an animal's affective or emotional state (Mason and Veasey 2009) – its well-being (see (Brown *et al* 2008). Good welfare means positive emotional states and poor welfare invovles prolonged suffering (see (Mason and Mendl 1993), (Brown *et al* 2008)). (Mason and Veasey 2009) state that welfare is not simply equal to health, nor genetic fitness, nor should all aspects of life in the wild be mimicked and that death should be differentiated from welfare.

Zoos should strive to provide an environment in which captive elephants are required to make the least effort in order to cope which can be achieved by providing for the expression of their behavioural needs (Poole and Taylor 1999) (and see Section 3.5, Elephant Behaviour and Captivity). At the very least, the five principles listed in the Secretary of State's Standards on Modern Zoo Practice (SSSMZP) should be followed:

Provision of Food and Water

Although an animal may be given sufficient calories and nutrients, if it is given them in concentrated form, it may still suffer from feelings of hunger and a lack of foraging opportunities. Consequently attempts MUST be made to closely match feeding activity seen in the wild. For elephants this can be achieved by providing poorer quality food (nutritionally) and increasing the intake time.

Provision of a Suitable Environment

The animal's environment should be maintained so that physical distress is avoided. Management practices MUST not predispose animals to injury or strain.

Provision of Animal Healthcare

Every attempt should be made to ensure the animal's physical well-being is maintained. Management practices, which may compromise physical well-being in terms of injury or disease risk, should be avoided. Thus rather than merely treating foot problems, which requires training, zoos MUST develop environments in which foot problems are unlikely to occur.

Provision of Opportunity to Express Most Normal Behaviour

Attempts should be made to identify which aspects of behaviour are important to the elephant, and subsequently to provide for the expression of these as far as possible. Attempts should also be made to provide animals with some choice and control over the way in which they spend their time. Reference to wild time-budgets will be required.

Provision of Protection from Fear and Distress

Every attempt should be made to ensure that fear is not a significant part of the life of elephants in captivity. Thus the role of fear in training should be minimised and training which might cause a fearful response should only be used if there is a proven net benefit to the animal's welfare.

MEASURING ELEPHANT WELFARE

Attempts to measure welfare can be made using indicators such as adrenal activity, activity levels, levels of stereotypy, degree of immune-suppression, severity of injury, reproductive output, level of disease prevalence, mortality rate etc. Athough these measurements are often impractical and difficult to interpret (Mason and Mendl 1993), two recent studies have used stereotypy, activity levels, adrenocortisol levels (Harris *et al* 2008) and reproductive output and mortality data (Clubb *et al* 2008) (Clubb *et al.* 2009) to assess welfare of zoo elephants.

(Mason and Veasey 2009) reviewed the techniques available and discussed them in terms of assessing welfare for elephants. They concluded that there are methods that are not commonly used in zoos, let alone on elephants, that would be helpful for assessing elephant welfare: measures of preference/avoidance; displacement movements; vocal/postural signals of affective (emotional) state; startle/vigilance; apathy; salivary and urinary epinephrine; female acyclity; infant mortality rates; skin/foot infections;cardio-vascular disease; and premature adult death, operant responding and place preference tests; intention and vacuum movements; fear/stress pheromone release; cognitive biases; heart rate, pupil dilation and blood pressure; corticosteroid assay from hair, especially tail-hairs (to access endocrine events up to a year ago); adrenal hypertrophy; male infertility; prolactinemia; and immunological changes. They state that no one indices will determine elephant welfare but a range of carefully chosen, complimentary indices, will reduce the risk of confounds.

Further information on behaviour and the captive environment is provided in Section 3.5. In order for new enclosures and management changes to ensure better elephant welfare, decisions need to be evidence based, it is imperative that welfare indicies such as those mentioned above are validated, refined and used (Mason and Veasey 2009).

It is therefore useful to have guidance on how to judge welfare, so that better management practices can be developed without relying on the absolute need to prove whether or not suffering is present. For this,

3.3 The Captive Environment

The welfare of elephants is to a large extent dependant on the size and furnishing of the enclosure, the composition of the group and the establishment of enrichment protocols. Various guidelines are available (AZA 2001) (Olson *et al* 1994) and the Federal Office for Nature Conservation in Germany also issue guidelines; this section is designed to provide guidance for a satisfactory enclosure and group composition that allows for modern elephant management. It is important to note that standards listed are the MINIMUM mandatory standards required by members; the word **MUST** is used for each of these. Members who did not comply with these in 2002 had a minimum period of five years from 2002 within which so to do. In 2007, all members were audited to determine compliance with the 2nd edition of the guidelines (see Section 6.8 Appendix 8). Overall there was 88% compliance (Field & Plumb 2007). Targets and plans submitted with the audit indicate that by the end of 2008, the compliance would reach 94%.

3.3.1 Social Structure

Elephants are one of the most social mammals and this should be borne in mind when managing them in captivity. Zoos **MUST** maintain elephants in as appropriate a social group as possible so that welfare needs, education and conservation potential can all be fully realised. The best way to achieve this is to replicate the social organisation seen in the wild. The broad similarity between the social organisation of African and Asian elephants means that management recommendations for the social environment is essentially the same for both species, however Asian and African animals **MUST** not be mixed in the same social grouping to reduce the risk of disease being spread between populations.

There is a need for the maintenance of appropriate social units not only for welfare and educational grounds but also for conservation. Conservation does not merely entail the preservation of genetic diversity, which, arguably, could be carried out far more cheaply in cryo-preserved gene banks, but **MUST** provide for the preservation of 'cultural' and learnt elements of an animals natural behaviour. In elephants, as in the great apes, much of their behavioural repertoire is learnt rather than innate; so that to truly ‘conserve’, as opposed to ‘preserve’, elephants in captivity as many naturally learnt behaviours and cultural elements should be maintained as possible.

COWS

As the basic social unit of the elephant is the family unit (see Section 2.9), zoos **MUST** establish stable, female groups, preferably of related animals, in order to replicate the wild state. Thus zoos **MUST** strive to keep a minimum group size of four compatible cows older than two years[1]. Zoos **SHOULD STRIVE** to ensure that for not less than 16 hours in any given 24 hour period, save in exceptional circumstances, compatible females have unrestricted access to each other. Thus whilst elephant facilities **MUST** retain the potential to separate elephants as required, routine and prolonged separation of compatible cows **MUST** not be practised. Separation is taken to include any barrier which restricts complete physical access. Facilities which have compatibility issues, such that individual cows are kept separated for prolonged periods of time, **MUST** ensure that these situations are resolved expediently. In these circumstances, the removal of individual elephants may be justified.

Particular care should be taken when leaving elephant groups unattended, particularly in houses. An objective assessment of risk of injury **MUST** be undertaken before giving unrestricted access to the house and each other for the first time. Staff should monitor the animals and be available to intervene if required and safe to do so.

Cows should be reviewed as to whether they should go into protected contact. Once an animal has physically challenged a keeper it **MUST** be put into protected contact until a full review of the situation surrounding the attack has been carried out. After this review, if the decision is to put the cow back to a free contact situation this **MUST** be fully justified in combination with renewed risk assessments.

The benefits of keeping cows in an integrated way are described below:

Animal Welfare. The nature of the bonds demonstrated between females within a group suggest that there are significant evolutionary and emotional benefits to the animals in developing and maintaining these relationships and that separation will inevitably be stressful. Moreover, social interactions are likely to be the most sustainable form of environmental enrichment for captive elephants.

Learning. Family groups are vital for the appropriate socialisation of young elephants of both sexes. The degree to which animals learn from the matriarch cannot be overstated. Many problems found in captive elephants relating to reproduction and aggression both to other elephants and keepers, are likely to be the result of poor social development. An example is the learning of relative strengths of individuals of differing sizes through play,

[1] This section was clarified in 2nd edition.

which allows individuals to more effectively assess and subsequently moderate interactions.

Decreased social tension. An increased level of relatedness is likely to be highly significant in promoting harmony and co-operation within a group.

Increased reproductive potential. It has been shown that there will be an increased success rate in calving if cows are given the opportunity to witness births in a captive environment (Olson 2004).

Increased education potential. The benefits of seeing family units with elephants of all ages, in comparison to single individuals cannot be overstated.

It is therefore recommended that, in zoos that are successfully breeding elephants, the herd is allowed to grow to a point where it is necessary to reduce its size only because of the physical limitations of the zoo or because the herd has reached a social 'critical mass'. Such an upper limit will depend on the nature of the individuals within the group, however a number of five to ten animals is realistic. If a reduction in herd size does become necessary then compatible female pairs (or preferably trios or more) should be moved together to other facilities in accordance with EEP recommendation.

Given the history of elephants in European zoos, it will take some time for matriarchal herds to become the norm. In the mean time, it is necessary for some collections to specialise as 'retirement homes' for keeping unrelated, non reproductive, often older females that do form part of a herd. All the MUSTS listed above are still relevant (strive to ensure they have unrestricted access to each other for at least 16 out of 24 hours and make every effort to provide a situation where they are compatible, stable group) with the exception of having four cows.

BULLS[1]

The management of bulls within zoos is a growing concern as breeding produces more bulls than there are facilities. This problem is likely to continue, as even if artificial insemination (A.I.) were to be practised more widely, sperm donors would still be needed, and more importantly, bull calves still produced. The EEP recommendation (section 3.6) **MUST** be adhered to. With their volatile temperaments, immense strength and social complexities, the keeping of a large number of bulls in captivity needs to be addressed long before the facilities are actually needed (see bachelor herds below).

In the wild, bulls typically grow up within their maternal herd until such time as they leave (around the time of puberty) either voluntarily or are driven out by the cows. They will remain close by and form loose bachelor herds with some kind of hierarchy which is dependant on regular, if infrequent, contact. Bulls perhaps have more contact with the cows than they have reputation for. (Nowak 1991) states Asian bulls spend 30% of their time with the herd. In the wild, males typically become mature at 25 years.

[1] This section has been re-written

It captivity, the different limitations mean that bulls exhibit musth-like behaviours earlier (Hildebrandt *et al.* 2006) and generally elephants behave differently. Comparisons to wild behaviours and time budgets may not be directly applicable. It appears that flexibility within a facility is key and being given the option of more contact with the herd would be a good thing. Much more research is needed in this area.

Running bulls with the cow herd

Those collections where the bull is run regularly with the cow herd suggest that the bulls, females and calves in captivity benefit from social interactions with one another (and see (Sukumar 2003)). Previous experience of seeing male/female interaction has shown to improve conception rates (Freeman *et al* 2004; Kurt and Hartl 1995; Olson 1994; Olson *et al* 1994).

Bull calves in particular appear to enjoy an adult bull's company, 'hero worshiping' them (Sheldrick 2009) and there is some suggestion that rearing bulls in the presence of an adult bull minimizes aggressive behaviours (Schulte 2000) (Olson 1994). (Hildebrandt *et al.* 2006) demonstrate the early onset of sexual maturity in captive bulls without the presence of an adult bull; successful siring has been seen in six year old Asian and eight year old African bulls compared to 25 years in the wild. (Hildebrandt *et al* 2000) found a huge variance in sperm motility, from 0-90%, in bulls that were dominated by female elephants, keepers or other bulls. This data has enormous implications for management and breeding of elephants in captivity.

African bull elephants in zero or protected management tend to be run with the herd every day and even for 24 hours when they have access to outside enclosure. Asian elephants on the whole are given less access. Some bulls are only run with oestrus cows, others with the whole herd when a cow is in oestrus and others run with the herd regularly irrespective of the oestrus status of the cows. The temperament of the bull, the cows and the calves is an important factor in deciding whether the bull is run with the herd and for how long. Decisions are not taken lightly as there are few tools available to separate elephants should anything go wrong.

There have three recent cases in the UK where adolescent/young adult bulls were mixed with a mature bull and the cow herd, (two Asian, one African). Although no collection did this by design, no serious problems occurred (probably down to the temperament of the individuals involved) and all suggested the situation benefitted all the elephants involved. However, orchestrating this situation would be very difficult. It may be that these collections had the right animal. As more bulls are brought up in a herd situation and so know how to behave in a social environment, the mixing of adolescent bulls, cow herds and mature bulls may become more common. It is too early to tell what the effect of this management practice is, but it is felt to be a step forward.

Asian bulls in musth tend to be aggressive and intolerant towards keepers and so an animal is deemed unmanageable. Few Asian bulls therefore are run with the herd when in musth so it is unknown whether this intolerance and aggression extends to other members of the herd. On the other hand, African bulls are routinely mixed with the herd, irrespective of his musth status. It is unknown whether this difference in management is a genuine species difference in levels of aggression during musth or due historic and present differences management regimes and enclosure types.

The decision to mix bulls with the herd will depend on the bull and his relation with the cows in the herd and exhibit flexibility, but it could be that he is manageable, if unapproachable by keepers, when in musth. In the wild, musth is accompanied by increased bouts of travel and greater interest in females (Schulte 2000) and further confinement in captivity during this period may result in heightened frustration and an increase in unresponsiveness (Harris *et al* 2008).However, the enclosure needs to be designed so staff, visitors and other animals are not hurt when/if the bull started to throw heavy objects.

Bachelor herds

As breeding becomes more successful the ratio of bulls to cows will increase in the long term (Wiese and Willis 2004). Currently, the number of facilities for cows far out numbers the available facilities for bulls.

Keeping bulls in bachelor herds in zoos capable of providing enough space is one such solution but the feasibility has not been fully explored. It is thought that to provide adequate facilities for a bachelor herd, that a large, complex area is needed. Environmental complexity, brought about through topography, vegetation, physical separation etc. would enable the bulls to have close contact and avoid each other when desired (Veasey 2006).

A facility in Spain has brought together adolescent bulls in a large area with some success. However, a facility full of mature males has yet to be tested and (Sheldrick 2009) has seen problems with bulls of similar age, rank and tusk size. Facilities of mixed age bulls that have formed a hierarchy and the (temporary?) removal of bulls for breeding from these facilities may be a solution but has yet to be tested.

Housing for bulls

A bull during musth may show behaviour that makes him difficult to manage so zoos should be prepared to house difficult bulls. To that end, all bulls **MUST** be maintained in such a way that they can be separated from females and other males. However, it is not acceptable to keep bulls in physical and social isolation until required for breeding. The more of the facility that is bull proof, the more flexible a collection can be in managing their elephants. All collections keeping bulls **MUST** have the facility to carry out any essential veterinary procedure in such a way that is safe for all staff and the elephant concerned (e.g. Elephant Restraint Device). New facilities **MUST** be built in consideration of EEP guidance, to accommodate both bulls and cows. For enclosure details, see Section 3.3.2: Enclosure.

a) Accommodation away from the females’ barn

Separate bull houses have been built to reduce the aggression within the herd when indoors and to better manage the bulls. Keeping them away from the cow herd and public makes them easier to manage during musth when they are often less tolerant, uncooperative and unapproachable. In addition, separation reduces the anxiety of cows that are not comfortable with the presence of males, though this may be a factor of upbringing.

b) Accommodation in same barn as the females

Bull pens in the same barn as the cow herd enable the opportunity for olfactory and auditory contact and social interaction to be available to the animals day and night. If the whole facility is bull-proof, greater flexibility is available and potentially the bull could be run with the herd 24 hours a day. African elephants are routinely run with the herd during musth but not Asians. It is not known whether this is a real species difference.

All collections keeping bulls **MUST** ensure that staff are adequately trained (see Section 3.8).

FIG. 6: ASIAN BULL ELEPHANT ASLEEP ON A DEEP SAND FLOOR OUTDOOR ENCLOSURE

CALVES[1]

It is important that calves are brought up in a herd nucleus. Calves have a long learning period and socialisation with other elephants is crucial. Efforts therefore should be made to integrate hand-reared animals back to the group as soon as possible. Females need to learn calf care, and the presence of young animal in the group benefits all its members. Depending on the management system, some calf training may take place.

Young cows become greatly involved in herd life and will nurture the younger calves. Bull calves are more independent, competitive, mischievous and adventurous, wrestling with one another and are generally rougher and more 'unruly' (Sheldrick 2009). Cows should always stay with their maternal herd while bulls will leave when his residency is no longer tolerated. This is typically when he has reached adolescence; as young as three or as old as eight or nine. This age will vary with individuals, herd structure and facilities – see section BULLS above. From the age of four, regular updates of a bull's profile and a six monthly review **MUST** take place in combination with a risk assessment as the character of individual bulls will largely determine how they can be managed. At some stage bulls should be managed in protected or no contact (See Section 3.8.2: Elephant Management Systems).

FIG. 7: ELEPHANTS SLEEPING LYING DOWN ON A SAND FLOOR AT DUBLIN ZOO

[1] This section has been re-written

NOCTURNAL BEHAVIOUR[1]

Elephants continue to be active after the public and keeping staff have left. Research has shown that elephants are most active between 1800 and 2400 and 0600 and 0700, exhibiting the normal social repertoire, social interactions and feeding behaviour. In general, observations show that animals are active and eat for more than 50% of the 'nocturnal' period (Brockett *et al* 1999) (Weisz *et al* 2000) (Harris *et al* 2008). These observations, hardly surprisingly, demonstrate that captive elephants are active for around the same period in captivity as in the wild (i.e. sleeping for a maximum of five hours in 24). (Harris *et al* 2008) found that the percentage of time spent stereotyping more than doubled during the night compared to during the day for a number of individuals and those with large outdoor enclosures stereotyped more than others when inside at night, indicating that indoor enclosures or night time husbandry were unsuitable for those animals. To enable elephants to have access to the outdoors, outdoor enclosures may need to be modified with windbreaks, shelters, mounds and non-compacted sand floors to enable elephants to lie down. Research is needed (with thermal imaging) to identify how elephants might react to temperature fluctuations to give an insight in to how enclosures might be designed to address an elephant's nocturnal needs.

Thus zoos **MUST** strive to keep animals in unrestricted social groupings at night (see section on cows above) and provided with sufficient enrichment and access to food. It has been demonstrated that elephants benefit considerably from having 24 hour access to the outside area (Priest *et al* 1994) (Harris *et al* 2008) (and see Section 3.3.2) and zoos **MUST** strive to provide conditions that allow elephants this choice consistent with welfare and safety consideration. Lighting **MUST** be on dimmer control so that a low light level can be provided when required (3.3.2) and there **MUST** be a means of providing food during the night (see Section 3.4) ultimately in both the indoor and outdoor exhibit.

A better idea of how elephants behave when the keepers are not around is needed. To this end, observation cameras, which can record nocturnal behaviour, **MUST** be fitted.

GENERAL

As far as possible, elephants, especially females, should be maintained in social contact with other elephants. Husbandry regimes entailing separation **MUST** be rigorously justified and approved at the highest of levels within the collection.

Sufficient time **MUST** be set aside for elephants to interact naturally within groups during the daily routine. Although the time spent by keepers with elephants can be mutually beneficial, it is inevitably on the keepers' terms and cannot be regarded as a proper substitute for elephant to elephant interactions. Freedom of choice and control are widely accepted by welfare

[1] Guidelines on nocturnal management have been updated in 2009

scientists as critical aspects of animal welfare, as are ability to express species-specific behaviours and interactions.

FIG. 8: HIGH HANGING HAY NEST ENSURE LONGER TIME FEEDING WHILE ZOO IS CLOSED

3.3.2 Enclosure

When looking at enclosure design, there is much more to a good outside area than just size. The indoor and outdoor environment **MUST** be positively challenging to the animals and should contain devices and structures which enrich the environment and encourage natural behaviour All elephants **MUST** have indoor and outdoor facilities and, when weather conditions allow, they should have reasonable access to both over a 24 hour period (i.e. the animals should not be shut in overnight under normal circumstances, see Nocturnal Behaviour section, above.). Enclosure design should take in to account social, physical and behavioural needs of elephants and the need to medically manage them. In particular, the ability to take bloods from calves of all ages, the need to increase the foraging time, particularly at night, increase activity and encourage elephants to move as much as possible. Tools in which to enable this (see Section 3.5: ENRICHED ENVIRONMENT) should be included with the original design of an enclosure, not as an after thought. Both enclosures **MUST** be designed to ensure that absolutely no physical contact is possible between public and elephant.

INDOOR[1]

It should be noted that these areas are **minimal** and zoos should strive to provide larger areas. It should also be noted that facilities should be striving to move away from concrete enclosures.

The indoor space for the cow herd **MUST** allow 200 sq.m for four animals and should increase by 80[2] sq. m. for each additional animal over two years of age (n.b. the minimum herd size is taken as four females over two years of age). Research (Harris *et al* 2008) has shown that elephants with 40-80 sq.m per elephant showed significantly less stereotypic behaviour than those with less space.

Since it has to be the objective of every collection to manage compatible herds, the housing **MUST** reflect this desire, and facilitate its fulfilment. The inside area therefore **MUST** be designed for such a herd, ensuring the elephants can move freely as a group and be able to move, turn and lie down. Separation and isolation facilities i.e. separate pens, **MUST** be available to allow veterinary and behavioural management such as maternity areas for cows and calves as required. For example, separate pens may be composed of moveable barriers which can be brought in to use when necessary. Institutions holding breeding females should provide facilities for holding bulls, whether for breeding bulls or young animals growing up in a herd. AI techniques should not be considered as an opt out for holding bulls.

The minimum indoor stall size for a bull **MUST** be at least 80[2] sq. m. Verticle dimensions should be planned around the fact that a mature bull animal can reach vertically up to six metres. Ceilings, plumbing and all electrical installations must be out of reach.

The inside temperature **MUST** be no less than [3]16 ^{O}C and there **MUST** be an area capable of maintaining a temperature of at least 21 ^{O}C for sick or debilitated animals (There may be cases that require higher environmental temperatures following veterinary advice). Indoor areas **MUST** be well ventilated but at low velocity to avoid drafts. Areas should be well lit with a gradient. Fluorescent lighting spectrum is acceptable but skylights are highly recommended. Lighting should not suddenly go from bright light to darkness but fade gradually. Thus a facility for dimming lighting should be present.

All collections have to manage the health and welfare of their elephants in a manner that is safe and effective for all concerned. Restraint chutes (ERD) are widely accepted as being a significant asset to that end. Chaining rings, if used, should be placed carefully and only used when necessary, e.g. for training and veterinary purposes; elephants **MUST** not be routinely chained for periods in excess of three out of 24 hours (and see SOP on The Use of Chains or Shackles on Elephants).

Standing water can cause foot problems and be contaminated with pathogens (see Medical Management 3.15.4: MUSCULOSKELETAL SYSTEM). Floors

[1] Updated in 2009
[2] Note this has increased
[3] Increased from 15ºC to come in to line with (Kane *et al* 2009)

should be quick drying and well drained, relatively smooth but not slippery and not rough enough to traumatise feet and which can be readily cleaned and disinfected. They should also have a degree of 'give' so that elephants can lie down comfortably. A range of materials is currently used e.g. wood, sand bricks, concrete or other rot-proof material (such as epoxy or rubberised coatings). Concrete has caused problems for elephants' feet (e.g. constant wear and uneven pressure) and joints (e.g. arthritis) over the years so new enclosures have looked to other substrates. Recent experiences using sand in indoor areas suggest that this may provide a good substrate (see Sand Floors below). If creating a new enclosure then a variety of substrates should be provided so that the elephants have the choice. The flooring should have properties that include insulation, so that the floor remains warm. Flooring such as earth, deep-litter and rubberised materials have still to be experimented with.

FIG. 9: REMINANTS OF RUBBERISED FLOORING LAID ON TOP OF CONCRETE

An adult elephant can discharge 50 litres of urine in 24 hours, which normally is slightly acidic and may contain a large amount of crystals, much of which is calcium carbonate. Good drainage and a daily hygiene routine **MUST** also provide for frequent removal of manure; this will assist with sanitation and aesthetics. If animals are washed, warm water should be used in the cold winter months.

Feed troughs need to be designed for filling and cleaning from outside the enclosure. There should be high-level feeders for hay and browse. Animals **MUST** have access to drinking water from the indoor area as well as the outdoor area and troughs should be cleaned daily. Ideally drinking water in indoor areas should be warm and if possible consumption should be monitored.

Adequate food storage areas **MUST** be in place allowing separation of fruit, vegetables, dry foods, hay etc. There **MUST** be a sink and washable work surfaces.

SAND FLOORS[1]

The use of sand floors in part of an enclosure has not been fully investigated but evidence from those collections that implement a management regime that includes managing the sand floor is very promising. Enclosures that do not use the right sand, the right underlying structure, an adequate depth, do not wash and turn the top layer over daily appear to have encountered problems.

FIG. 10: INDOOR ENCLOSURE AT CHESTER ZOO

Therefore it is important to note that sand floors need to carefully managed if they are to be used as a successful substrate for elephant enclosures. If done so correctly, sand floors have shown promising results.

[1] This section has been added in 2009

FIG 11: URINE DRAINS AWAY INTO SAND FLOORS IMMEDIATELY

Improved health of the soles nails and skin of the foot have been seen as shown by the notable decrease in amount of active foot care needed. Good drainage offered by a sand floor eliminates elephants standing or lying in residual water, urine or wet faeces. This has huge benefits for elephants with arthritis and other problems exacerbated by hard, cold, wet, conditions. This also means that elephants do not have large patches of urine and faeces stains on their sides in the morning and so the need for scrubbing to remove caustics stain is greatly reduced and in some cases removed.

Collections have noticed a change in physique of their elephants as they build up the shoulder, neck, leg and feet muscles through digging. Old and/or arthritic cows that had ceased to lie down are able to make use of a man- or elephant-made incline on which to sleep with subsequent physical and psychological benefits (see pictures below). Sand floors offer a different variety of environmental enrichment to more conventional floors; burying

FIG 12: OLD ELEPHANT LYING DOWN, FOR THE FIRST TIME IN DECADES, ON A SAND PILE AT SOFIA ZOO

food deep, digging holes, building mounds, bathing and throwing around.

The few births that have occurred on sand floors have all been successful in regards to the speed of calf recovery and standing (under six minutes, A.

Roocroft, pers. comm.) (see 3.6.4 Pregnancy and Birth: BIRTH). The immediate drainage of birthing fluids appears to help the calves stand up much quicker and without sliding and flopping around that can cause stress and anxiety in the mother, which in turns leads to horrendous scenarios. In one case, the cow pushing the calf on sand helped it stand up rather than send it sliding across the floor (see **http://www.biaza.org.uk/members/pages/resources/index.asp?catUid=34**). It must be noted that these births have occurred in well established herds and/or multiparous females. As herd births are also relatively new, success of the births can not be put down to sand floors alone.

The dominant argument against sand floors is the huge cost of putting them in properly, the difficultly in obtaining the 'right sand' and the fact that benefits are anecdotal. There continue to be sceptics but those who have committed to sand floors say the welfare and visitor attraction benefits far outweigh the costs. The risk of digestive impaction is said to increase with sand floors but no collections consulted knew of any incidences that they could name.

The 'right sand' does appear to be imperative so it is not dusty, drains well and does not compact (in the enclosure or gut). Sand that includes fine sand, silt or clay grades is likely to result in a dusty enclosure and is likely to compact in to a solid floor. Sand grains need to be of a single size to reduce compaction and should be between 0.25 and 0.063mm in diameter (Zootech). A grain with a round, rather than angular shape will ensure less compaction and will not be over wearing on the feet. Watering and turning the sand stops the build up of anoxic bacteria. Anoxic bacteria use sulphur as a terminal electron receptor which makes the sand go black and smell. The sand will contain both aerobic and anaerobic bacteria that will digest the biological matter, much as a sand filter in aquariums does (Sustainable Sources Ltd.).

An average depth of 1.5-2m appears to be sufficient. At this depth, elephants are able to dig substantial holes, food can be buried up to a meter deep and there is enough sand to build a large pile without leaving the remaining floor too shallow.

Sand floors of this description can be used in both the indoor and outdoor enclosures. In collections where the elephants have access to outdoor enclosures for 24 hours, it may be beneficial for elephants to have an area they are able to lie down on outside as well as inside.

FIG. 13: ENJOYING A SAND BATH

OUTDOOR

Again it should be noted that these areas are minimal and zoos should strive to provide larger areas. An outdoor enclosure MUST[1] be 2,000sq.m. with another 200sq.m. for every additional cow (over 2 years of age) over a herd size of 8 females. Ideally no outside area, designed for cows and bulls, should be less than 3,000 sq metres in area and should allow some flexibility should separation be needed. The outside bull pen MUST be no smaller than 500sq.m. The bull should be allowed to roam with the cow herd.

There is, however, much more to a good outside area than just size. The environment **MUST** be positively challenging to the animals and should contain devices and structures which enrich the environment and encourage natural behaviour (see section 3.5) and in particular space to move (Kane *et al* 2009) encouraging exercise and good foot care (see 3.15.4: MUSCULOSKELETAL SYSTEM). Outside substrates MUST[2] be primarily

[1] This was made mandatory in 2009
[2] This was made mandatory in 2006

natural e.g. soil, sand (see above) or grass with good drainage and discrete hygienic areas for feeding. Access to sand or soil for dust bathing is essential as is the provision of rocks, tree-stumps or equivalents for rubbing and scratching in order to keep their skin in good condition (see 3.15.4: SKIN). A combination of an all weather substrate such as sand or hard-standing (concrete) and a softer substrate such as earth or sand (see above) is recommended. The combination of surfaces will help reduce foot/toenail growth and allow for a greater variety of interaction with the environmental and greater scope for enrichment. A variety of slopes and terrains will encourage significant muscular activity, provide vistas for the elephants and allow elephants the choice of social interaction.[1] A full range of exercise including walking, running, turning, reaching, stretching, climbing, bending, digging, pushing, pulling and lifting (Kane *et al* 2009) and use of the entire enclosure (Barber 2009)should be designed for. Oakland Zoo (Kinzley 2009)used browse, training, exhibit design and 24hr access to get their elephants to walk two miles a day in a 6,000 sq.m. enclosure. However, more research is needed in to the appropriate size and complexity of outside enclosures, and how the elephants use them.

A pool, waterfall, sprinkler, dust baths and wallows provide enrichment, allow cooling and bathing and may also assist skin-care by protecting from sun and biting insects. Elephants **MUST** have access to water for bathing, especially during hot weather. If man-made, the pool **MUST** have gentle entry slopes (not normally greater than 30°) with non-slip surfaces. Pools should not have vertical sides such that they pose a danger to animals when empty. The size of the pool should be large enough to accommodate the needs of all the elephants in the group and sufficiently deep to allow for bathing behaviour and the full immersion of an adult lying on its side. Swimming allows vigorous exercise in a controlled and limited environment. It has been noted that elephants are more likely to use the pools once already wet, through rain or from keepers spraying them with hoses and water cannons[2].

[1] Updated in 2009
[2] Clarified in 2009

FIG. 14: ROOT BALL, BROWSE AND BARK CHIPS AT DUBLIN ZOO

The use of water cannons in the pool at Dublin Zoo not only encourages the elephants to swim and dive, but provides the visitors with a focus for entertainment and learning (G. Creighton pers. com.). Some collections use natural lakes to bath their elephants.

The outdoor area **MUST** be protected from extremes of sunlight, wind and rain, i.e. sufficient sheltered areas should be provided. Extra monitoring should take place at extreme high and low temperatures (temps25-10C.) Animals should be monitored at temperatures below 5°C. Choice is important so that animals can effect behavioural thermoregulation and choose whether to be social or not. Natural daylight cycles are adequate for elephants even in temperate climates.

FIG. 15: CHESTER ZOO OUTSIDE AREA BULL PEN

FIG 16: LANDSCAPING THE OUTDOOR ENCLOSURE AT BLAIR DRUMMOND

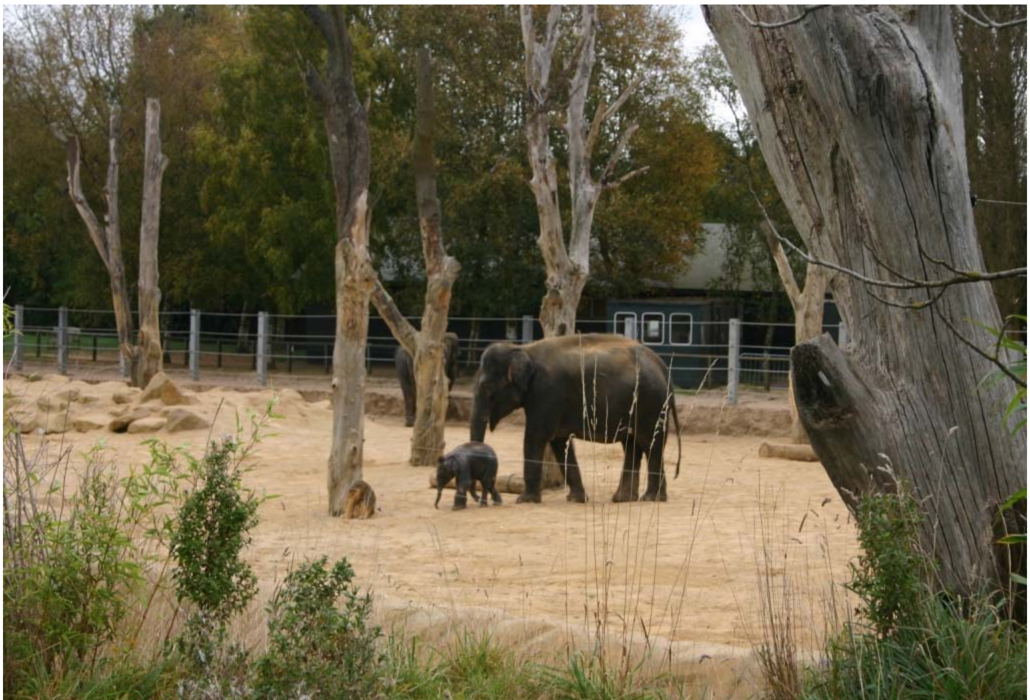


FIG 17: OUTDOOR SAND ENCLOSURE AND POOL AT TWYCROSS ZOO

FIG 18: OUTDOOR SAND ENCLOSURE AND POOL AT TWYCROSS ZOO

FIG. 19: EXAMPLE OF A GOOD OUTSIDE AREA BOUNDARY (CHESTER ZOO)

3.3.3 Boundary

Barriers **MUST** be maintained and escape-proof. The choice of actual material is secondary to criteria relating to strength and prevention of direct contact with the public. If a tusked elephant has a tendency to dig at walls then it should be housed in facilities with smooth walls (assuming the area is walled) to prevent damage to both walls and tusks. However tusks can also be damaged on cables and chains and this also needs to be addressed. One solution is to hotwire the cables/chains to keep the animal back from them.

Door and gate design is vital for the safety and well being of both elephants and staff. Gates **MUST** be suitably robust and any electronic hydraulic system has to have manual back-up and or alternative power. Neither gates nor barriers should have horizontal bars, which would allow elephants to climb. The minimum height for gates and barriers for cows is 1.9 m. and bulls 2.5 m.; however a large African bull can climb up to 2.5 metres and therefore may require a 3m. barrier (Terkel, pers. comm.). Safety corridors and stand off areas should be at least 4 m. wide. Gates **MUST** be designed to operate remotely by staff, i.e. outside the area within elephant reach, and be quickly opened and closed. They should have a stop facility to ensure tails/trunks are not squashed and elephants can not open half closed gates.

Electric fences are a popular and efficient secondary barrier but **MUST** be of sufficient power to deter elephants i.e. about 8000v @ 3.5 joules. They should have a fail-safe alarm system. When electric fences are used as a main barrier, as in cases when they are used to give access to large grassed areas, suitably trained staff members **MUST** be present.

Dry moats have become obsolete in the British Isles and Ireland, as they pose a real threat of injury, especially to young elephants. Particularly bad are moats that are deep (> 1 m.), narrow (< 3m.) and hard bottomed. Moats should be dry and wide enough for an elephant to turn in and no deeper than 1.75m. The surface **MUST** be soft and a ramp, or similar, provided so that an elephant can clamber out of a moat if necessary. They **MUST** be replaced and interim plans made for getting out any animals that fall or are pushed in[1].

Whatever the form of elephant containment, there **MUST** be methods so keepers have access to escape.

[1] Section on moats was clarified in 2006

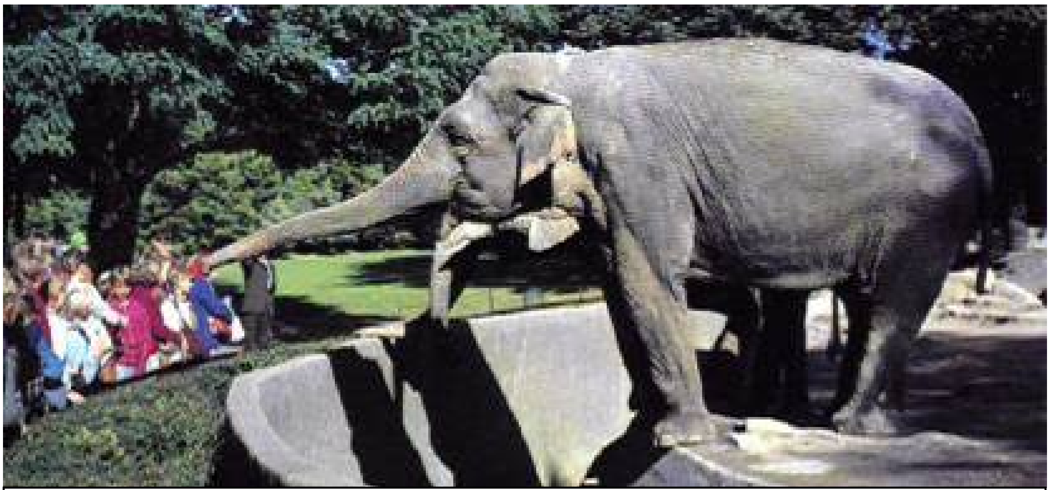


FIG. 20: ELEPHANT REACHING OVER UNSUITABLE MOAT

3.4 Feeding and Nutrition

Knowledge of nutrition is important is important, not least in relation to the occurrence of nutrition-related diseases, which may be associated with welfare issues and low reproduction rates. The nutrition of elephants, looking at the full range of feeding behaviour and digestion, has been reviewed by (Dierenfeld 1994) and (Ullrey *et al* 1997) and more recently by (Hatt & Clauss 2006). This section draws significantly from those papers and experience of maintaining a herd of Asian elephants at Chester Zoo.

3.4.1 Biology and Field Data

The average weight of adult Asian elephants (*Elephas maximus*) tends to be less than that of adult African elephants (*Loxodonta africana*), although in the wild their weight ranges overlap (Asian, 1,800-5,000 kg; African, 1,800-6,000 kg) (Silva and Downing 1995) and are influenced by age, sex, health, and food supply (Ananthasubramaniam *et al.* 1982) (Malpas 1977). Their nutrient needs have been studied very little. With the exception of energy requirements for basal metabolic functions and for maintenance, nutrient needs of elephants have been largely inferred from field studies of food plants and extrapolation of data from the horse.

FEEDING ADAPTATIONS, DIGESTIVE TRACT ANATOMY AND PHYSIOLOGY

One of the most obvious and unique physical features of the elephant is its elongated upper lip and nose, forming a muscular trunk capable of reaching from ground level to high branches in its search for food.

Food is transferred to the mouth where there is a large grinding tooth in wear on each side of the upper and lower jaw. Unlike the horse, the elephant has no canines or lower incisors, and the upper incisors, when present, have been modified to form tusks. Grinding teeth migrate forward from the back of the jaw. As the foremost tooth wears down, it is pushed out, often breaking off. Transverse ridges on the teeth produce a grinding surface that is particularly important for reducing foods to a more digestible particle size. If a tooth erupts at an improper angle or wears unevenly, grinding surfaces may not meet, and the physical form of the diet may need to be modified to assist in the particle size reduction normally accomplished by chewing (Reichard *et al.* 1982). These modifications may also be required when animals lose teeth due to old age.

Thereafter, the elephant digestive system roughly resembles that of a horse in structure if not size. Elephants have a single stomach and a short but voluminous hindgut fermentation chamber, inhabited by anaerobic bacteria and protozoa similar to those found in the rumen and reticulum of the ruminant (Clemens & Maloiy 1982). These micro-organisms digest plant fibre that otherwise could not be used, since elephants, like other herbivores, have no fibre-digesting enzymes of their own. Microbial fermentation of plant fibre in this hindgut area provides the main energy source for these animals; they are adapted to eat complex plant fibre so it should be a large part of their diet.

NATURAL DIETARY HABITS

Numerous studies on feeding habits of African and Asian elephants indicate that they are generalist feeders, consuming a large number of plant species but with wide variations regionally and seasonally in the proportions of grasses, sedges, forbs, shrubs, and trees (see (Eltringham 1982) and (Sukumar 1993)). Fruits, bulbs, plant bases, and roots also are consumed. Both browsing and grazing are practiced, but elephants tend to take plant types in proportion to their availability. Studies suggest the natural diet of Asian elephants may include a higher proportion of grass than the African elephant, but browse generally accounts for the majority of the diet of both species.

The natural diet is characterised by a high fibre content (crude fibre 30-50%) and low-to-moderate protein content (crude protein 8-12%). Studies have demonstrated passage of food through their digestive tract is fairly fast, with correspondingly low digestive efficiency (see (Hatt & Clauss 2006) for a more thorough review). In other words, elephants eat large quantities but it passes through quickly, thereby reducing the concentration of nutrients which can be absorbed and utilised.

Animals consume feed to meet their daily needs for these nutrients and therefore, it is important to establish the amount of feed potentially consumed. All feeds are composed of two basic components - water and dry matter. The dry matter contains all the nourishment: protein, fibre, carbohydrates, fat, minerals, etc. Thus rather than describing intake on a fresh weight or as-fed basis, the amount of food eaten is more typically referred to as dry matter intake: the total amount of feed ingested (usually per day), expressed in terms of its dry matter content. This is often expressed in relation to body weight.

Estimates for an adult elephant are typically around 1-1.5% of body mass (Ullrey *et al* 1997), however intake varies according to the nutritional quality of the feed, environmental conditions the animal is experiencing, their level of activity, reproductive status and growth stage. These physiological factors also influence energy requirements and therefore, the percentage of forage and pelleted feeds required to meet energy needs.

3.4.2 Management in zoos

RECOMMENDED FEEDING PRACTICE

Captive elephants are totally dependant on food provided by their keepers, making it essential that their diet contains all required nutrients both in sufficient quantities and a form which is usable. Specific dietary requirements for particular nutrients for elephants are not known, however due to their similarity to horses, it is reasonable to use extrapolate from data for minerals and some vitamins.

TABLE V. PROPOSED MINIMUM NUTRIENT CONCENTRATIONS (ON DRY MATTER BASIS) IN ELEPHANT DIETS, BASED LARGELY ON EXTRAPOLATION FROM HORSES

Nutrient	Unit	Maintenance, breeding, early pregnancy	Late pregnancy	Lactation	Growth of juveniles
Crude Protein	%	8-10	12	12-14	12-14
Calcium	%	0.3	0.5	0.5	0.5-0.7
Phosphorus	%	0.2	0.3	0.3	0.3-0.4
Magnesium	%	0.1	0.1	0.1	0.1
Potassium	%	0.4	0.4	0.5	0.4
Sodium	%	0.1	0.1	0.1	0.1
Iron	mg/kg	50	50	50	50
Copper	mg/kg	10	10	10	10
Manganese	mg/kg	40	40	40	40
Zinc	mg/kg	40	40	40	40
Cobalt	mg/kg	0.1	0.1	0.1	0.1
Iodine	mg/kg	0.6	0.6	0.6	0.6
Selenium	mg/kg	0.2	0.2	0.2	0.2
Vitamin A	IU/kg	3000	3000	3000	3000
Vitamin D	IU/kg	800	800	800	800
Vitamin E	mg/kg	100	100	100	100

(Ullrey *et al* 1997)

The low digestive efficiency of elephants means estimating energy using horse equations is not possible, nonetheless supplying a combination of hays and nutritionally complete pellet at an appropriate ratio provides a balanced diet for elephants. Adjusting the type of hay and/or pellet and also the ratio of hay to pellet (hay:pellet) allows adjustment for an individual (e.g. maintenance versus growth, lactation, weight management or old age).

Grass hay should be the staple dietary ingredient, comprising a minimum of 70% of the total dry matter (Ullrey *et al* 1997), although the proportion can rise to 85% without any detrimental effects being observed (Fidgett, pers. obs.). Nutritionally balanced pellets should be fed in the range of 10-30% of the total dry matter. Exceeding this may lead to energy and mineral imbalances.

Dietary items that deliver readily digestible energy, such as grains, bread, fruits, vegetables and low-fibre pellets should not be used in bulk as a matter of course – see Fruit and Vegetables below.

TABLE VI: PROPOSED DRY MATTER INTAKE TABLE; DRY MATTER INTAKES ARE EXPRESSED AS A PERCENTAGE OF BODY WEIGHT.

	Dry matter	**Proportion of DM**	
Life stage	**intake**	**% forage**	**% concentrate**
Adult			
Maintenance, pregnancy	1.5	75	25
Lactating	2	60	40
Geriatric	2	65	35
Overweight	1	85	15
Growing			
(1-3yr)	2	65	35
(3-5yr)	1.5	70	30

An individual elephant may consume ~ 10% more or less than predicted. If intake is substantially different, check the animal weight or investigate feed wastage. The percentages of hay and pellets are guidelines based on average quality hay, but note that intake varies with hay quality. Typically, animals eat more high quality hay and less when quality is low but since few zoos analyse hay quality, it is sensible to restrict the amount of pelleted and allow *ad libitum* access to forage in the form of hays and browse.

How much food should an elephant eat and in what proportion?

With the help of an intake table and providing an individual elephant's body weight is known or can be estimated, predicting feed intake is straightforward by calculating as follows*:

Dry matter intake (kg) = Body Weight x (%Dry Matter Intake/100)

Example: 3500 kg adult elephant (maintenance, non-breeding) consumes 1.5% of its body weight per day.

Dry matter intake (kg) = 3500 x (1.5/100) = 52.5 kg

Note this value is the quantity of food expressed on a dry matter basis.

***

Using the proportion of 75% hay : 25% pellets:

Quantity of hay (kg) dry matter = 52.5 x (75/100) = 39.4 kg

Quantity of pellet (kg) dry matter = 52.5 x (25/100) = 13.1 kg.

If the diet consists of only hay and pellet, the amounts to feed can be calculated by assuming both feeds are 90% dry matter.

Amount fed = kg dry matter / (Dry Matter %/100)

Quantity of hay (kg) as fed = 36.8 / (90/100) = 43.8 kg

Quantity of pellet (kg) dry matter = 15.8 / (90/100) = 14.6 kg

Thus

Total As Fed intake (kg) = hay + pellet = 58.3 kg

**all values rounded to one decimal place for the purpose of the example; whole numbers likely to be more useful in practice.*

CURRENT FEEDING PRACTICE

The International Zoo Veterinary Group carried out a survey on the diets of elephants in British and Irish collections in 2001 (see 1st Edition of the guidelines, Federation of Zoos 2002). The survey indicated most facilities in the British Isles and Ireland used hay (meadow, timothy or other) as the major dietary ingredient. Hay was complemented with pelleted feeds designed for equids and some also use vitamin and mineral supplements, e.g. Equivite and Ele-Vit-E. Additional food items might include fruit and vegetables, bread, bran and other grains. Browse may be provided, although typically for behavioural benefit rather than to meet nutritional requirements. Each of these dietary categories is considered below.

HAY

Grass hay is ideal for species adapted to eating plants high in fibre, however primary concerns are the hygienic quality of the hay itself and potential for nutritional deficiencies.

It is important that the hay is of good quality, properly dried and cured (Oftedal and Allen 1996). That is to say, purchased hay should be green and leafy, have fine, pliable stems and be free of weeds, insects, mould, twine, wire or any other foreign objects. Hay should be visually inspected before a delivery is accepted and rejected if found to be substandard (mouldy, excessively dry and dusty, poor colour/leaf). (Hatt & Clauss 2006) describe hay at Zurich Zoo being processed with a shaker, which permits detection and removal of foreign material, and substantially reduces levels of dust thrown up when the hay is handled by both keepers and elephants.

While there is a general relationship between physical appearance and chemical composition, palatability is the most convenient measure of hay quality. Nutritional deficiencies can only be detected through laboratory analysis of a representative sample which few zoos do at all, far less on a regular basis. Ideally hay should be regularly analysed for nutritional content, a process that entails collecting 'core' samples from 15-20 bales from the same 'batch' or delivery. Handfuls of material pulled from the outside of bales will not provide an adequate or accurate representation of the hay's nutritional value. Representative samples of each hay delivery should then be assayed for dry matter, crude protein and fibre. Forage testing laboratories will also be able to provide an estimate of the energy value of the hay, a useful aspect in managing elephants' weight given the substantial contribution hay generally comprises in any captive diet. Mineral data may also be useful, specifically calcium and phosphorous.

PELLETS

Selecting the most appropriate pellet relies on understanding what it provides that cannot be supplied by offering more hay. However since few zoos analyse hay, pellets are selected to provide a reliable, concentrated source of specific nutrients which cannot otherwise be guaranteed in forage (hay or browse). Thus pellets used for elephants typically contain a protein, high concentrations of minerals and vitamins and (potentially) some fat.

Selections of pellet nutrient specifications are given in Table VII.

TABLE VII. NUTRIENT COMPOSITION OF PELLETS USED TO FEED ELEPHANTS. NOTE, PRODUCT SPECIFICATIONS ARE LIABLE TO CHANGE AND ARE INTENDED FOR GENERAL GUIDANCE ONLY.

Nutrient	Units	Elephant Cube (Nutrazu)	Horse & Pony Cubes (Spillers)	Senior Conditioning Mix (Spillers)
Crude fat	%	4	4	5
Crude protein	%	10	10	14
Crude fibre	%	10	15	10
Acid detergent fibre	%	16		
Neutral detergent fibre	%	22		

Calcium	%	1.2		
Phosphorus	%	0.64		
Copper	mg/kg	28	30	30
Manganese	mg/kg	100		
Selenium	mg/kg	0.6		0.3
Zinc	mg/kg	100		100
Vitamin A	IU/kg	10000	10,000	
Vitamin D	IU/kg	1000	1500	
Vitamin E	mg/kg	500	200	250
Biotin	mg/kg	420		
Digestible Energy	MJ/kg	~8	8.9	12.2

Note that the pellets selected for this table are intended to be indicative of feeds used in UK collections. Product specifications are subject to change, thus the values are intended for general guidance only. Taking this into consideration, all pellets are low in fat (<5%). The Elephant Cube and Horse and Pony Cubes both contain protein at the appropriate concentration proposed for elephants on a maintenance diet (10%), while the senior mix, intended for geriatric animals, has slightly more protein (14%) derived from higher quality plant sources. Vitamin E concentration is highest in the Elephant Cube (500 mg/kg), twice that present in Senior Conditioning Mix (see later). Most other nutrient levels are similar.

Differences in the first two pellets allow for some manipulation of energy and nutrient supplements to hays of different qualities for elephants with different needs, but either can be useful and important when feeding growing young elephants, females in the last third of gestation, or lactating females. They may also be necessary in larger quantities for adults with missing or misshapen teeth, but also see GERIATRIC CARE below.

To avoid digestive upsets, the introduction of any pellet into the diet should be gradual (increasing slowly over 2 weeks), and the amount fed should be appropriate to need but should never exceed 30% of total dietary dry matter. Pellet diameters of 1.3-1.9 cm are reasonable, although elephants can successfully pick up pellets as small as 0.5 cm in diameter. As with all feeds, appropriate storage conditions are important to retain product quality, including appropriate insect and rodent control measures. Purchased supplies should not exceed the amounts needed over a 4 to 6-month period, assuming ideal storage conditions.

VITAMIN AND MINERAL SUPPLEMENTS

The dietary concentrations of minerals and vitamins recommended for horses should also be sufficient for elephants (Ullrey *et al* 1997). Mineral deficiencies have rarely been reported and are best avoided through the adequate use of a supplementary, pelleted feed as described in the previous section. Regarding vitamins, the importance of vitamin E for elephant nutrition has received considerable attention and warrants a brief discussion here.

Deficiencies in vitamin E in captive elephants has caused a range of symptoms including necrotising myopathies, anaemia, reproductive failure (Kenny 2001), capture myopathy and white muscle disease (Dierenfeld and Dolensek 1988). Elephants have low circulating plasma serum levels compared to domestic herbivores and differences are noted between African and Asian elephants. Green forage and other leafy material are good natural sources of vitamin E; young grass being a better source than mature herbage and lucerne being especially rich. Leaves may contain 20 times as much vitamin E as the stems. Yet losses during haymaking can be as high as 90%, therefore captive elephant diets based primarily on hay are almost certainly lacking in vitamin E. Consequently interest in the importance of vitamin E for elephants has followed, resulting in supplementation products marketed specifically for elephants.

It has been estimated that captive elephant diets should aim to provide 130-167 IU/kg DM vitamin E in the diet, to achieve circulating α-tocopherol levels similar to those seen in wild elephants, (Dierenfeld and Dolensek 1988). Using the data presented in Table VII above, pellet contains vitamin E in 500 mg/kg; diets formulated for Chester Zoo's elephants in 2007 indicate that the elephants are getting enough vitamin E from the pellets and therefore do not require additional supplementation with a separate vitamin E supplement (A. Fidgett, pers. com.).

A water soluble vitamin E preparation (d-alpha tocopherol polyethylene glycol succinate, or TPGS) has been promoted in recent years as a supplement for zoo elephants and many UK zoos use a product based on this compound. However several long-term studies have shown that elephants do respond to supplementation with conventional (less expensive) forms of vitamin E. Section 6.6 Appendix 6 provides guidance on vitamin E supplementation, taking into account our current knowledge and, due to confusion about supplement form and efficacy, compares several different products available in the UK on the basis of potency and relative cost.

FRUIT AND VEGETABLES

Many zoos continue to offer fruit and vegetables (produce) to large herbivorous animals. When used sparingly, fruits and vegetables are not harmful and may help animal management, including training or medication. However, these high energy, low fibre foods types contribute to unnecessary weight gain. Other palatable products, such as dog biscuits can be used as an enticement for training, often at appreciably less cost and in smaller amounts. There is no scientific basis for including large amounts of apples, bananas, carrots, leafy greens and other commonly used produce items in elephant diets. Their contribution to the overall nutrition of the diet is slight, but the total cost (financially and in weight gain) is not.

BRAN, OTHER GRAINS AND COLIC

As with horses, bran, oats, corn, and other grains were traditionally used in feeding programs for elephants, and some zoos continue this practice. With the appropriate use of nutritionally complete pelleted feeds and adequate amounts of fibre from good quality hays, the benefits of bran may be overstated, and, indeed, excessive use of bran for the horse has been associated with nutritional secondary hyperparathyroidism, due to bran's high phosphorus content and a marked inverse Ca:P ratio. The use of whole grains, once necessitated by the unavailability of nutritionally complete pelleted feeds, is, likewise, no longer required. Upon occasion, bran has been used as a carrier for liquid medications, and different carriers may be required for medications in other forms. Because elephants are reluctant to consume unfamiliar foods, it is appropriate to offer potential medicant carriers periodically so they will be consumed when needed. However, it should not be necessary to offer such items continuously.

It has been suggested that use of bran may prevent colic in elephants. Horses and elephants are not "meal-eaters", but have evolved to consume large amounts of food throughout the day. Bran, when offered along with pellets as part of a meal, provides a bolus of high fibre material to the gut. By contrast, consumption of properly selected hay throughout the day better simulates the natural feeding strategy of elephants and provides fibre continuously over a longer period.

Colic is a general term for abdominal pain that may be chronically intermittent or may have a sudden, acute onset. Colic in horses has been attributed to parasites, behavioural problems, and a number of poor husbandry and feeding practices, including stress due to changes in routine, insufficient roughage of appropriate quality, rapid consumption of grains or pelleted feed, sudden changes in amounts or types of feeds/roughage, and lack of continuously available fresh, clean water. Considering the nature of their digestive tract and the composition of foods in the wild, hay should form the base of the captive elephant diet. Nutrient concentrations are important, of course, but fibre intakes should be sufficient to ensure normal gut function. Although exercise is difficult to promote, distribution of hay among several feeding locations encourages movement and may provide some behavioural stimulation. Rapid consumption of more concentrated foods, such as pellets, can be controlled by keepers. Any changes in the amounts or types of roughage and other foods offered should be made gradually (over 1-2 weeks) to allow for adaptation by intestinal microorganisms. Providing water continuously for elephants is also advised.

BROWSE

Browse allows animals to exhibit normal behaviour, increases foraging time and has additional nutritional benefits. Two listings of browse commonly used in UK collections are available (see Section 6.6 Appendix 6), which also give details of poisonous forms (Frost 1992) (Plowman and Turner 2001). To date there is still no data compiled on the nutrient composition of browse in the UK. Details on use of food as enrichment is given in a later section (3.5), but generally, it is important to increase time spent feeding as much as possible.

3.4.3 Special dietary requirements and considerations

PRESENTATION OF FOOD

Elephants spend up to 18 hours a day in the wild looking for food and eating. Their digestive anatomy is designed to cope with large amounts of food that is low in nutrients and very high in fibre. It is important to ensure that each elephant receives adequate quantities of the pellet feed, although presenting elephants with one meal of pellets may ensure they get exactly the right amount of each desirable nutrient, it deprives them of a large proportion of their behavioural repertoire and will lead to behavioural and physiological problems. Therefore it is ideal to provide a variety of feeding opportunities that ensures elephants can feed for 20 hours a day. Elephants should be fed repeatedly throughout the day and in the evening and early morning (and see Section 3.5 on enrichment for details of a device which will deliver food overnight). Staff should monitor diet consumption and report variations.

The provision of browse is a perfect way of feeding large quantities of low calorific and high fibre food in a way that takes them time to process. Browse should be distributed around the enclosure to encourage the elephants to walk as far as possible. Different ways for presenting browse, hay and other food types are described in Section 3.5: AN ENRICHED ENVIRONMENT.

Food used as treats for enrichment and training must be factored into the overall diet formulation and not be considered 'extra'.

HAND REARING

It is imperative that the calf remains as much as possible with its mother (and family) to ensure any bond formed was not lost and the bond is allowed to develop. In the case of not suckling, every effort should be made to encourage suckling and there are many cases of supplementary feeding that occurs along side normal, but inefficient, suckling (N. Dorman pers. com. 2009).

Colostrum should be given, ideally that milked from the dam. If this is not possible artificial or cow colostrums can be used or elephant plasma administered intravenously to the calf in a method similar to that used for a foal. On the basis of analysed milk samples (Mainka *et al* 1994), (Dierenfeld 1994) suggests that diluted whole cow's milk (1:1) with supplemental vitamin

C fed at intervals of 2 to 3 hours, totalling 4-5 litres per day for the first month. (Flach *et al.* 2007), and (Reitkerk *et al* 1993) report an intake of 8-10 litres a day in 5-8 feeds raising to 5-13L/day in months 2-7. As Ochs reports 20-15L/day for this period (Ochs *et al* 2001) and the growth chart of the calf did not match others published ((Reitkerk *et al* 1993); (Reuther 1969)), (Flach *et al.* 2007) supplemented the milk with oatmeal and desiccated coconut, both in the milk and as a feed. This tallies with (Kinzley 1997) who suggests that after the first month, undiluted milk with added saturated fat should be used. (Reitkerk *et al* 1993) provides an analysis of Asian milk taken monthly after the birth of calf and shows higher fat content than for previously published data. Bovine bottles and nipples are suitable.

At eight months, (Flach *et al.* 2007) introduced a feed of dessicated coconut, oatmeal, Horse and Pony pellets (Clarke & Butcher, Soham, UK), calcium carbonate and an equine vitamin/mineral supplement (Equivite Original, Spillers, Milton Keynes, UK). Hay and grass were available as for the adults. This calf was weaned by 18 months (with the milk intake reduced over 6 months) and was on an adult diet a few months later.

Several milk replacers have been tried:

Grober Company, Ontario, USA (www.grober.com) produces the most commonly used elephant milk replacer in North America and full instructions are provided with this. Two versions of Elephant Gro are available, one formulated for African and one for Asian Elephants. It is also recommended that a plan to reintroduce the calf to the dam should be drawn up. There are instances of successful reintroduction after a period of up to 10 days.

Salvana (Salvana Tiernahrung GMPH, Elmshorn, Germany) milk formula was used to successfully hand rear a calf in Berlin Zoo (Ochs *et al* 2001). However, while this formula has all the correct nutrients, Whipsnade Zoo found their calf did not drink enough of it to put on sufficient weight (Flach *et al.* 2007) and Twycross found it appeared to cause a stomach upset (N. Dorman pers. com.).

SMA Gold (SMA Nutrition, Maidenhead, Berkshire, UK) was used by both Whipsnade and more recently Twycross with success; (N. Dorman pers. com.). The calves liked it and gained sufficient weight, though care must be taken to ensure calves are getting the right nutritional content.

Published growth rates for hand reared calves vary between 1.0 – 1.2kg a day (Reitkerk *et al* 1993), (Reuther 1969) to 0.7kg a day (Flach *et al.* 2007), which was deemed too low by the keepers to 0.6kg/day recently at Twycross Zoo (N. Masters, pers. com. 2009). Mother reared calves in captivity vary from 0.4 kg/day (Andrews *et al.* 2005), 1.1kg/day (Reitkerk *et al* 1993) to 1.8kg/day (L. Sambrook, pers. com. 2009). What is not known, is what is a growth rate is ideal for as there is no published data from the field. However, (Andrews *et al.* 2005) note although it is thought the growth rate was not as high as it would be in the field, that the suckling pattern of the African elephant calf at San Diego Zoo were almost identical to those seen in the wild. As one of the problems that the captive population addresses is young reaching maturity too early, are the higher growth rates too high? More research is needed in to the area of growth rates and the effect of birth weight on these rates.

Note that young African elephants fed alfalfa as the major dietary constituent can develop inward buckling of the tibio-tarsal joints, probably arising from too rapid a growth rate. This is treated by reducing dietary protein intake (Schmitt 1986).

OBESITY

Many elephants in captivity are obese (e.g. body condition/body mass/excessive fat on post mortem) (Harris *et al* 2008). (Ange *et al* 2001) report an average difference in body mass between females in captivity with published average values for wild African elephants (2800kg) and Asian elephants (2720kg) of 21% and 27% respectively. Obesity in elephants can cause behavioural and physiological problems (see Section 3.15.4: Medical Management) Moderate body mass (using values for free-ranging wild animals as the guide) should be the aim of husbandry and diets of overweight elephants should be reduced accordingly. Therefore elephants must be regularly weighed and measured (using a calibrated weigh-bridge) and then calculate ideal weight using one of the body ratios described in Section 6.4.2 BODY CONDITION SCORING).

GERIATRIC CARE

Captive elephants are becoming a focus species within the field of geriatric animal management due to their longevity and the significance of individual animals in the dynamics of a herd. Females can live for seventy plus years in a zoo environment (Douglas-Hamilton *et al* 2001). The oldest female usually fulfils the role of matriarch and is very influential upon the behaviour of the other elephants around her (Douglas-Hamilton *et al* 2001). Taking appropriate measures to treat symptomatically any ills of old age and also the regular testing of parameters liable to change in elderly elephants are increasingly seen as good management techniques. The significance of nutrition in maintaining health throughout life is vital as a well nourished animal is likely to benefit in its resistance to disease, energy levels and general welfare.

As mentioned earlier in this section, elephant dentition is unique among mammals since they never have more than two molar teeth in functional occlusion in each side of the upper and lower jaw at any one time. They undergo dental eruption six times beyond the teeth they are born with and teeth migrate horizontally along the jaw. As a tooth wears it is pushed forward to the front mouth, the root is absorbed and it slowly forms a shelf which will break off and the remaining fragment be pushed out of the mouth. Molars have pronounced ridges that act as coarse rasps to shred the plant tissue consumed and grinding surfaces must meet correctly in order to break down foods to a more digestible particle size. The final set of molars have no other teeth pushing them forward into position and in time they too will wear down, greatly decreasing the elephants' ability to grasp and grind feed. Incomplete processing of food due to malocclusion or age-related dental changes leads to incomplete digestion and poor nutrient absorption, with weight loss, changes in body condition and demeanour likely symptoms.

Dental abnormalities may also cause more acute gastrointestinal problems, such as colic, intestinal impactions or constipation, as a result of inadequate reduction of plant fibres.

(Ralston 2001) makes the point that dental problems are amongst the most common causes of condition loss in older horses. Dental abnormalities in wild elephants ultimately result in death due to starvation; in captivity the physical form of the diet can be adjusted to assist in the particle size reduction normally accomplished by chewing. Provision of easily assimilated or pre-processed diets (eg chopped hay, beet pulp etc) may reduce the effect of inadequate mastication. However, only if caught early. Many captive elephants do not readily allow visualisation of both upper and lower molars. Training can allow visual examination of the upper cheek teeth, however in older (and thus taller) animals, examination of the lower teeth requires manipulation of the cheeks and may be difficult and potentially dangerous to achieve.

Given the last point in particular, faecal consistency and composition can be used as an indicator of poor mastication, allowing prompt intervention and specialised dietary management. Compared to control animals within the herd at Chester, an elderly female elephant's poor molar occlusion and tooth loss (assessed visually) were reflected in greater mass of longer faecal fibres (Fidgett *et al.* 2006). Assessment of faecal consistency is a straightforward method that can alert keepers of potential tooth problems. Emerging difficulties can then be tackled before significant condition loss occurs, using management options such as pre-processing feeds (e.g. chopping hay), providing more easily digested fibrous foods, for example soaked beet pulp and/or pelleted feeds formulated for elderly horses and more time for the elephant to feed uninterrupted. The most suitable balance of foodstuffs and time to feed, needs to be determined on a case-by-case basis and may vary over time, but faecal consistency can a simple monitor for keepers of the efficacy of any treatment or dietary manipulation.

TABLE VIII. SUMMARY OF DIET COMPOSITION OF UK ELEPHANTS

Nutrient	Recorded range in diets (DM)	Mean	Standard Deviation	Recommended level
Ash %	6.8 – 8.99	**8.3**	0.6	**-**
Fibre %				**-**
Crude Fibre	16.03 – 33.01	**28.6**	4.5	**-**
ADF	18.89 – 40.24	**33.6**	5.5	**48**
NDF	49.33 – 70.8	**60.4**	7.0	**62**
Lignin	2.21 – 6.46	**5.3**	1.0	**15**
Crude Protein %	10.61 – 14.51	**13.6**	1.1	**8-10**
Crude Fat %	0.21 – 1.48	**0.7**	0.5	**1.2-1.8**
Vitamin E mg/kg	5.44 – 212.63	**60.3**	64.9	**130-167 IU/kg**

Nutrient	Recorded range in diets (DM)	Mean	Standard Deviation	Recommended level
Calcium %	0.23 – 0.86	**0.5**	0.1	**0.3**
Phosphorus %	0.14 – 0.42	**0.3**	0.05	**0.2**
Sodium %	0.12 – 1.0	**0.3**	0.2	**0.2**
Iron mg/kg	0.23 – 42.93	**12.2**	10.7	**50**
Zinc mg/kg	0.1 – 20.97	**5.8**	4.7	**-**

*Vitamin E : 1 IU is roughly equivalent to 1 mg

3.5 Elephant Behaviour and Captivity

As elephant social organisation and behaviour is complex, it is useful to examine the effects of the captive environment on this, from both positive and negative perspectives. Our knowledge of elephant behaviour and social organisation has increased enormously in the last 30 years and this has to be reflected in the way we monitor behaviour in captivity (see Sections 3.2 and 3.3). No longer can there be any excuse for interpreting 'weaving' as a sign of good health (Chipperfield 1983). Kiley-Worthington lists abnormal behaviour observed in zoo and circus elephants; the most common being head nodding and weaving, which were stereotypic in form (Kiley-Worthington 1990). She also lists bar-biting, head shaking and hitting the wall and floor with the trunk. However, hitting the ground with the trunk is a normal threat display in Asian elephants (McKay 1973) and should therefore not be described as abnormal. Work carried out on the development of abnormal behaviour in captive animals (Kurt and Hartl 1995), suggested that weaving develops from frustrated attempts to explore and move while being shackled. Stereotypic weaving is also observed in shackled temple elephants in Asia and the behaviour continues to be observed, albeit at a much lower frequency, when they are moved to jungle camps (Kurt and Hartl 1995). Schmid studied 29 elephants from four circuses in Europe, all displayed some form of weaving stereotypic movement, each elephant had a particular individual behaviour pattern, e.g. one put her left foreleg one step in front of her right one while nodding continually, when she bowed her head she lifted the back part of the sole of her left foreleg, lifting her head she bent the knee of her right leg, the trunk swung in synchrony with the head (Schmid 1995). When the elephants were in paddocks this behaviour significantly reduced in frequency and in 10 animals was observed only when shackled. Similar work in North America on thirteen circus elephants, again showed a significant increase in stereotypic behaviour in restrained animals (Gruber *et al* 2000). Shackled elephants are not only restricted in movement, they are also deprived of social contact, only able to display tactile communication (a significant aspect of elephant social behaviour) with the immediate neighbouring elephant. Although shackling contributes to the onset of stereotypy in elephants recent work has suggested that it is also triggered by lack of adequate social partners (Kurt and Garai 2001), and they found that socially integrated elephants, when unchained, weaved only when separated from group members, thus confirming the view that deprivation from group members also triggers the behaviour.

Distinguishing between stereotypies and other forms of behaviour can be difficult (Mason 1993). In general stereotypies are repetitive, invariant behaviour patterns with no obvious goal or function (Mason 1991); although abnormal in form and frequency they are probably the product of normal behavioural processes. They are often associated with past or present sub-optimal aspects of the animal's environment.

Stereotypies may be a mechanism whereby animals cope with sub-optimal conditions by regulating incoming neural information. For example, in humans, pacing or fidgeting prior to an interview allows the candidate to regulate incoming neural information in the form of feedback from the movement of limbs etc, which is preferable to the uncontrollable levels of neural information in the form of concern and worry. On the other hand, the same person may also fidget when bored to increase the level of neural stimulation whilst waiting for a bus. In cats, pacing is seen when stimulation is lacking (throughout the day) or when over-stimulated (excitement prior to feeding). Obviously an animal spending 70% of its time pacing is a cause for concern, but intermittent bouts associated with feeding time, for example, are of less concern. Thus stereotypies have some linking characteristics, but they differ in others. It is therefore not reasonable to assume that all stereotypies are homogeneous. This should be taken into account when discussing their welfare implications or functional significance (Mason 1991). Stereotypic behaviour is usually a form of a 'normal' behaviour seen in the wild, performed at a much higher frequency. For example 'tongue-playing' and 'mane biting' are seen in wild giraffe; observed at a higher frequency in captivity these behaviours are categorised as stereotypic (Veasey *et al* 1996). Similarly elephants have been seen 'weaving' while standing stationary in the wild. The individual behaviour of elephants MUST be monitored and assessed on a regular basis. Recommended techniques in the future will be researched by the BIAZA research group, alternatively techniques used by Harris et al could be considered.

STEREOTYPING IN BRITISH AND IRISH ELEPHANTS[1]

(Clubb and Mason 2002) found that 40% of elephants in zoos perform some kind of stereotypic behaviour for an average of 10% of their time (15% for Asians, 5% for Africans). A more recent study showed the 54% of 77 elephants in British and Irish collections showed stereotypic behaviours during the day time, rising to 68% if night time data was included (some elephants only stereotyped at night) (Harris *et al* 2008). Of those that stereotyped for more than 1% of their time, the average time spent stereotyping was 9.2% (max 60%) during the day and 5.7% (range 0-53%) during the night. Increases of stereotypic behaviours were seen prior to feeding time and being let in/out of the house. (Harris *et al* 2008) have provided data to what elephant managers have thought for some time, that elephants are active for most of the night, only sleeping for ~4 hours, hence the recommendation that food and enrichment (social and physical) MUST be provided over night (see Section 3.3.1: NOCTURNAL BEHAVIOUR).

[1] This section was added for the third edition in light of the publication of (Harris *et al* 2008)

There was a species difference with African elephants stereotyping for an average of 1% during the day and Asian elephants for 6% during the day, rising to 4.4% and 6.6% in African and Asians respectively at night. There was no difference seen between the sexes. Elephants of unknown origin (Asian only), stereotyped significantly more than those of unknown origin. Two of the four came from a circus and one from a zoo where conditions were said to be 'cramped'. In fact, elephants that had been in circuses at some stage in their life stereotyped significantly more than those that had not. Time spent stereotyping was not correlated to feacal cortisol metabolites (FCM) levels. The correlation between stereotypies and enclosures was not clear; those with more outdoor space during the summer or winter stereotyped less during the day time, those with more indoor space/elephant stereotyped more during the day (when they would normally be outside – *Editors note: it is unclear whether these elephants were recorded indoors at the time*); elephants with a large amount of indoor space stereotyped (8.1%) less than those with a small amount of space (12.1%) and those with a medium amount of space (1.6%) and the larger the outdoor space, the less indoor night time stereotypies were seen. Certainly more research is needed in this area (See Section 3.17: Research).

There is some evidence here that shows that current husbandry conditions are not necessarily the cause of stereotypic behaviours. However, there is also evidence that stereotypies have evolved in current conditions. One born in a British and Irish zoo and still in its maternal herd, stereotypes for 8.9%, possibly having learnt from its mother who stereotypes 15.4% of her time.

(Harris *et al* 2008) benchmarked the number of elephants seen displaying stereotypic behaviour in British and Irish collections with those seen in a timber camp in Assam (21%) and the Myanmar Timber Enterprise (very rare (Mar 2007)). An elevated level of stereotypic behaviour is often seen with increases in other poor welfare indicators (e.g. avoidance/escape attempts, increased infant mortality etc.) (Mason and Veasey 2009). Although the causes are complex, it can be concluded that conditions for elephants in UK elephant collections are not yet optimal. The production of guidelines such as these with continual review and ongoing research are initiations BIAZA is committed to in order to ensure elephants are kept in continuously improving environments.

Certainly much more research is needed in to determining welfare indicators and what is good welfare for elephants (see Section 3.17: Research). One way to help reduce the amount of time an animal spends stereotyping is to reduce the opportunities available to them. An enriched environment will go some way towards doing this.

AN ENRICHED ENVIRONMENT

In order to provide elephants with the stimulation that they require to exhibit a full repertoire of behaviour, it is essential that the captive environment is enriched. Enrichment MUST occur in both the inside and outside environments and be part of the daily routine. Routine husbandry and behavioural enrichment strategies should stem from our knowledge of the biology of the species in the wild (Shepherdson 1999) and it is beneficial to identify some of the key characteristics of elephant biology that might be important to the design of captive facilities and an enrichment programme:

- **Elephants are highly social animals**. Successful interaction within a society typically requires a level of understanding of conspecifics and as such a higher level of intelligence and self-awareness.
- **Elephants are highly intelligent.** Though intelligence is difficult to assess, examples of problem solving and learning are indicative of a high intelligence as are large brain size relative to body weight. The evolution of a complex social environment may also be correlated with high intelligence. Therefore the enrichment programme should provide mental stimulation.
- **Generalist /opportunistic feeders.** Animals such as elephants which are generalists rather than specialist feeders have evolved to be adaptive, flexible and opportunistic in order to cope with a variable/unpredictable environment/diet. In the case of elephants the opportunity to exhibit the equivalent of foraging behaviour, in terms of food presentation and activity, may be important. They also use a variety of techniques from grasping with the trunk, to knocking over, to uprooting and may use various postures to obtain food.
- **Animals with a large behavioural repertoire.** Animals which demonstrate a large diversity of behaviour typically have a high neural capacity. As a result elephants are more likely to be more susceptible to impoverished environments and require an environment which allows them to mud/dust bathe, climb up slopes and swim.
- **Animals that roam over large home ranges.** Elephants range over large distances (8 – 22km/day) in order to exploit resources. Captive elephants are less active and this may cause foot problems and contribute to some animals being overweight.
- **Animals need the opportunity to express behavioural needs.** That is behaviour which is categorised as being, (and see Section 3.2):
    - Of high survival / reproductive value.
    - Internally stimulated.
    - Something from which an animal will work to perform, such as to obtain food i.e. work for a reward (see below 'work').
    - Parts of the repertoire that have evolved over a long duration in the wild.

When considering the design of environmental enrichment project a number of points are worth considering that relate to elephant behaviour:

- **Longevity.** For enrichment devices/regimes to be worthwhile they should represent a long-term solution that makes a difference over the life span of the animal. With that in mind, the systems put in place should be robust i.e. built to last and the animal should not readily acclimatise/habituate to it.

- **Control/choice.** Animals may benefit greatly if they have some form of control over their environment. Research on farm animals has shown that animals given control over various aspects of their life (when to feed, where to go etc.) fare far better than animals that have no control or choice (Dawkins 1980).
- **Work.** Animal motivation can be measured in how much an animal is prepared to 'pay' to achieve the goal, i.e. how hard it is prepared to work. The greater the behavioural need, the harder the animal is prepared to work. For example an animal may be prepared to push open a door for a food reward but not if the reward is the company of another animal (Webster 1994).
- **Predictability/unpredictability.** Positive stimuli occurring in an unpredictable fashion both temporarily and spatially are of greater benefit than when it is predictable (see additional points under interaction below). Conversely, aversive stimuli are of less concern when they are predictable.
- **Reinforcement.** Enrichment devices will only work long term if the attraction of the device lasts beyond the initial period of novelty. For this to be the case, reinforcement is critical. For example an animal will play with a ball for the first five minutes or so and soon ignore it. However, a feed ball that delivers a feed reward as the animal plays with it will hold the animal's attention far longer.
- **Interaction of the above factors.** Some of the factors listed above interact in terms of their benefit to animal welfare:
    - ***Control/predictability.*** Ideally, we need to provide elephants with unpredictable control which at first appears to be a contradiction in terms, but that is exactly the type of contingency animals face in the wild. Animals choose when to hunt/forage (control) but cannot guarantee the nature of that reward (unpredictability); this is shown in the delivery mechanism of the 'feeding tower' described above.
    - ***Longevity/reinforcement.*** Reinforcement is important to maintain interest in a device/regime, but it should not be too rewarding, or too consistently rewarding as the animal loses interest. The anticipation of whether or not it will be rewarded adds to the sense of well-being when it eventually is rewarded, and elevates welfare for a longer period of time than if welfare were dependant only upon the duration for which the reward were given. Positive reinforcement training (see Section 3.8) has been suggested as an enrichment strategy (Laule and Desmond 1998).

FIG. 21: FEEDING BROWSE INCREASES TIME SPENT FEEDING

Feeding browse has been shown to result in a significant increase in feeding duration and decrease in drinking and inactivity when the browse was present (Stoinski *et al* 2001). This also had a positive effect on the reactions of zoo visitors. Other methods of using food as a means of enrichment include: scatter feeding, elephant feeding devices, an elephant food-ball and freezing food in ice blocks (Leach 1998); also see Redmond (1994) and Law and Kitchener (2002). Elephants will also remove fruit from tubes and other feeding enrichment objects (Haight 1994). Overhead hoists moving food to within reach of the elephants can be used in conjunction with a timer, moveable hay boxes, swing out feeders and feedwalls are all ideas for presenting food items. It is important that these techniques are used in non-routine and unpredictable bases (Shepherdson 1999). Vienna zoo has developed a 'feeding tower' for elephants which can be programmed to deliver food in various amounts and at varying intervals throughout the night-time, when no staff are present (Barina *et al* 2001). Dublin Zoo have log piles and rootballs that can have food and novel scents scattered within and moved, both within the enclosure and from the enclosure (see Fig 14 in OUTDOOR ENCLOSURE) and a wobble tree which simulates the natural behaviour of pushing/shaking/pulling trees to food items down (see Fig 22).

Enrichment **MUST** be incorporated into all aspects of elephant management and enclosure design (both inside and out[1]), with objects to rub against, interact and play with. Elephants frequently dig holes in the wild and it is important that the facility allows for this (Redmond 1994) (see Section 3.4: ENCLOSURE and Section 3.15.4: MUSCULOSKELTAL SYSTEM); the outside area should encourage walking and natural foot wear, reducing the need for keeper intervention. Objects should be provided to stimulate the ability to fashion and use tools. Pools, fountains and moving water stimulate natural behaviour as do natural substrates that allow digging and dust bathing (Leach 1998)[2]. Phoenix Zoo has an integrated misting system that is operated by the elephants. Dublin Zoo aims to fit systems in side tall feeding poles and other

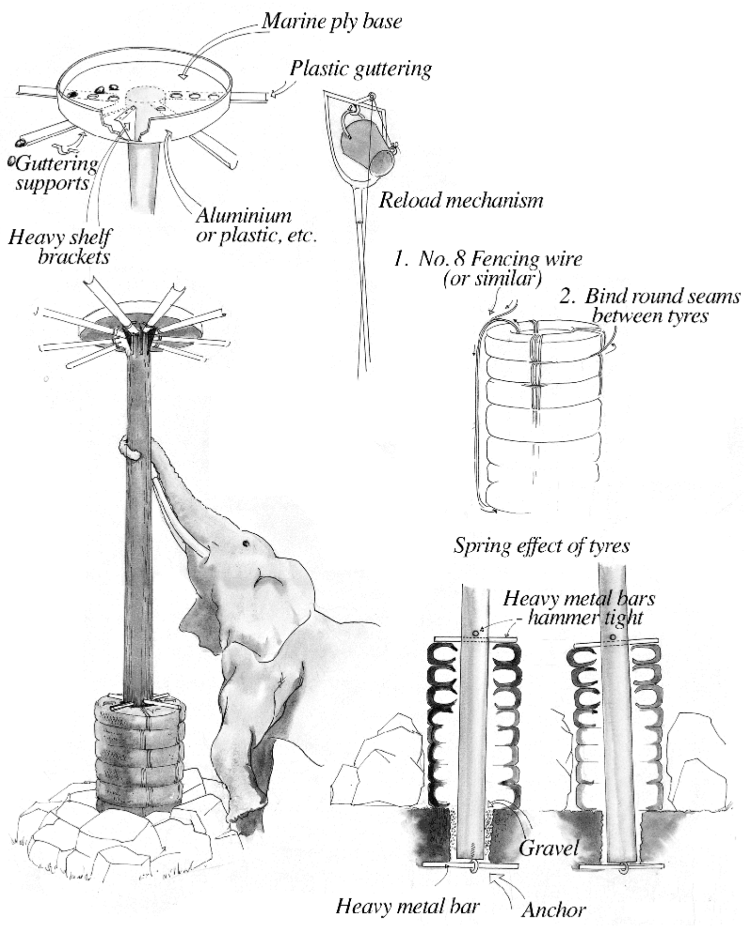


FIG. 22: WOBBLE TREE STIMULATES NATURAL BEHAVIOUR OF PUSHING/SHAKING/PULLING TREES (DUBLIN ZOO)

high areas of the enclosure to turn on randomly. A mister above a wallow would provide enrichment for the elephants and water for the wallow. A wallow provides an area for elephants to kick, splash, throw substrate (sand, soil), roll, dig and generally play in which increases the over activity of the elephants and provides increased enjoyment for the visitors. Mud would provide excellent exfoliation and protection for elephant's skin.

1 Inside and out added.

2 Clarified that enrichment is mandatory.

It should, of course, always be remembered that one of the best methods of enrichment is the presence of other elephants (Rees 2000a). Apart from conspecifics, animals of other species can be a source of enrichment. Elephants are not normally in mixed exhibits but recently some experimentation has been carried out: with baboons in Beekse Bergen Safari Park (where the baboons actually climb on the backs of the elephants) (Deleu *et al* 2003) and Amersfoort are planning a new exhibit with elephants sharing an outside area with cattle egrets and blackbuck. They were also considering mixing elephant and cheetah (Hoedemaker 2001). Ganserndorf Safari Park in Austria has hoofed animals in with elephants as does Parque de la Naturaleza de Cabarcneo in Spain (African elephants and eland) and Heidelberg Zoo (Asian elephants and Indian antelope and deer). Thus using elephants in a mixed exhibit has potential, but the other species **MUST** have safe areas they can get to away from elephants. Positive reinforcement training is great enrichment for elephants as well.

Auditory and olfactory enrichment are also effective with elephants, such as placing novel scents in the enclosure (Leach 1998).

There is thus considerable scope for enrichment, ranging from enclosure design, to feeding regimes and devices, to the presence of other animals, to innovative gadgets and as part of a training programme (Laule and Desmond 1998). However, to be effective, enrichment **MUST** be a continuous process, carried out each day as an integral part of the management programme.

FIG. 23: FAMILY GROUP IN PADDOCK WITH FEEDERS

FIG. 24: A WATERFALL

3.6 Breeding in Zoos

The demographic situation for both species of elephant kept in captivity is not good ((Clubb and Mason 2002; Clubb *et al.* 2009) (Hutchins 2006) although it has improved over the last five years (see Section 3.7. on population management), and the reproductive rate is approaching that necessary to maintain a self-sustaining population[1]. These successes have occurred following leaps in our knowledge of the reproductive physiology of elephants and the successful implementation of artificial insemination programmes globally. The reasons for the lack of sustainability are multifactorial. Primary concerns are the relatively high number of aged nuliparous females in the population compounded by associated reproductive pathology, poor survivorship of calves produced and shortened lifespan of adult females, zoo-bred ones in particular (Clubb *et al.* 2009; Clubb *et al* 2008).

The European populations are managed by the Asian Elephant EEP and the African Elephant EEP. The EEPS are under the auspices of the EAZA Elephant TAG whose mission is as follows:

"Elephants, both African and Asian are flagship species in our zoos. Because of their appearance, intelligence and social behaviour, they form a core of interest and empathy among our visitors. The main roles for elephants in our zoos should be for education, conservation and research. The zoo population should be self-sustaining, without any plan at the moment for reintroduction into the wild. The Elephant TAG should strive for excellence in management and welfare of elephants in captivity, taking into account the physical, handling, medical and social needs of these animals. The TAG will benefit by improving flow of information by sharing of knowledge, staff training, research, education and publicity campaigns. This includes knowledge flow with range states.

[1] Updated and also see updated section 3.7.

The primary goal of reproduction in captivity is to maintain the population size as anticipated and planned by participating institutions, without having to rely on importations of animals. In order for such a program to work, all participating zoos are partners, whether they hold a breeding herd, non-breeding females, or bachelor males. Cooperation with breeding programs in other geographic areas is important to increase genetic diversity."

For success and management of captive populations, the movement of animals or semen between EAZA collections is essential. As captive reproduction management continues to improve the focus is shifting towards the management of the calf during its early years (see CALVES) and looking at the management of a greater number of bulls (see BULLS). Breeding management of elephants requires the consideration of multiple factors from the elephants themselves, the collection's facilities and the management of infectious diseases such as Elephant Endotheliotropic Herpes Virus (EEHV). In addition, a good understanding of the reproductive biology of elephants and how, when pathology occurs, is fundamental.

3.6.1 Elephant reproductive system anatomy

Although similar to other mammals, there are several anatomical factors that are considerable different in both males and females that create challenges for reproductive management for veterinarians at times of need. Reviews of the elephant reproductive anatomy can be found in (Balke *et al.* 1988; Hildebrandt *et al* 2000; Hildebrandt *et al* 1998; Hildebrandt *et al* 2000; Mariappa 2005; Schmitt 2006; Watson 1881) and diagrammatically in Fig. 25.

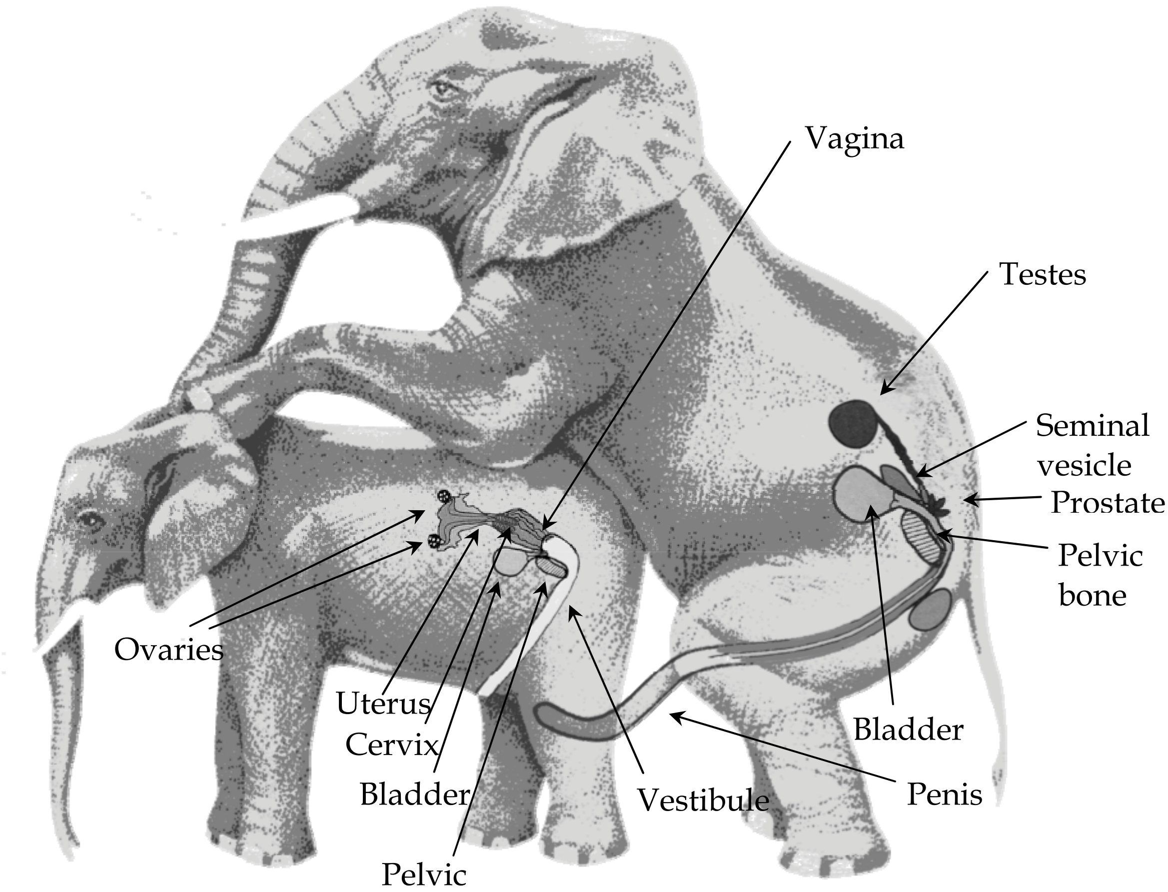


FIG. 25: DIAGRAM SHOWING COPULATION POSITION IN ELEPHANT WITH MAIN ORGANS LABELLED

FEMALE ANATOMY

(See Fig. 25) (Balke *et al.* 1988) provides measurements of the length of the reproductive organs in both pregnant and non-pregnant cows. Ovaries are relatively small (7x5x5.5cm in adults) and are located in the dorsal abdomen. The elephant has characteristic fat bodies associated with the ovary that are not seen in other mammals.

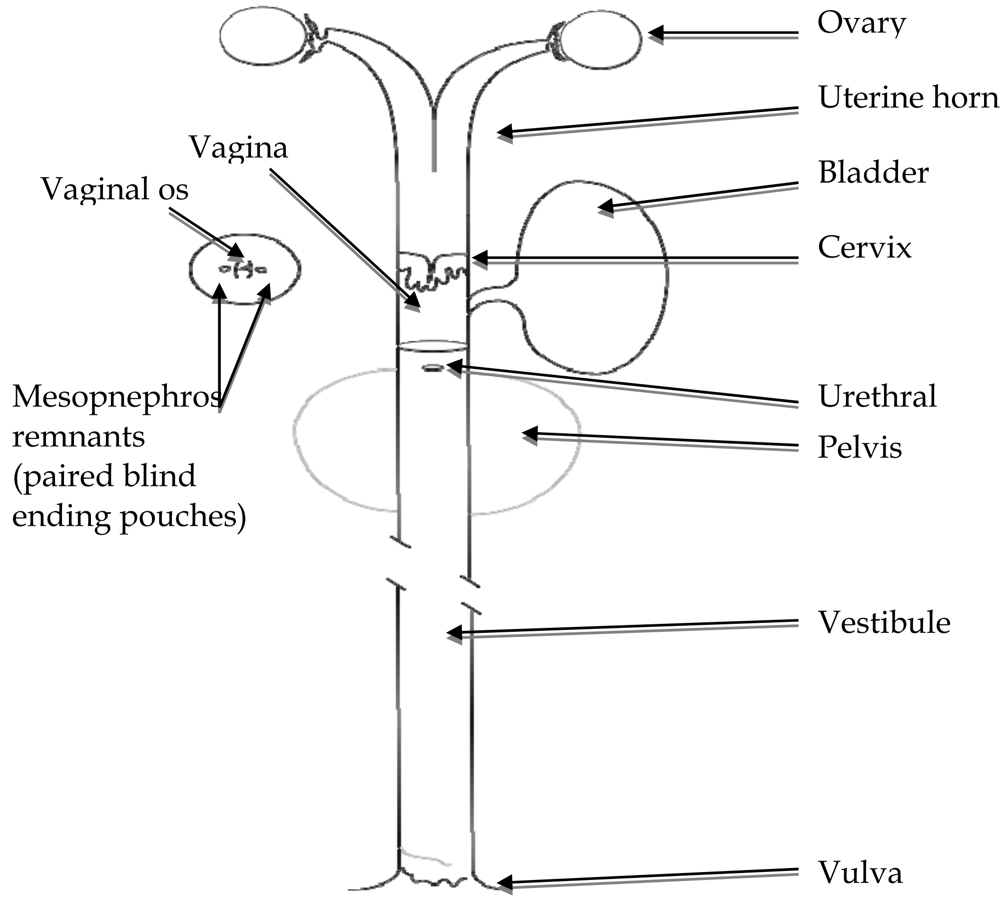


FIG. 26: DIAGRAMMATIC REPRESENTATION OF THE FEMALE ELEPHANT'S REPRODUCTIVE ORGANS, DORSAL VIEW, NOT TO SCALE. INSERT SHOWS VAGINNAL OS.

The uterus consists of a body and two cranial horns and lies within the pelvic canal when not pregnant. Length will depend on the parity (number of calves) of a given female. Calves are found in the uterine horns, with twins generally occur one in each horn.

The cervix is the opening to the uterine body and has a 'Mickey Mouse hand' appearance on the vaginal side. The opening of the vagina is flanked by two blind pouches, also known as Wolffian ducts or Canals of Gaertner. The hymen is torn during parturition, typically destroying these blind pouches. In older, nuliparous cows, the hymen can become rigid and in some cases fail to rupture, leading to dystocia.

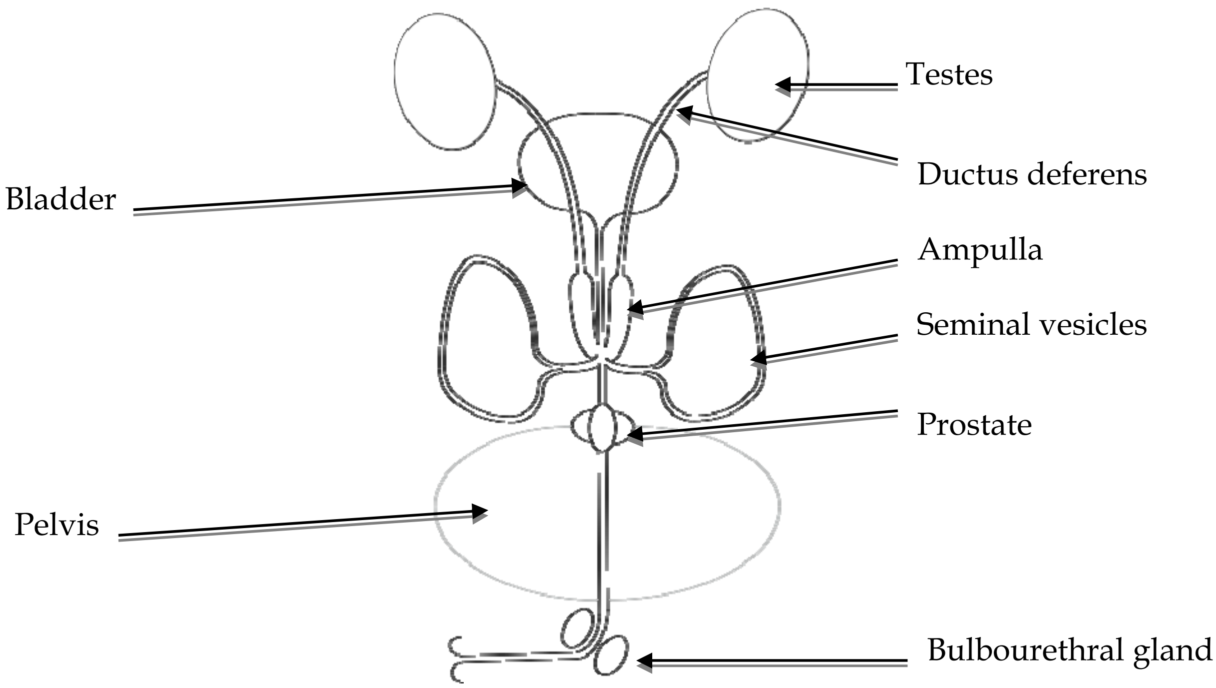


FIG. 27: DIAGRAMMATIC REPRESENTATION OF THE MALE ELEPHANT'S REPRODUCTIVE ORGANS, DORSAL VIEW, NOT TO SCALE

The vestibule is extremely long (1-1.4m) and is shared by the urinary and reproductive tracts. It starts at the vaginal os, progresses horizontally above the pelvis and then curves vertically to run ventrally to between the hind legs, ending in the vulva. During parturition a bulge is seen under the tail, this is the foetal sacs passing in to the proximal vestibule and is indicative of imminent birth.

MALE ANATOMY

(Short *et al.* 1967) provides an excellent review of the anatomy of the male elephant and see Figure 27. Elephants have internal testes, situated caudoventral to the caudal pole of the kidney. The ampulla is used to store mature spermatozoa prior to ejaculation. They vary in size and can be used to assess the current reproductive status of a bull: estimates on volume and sperm concentration can be made by ultrasound assessment.

The accessory sex glands produce the seminal fluids, that along with the spermatozoa, make up the semen ejaculate. They are the paired seminal vesicles, prostate and paired bulbourethral glands. The African elephant's prostate is clearly distinguished into three lobes, whilst that of an Asian bull is fused into a solid mass.

The urethra extends from the neck of the bladder to the glans penis and is approximately 180cm long. The penis is 150cm and is similar anatomically to other mammals, ending with an external urethral orifice that is ellipsoidal in shape.

3.6.2 Elephant Reproductive Physiology

(Brown 2006) has an excellent overview of elephant reproductive endocrinology. (Hermes *et al* 2000) shows the physical ovarian changes documented with ultrasonography.

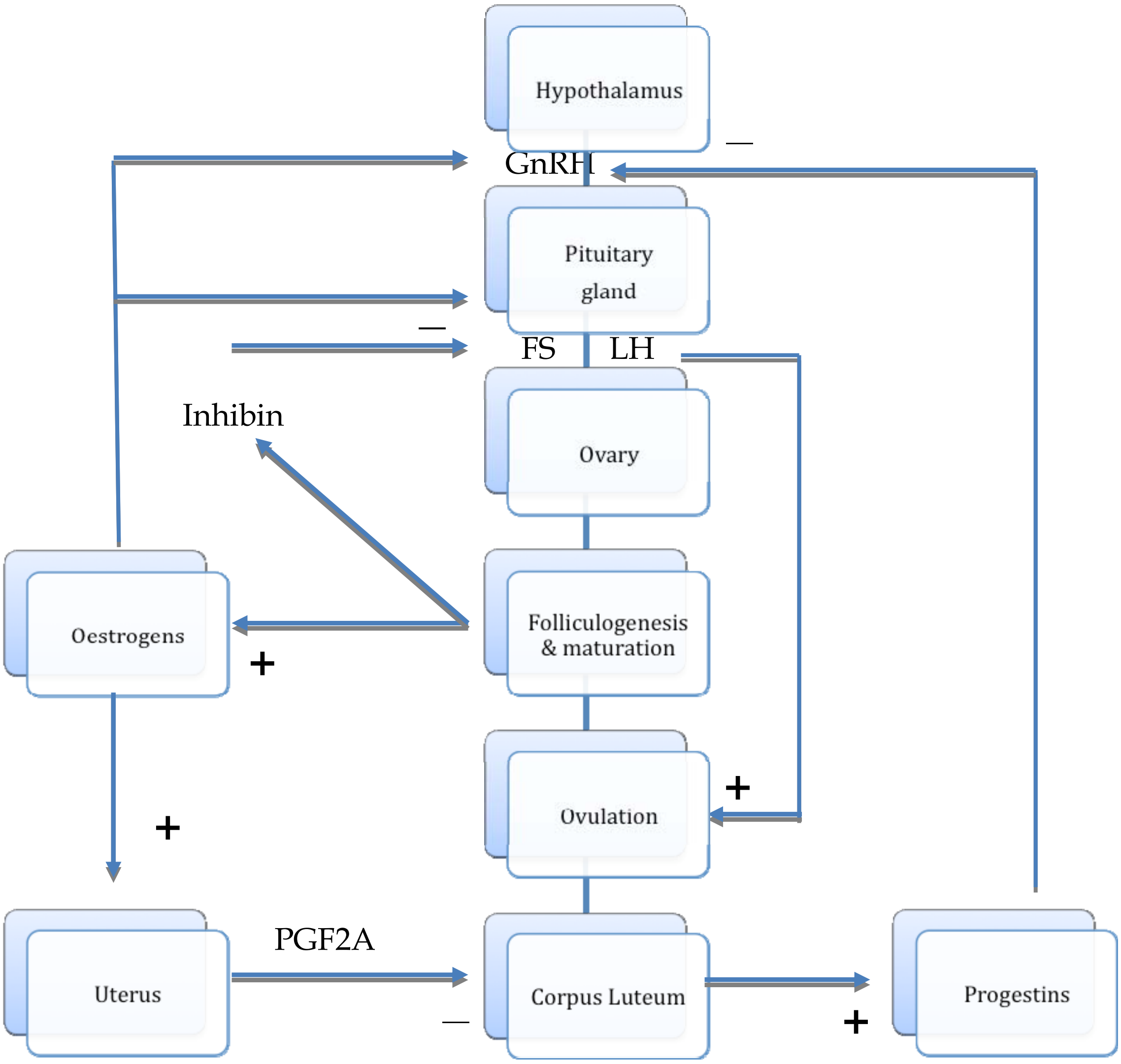


FIG. 28: THE SYSTEM OF FEEDBACK WITHIN THE OESTRUS CYCLE

Described below and depicted in Figure 29 is a normal cycle. It should be noted that a substantial number of cows in captivity do not cycle normally (Schmitt 2006).

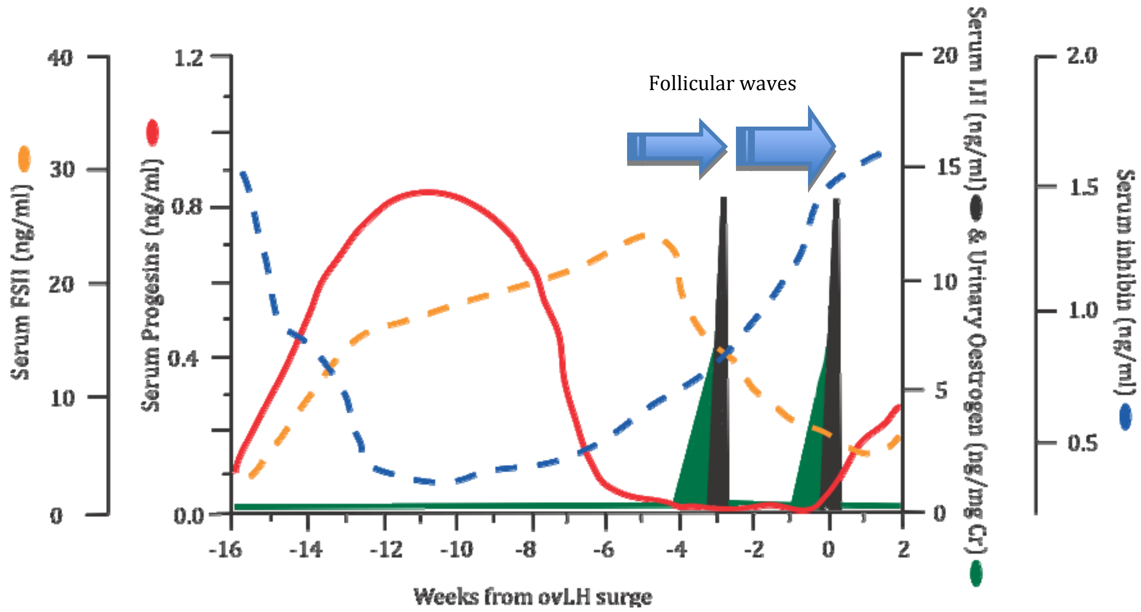


FIG. 29: MODEL OF THE ELEPHANT OVARIAN CYCLE

The oestrus cycles is the longest of any mammal (Brown 2006) and is considered to have two phases:

i) the **luteal phase**, which is where the reproductive tract is prepared to accept a fertilised ova and is primarily under the influence of progestin hormones produced by the corpus luteum. The corpus luteum is a structure that develops on the ovary following ovulation of the mature follicle.

ii) the **follicular phase**, where oestrogens produced by the developing follicle dominate and produce oestrus behaviour and ends with the ovulation of the ova.

Oestrus cycle	13-17 weeks
Follicular phase	4-6 weeks
Luteal phase	8-10 weeks

The difference to other mammals is the two follicular waves (see Figure 11) and associated endocrine changes. The principle hormones involved in the reproductive cycle that are managed are listed below.

- 5 α-pregnane-3, 20-dione (5αDHP): dominant progestin serologically
- 5 α-pregnane-3-ol-20-one (5α-P-3-OH): another progestin
- Progesterone: extremely low circulating levels in elephants, not the major circulating progestin in elephants as it is in other mammals
- Estradiol (or oestradiol): similar to progesterone, in that extrapolation from other species not proven useful due to low concentrations and high blood volumes
- Oestradiol-3-glucuronide: principle urinary oestrogen used to describe the two follicular waves
- Lutenising hormone (LH): produced by the pituitary and works with FSH, its role primarily is the stimulation of ovulation
- Follicle Stimulating Hormone (FSH): produced by the pituitary and has many roles, one of which is to stimulate ovarian follicular growth

Luteal phase: At the start of the cycle, and following the formation of a corpus luteum (CL) from the previous cycle, the level of progestins are high, raising to a maximal level midluteal phase. Progesterones are the principle progestin in other species, but in the elephant it is 5 α-pregnane-3, 20-dione (5αDHP) that is dominant. In Asian elephants 17 α-hydroxyprogesterone (17 α-OHP) is also present. Others exist. Standard progesterone assays designed for other species are relatively effective in elephants due to cross reaction with the pregnanes, however the values are consistently higher than the actual levels of progesterone. This is not considered to be a problem as long as the same tests is used qualitatively rather than quantitatively i.e. the actual numbers are not relied upon, just the trends in increases or decreases that follow. See (Brown 2000) and (Hodges J.K. 1998). With the failure of pregnancy, the uterus likely produces prostaglandins that result in luteolysis of the CL, as in other species. In other monovular species, loss of the progestin block is required for Follicle Stimulating Hormone (FSH) to be release from the pituitary; this is not the case in the elephant, where FSH is relased whilst progestins are high. The FSH has a protracted secretory profile that lasgs behind progestin changes by about a week. FSH is required for follicular development, including oestrogen production. FSH reaches a maximal level at the end of the luteal phase, whilst the CL is still present and decreases at the end of the follicular phase. In the elephant high levels of oestrogens and inhibin (produced by the developing follicles) suppress FSH preventing the recruitment of less developed follicles. A decline in FSH circulating at the end of the follicular phase permits the dominant follicle to be selected. The decline in FSH and combined increase in the oestradiol elicits and ovulatory LH surge (see Figure 12 and below).

Follicular phase: The increase in oestrogens produces positive feedback on the hypothalamus resulting in the lutenising hormone (LH) surge required for ovulation. However, the elephant is unusual in that it has two waves of follicular development; the first does not result in a dominant, mature follicle suitable for ovulation despite the response of an anovulatory LH surge. It is thought that this is because the FSH concentrations are too high to facilitate dominant follicle development. As the follicular phase develops the FSH levels drop (in response to the increasing oestrogens and inhibin levels), allowing a mature follicle to develop and ovulate in response to the second ovulatory LH surge 3 weeks later. During the first follicular wave multiple small follicles develop, none of which ovulate. These are important as they may potentially become accessory corpus lutea which are responsible for the increase in pregnanes around the time of ovulation. An alternative hypothesis is that pre-ovulatory luteinisation maybe occurring.

These two follicular waves are thought to have evolved in response to the long distances that bulls have to travel in the wild, and allows an advertisement of impending ovulation and fertility. Behaviourally this has been recorded as the false oestrus that is sometimes seen several weeks before true oestrus. Ovulation occurs three weeks (19-22 days) after the first LH surge. The two LH spikes are extremely useful for the timing of natural matings or artificial insemination.

The ruptured follicle turns develops into the corpus luteum which produces progestins and is therefore the start of the next luteal phase.

Puberty: Captive and wild elephants show differences of the age at onset of puberty. The youngest reported age of first pregnancy in a captive-born-Asian was 3.5 years, whilst that of wild counterparts was 10-12 years of age (Hildbrandt et al., 2006b). This is similar to African elephants in captivity. The cause for this shift is unlikely due to captivity per se (Hildbrandt et al., 2006b) but a result of husbandry practices such as access to high-quality feeds. Sexual maturity in captivity is recorded as 4-7 years of age. With EEP recommendations of not breeding until 10-12 years this may lead to premature alterations in reproductive function (Hermes et al., 2004).

MALE PHYSIOLOGY

The annual period of heightened sexual activity in bull elephants in the wild is termed musth. It is characterised by hormonal and behavioural changes - heightened aggressive and sexual behaviour, temporal gland drainage, urine dribbling, and increased androgen secretion for periods of a few weeks to several months (Brown, 2006). In captivity, these musth-like behaviours cannot be clearly related to sexual activity due to poor quality semen (<5% motility (Schmitt and Hildebrandt 1998) (S. Blottner, F. Goritz & T. B. Hildebrandt, unpubl. data) and lack of libido during these periods (Hildebrandt *et al.* 2006).

Testosterone is the principle androgen of musth (Yon et al., 2008). Testosterone in other mammals is essential for spermatogenesis, and it is likely this is true for elephants. It is also responsible for male behaviour and morphological changes. Production is age dependent and related to social rank, with dominant males exhibiting higher concentrations then subordinates (Lincoln and Ratnasooriya, 1996). Other androgens exist and include dihydrotestosterone (DHT). DHT and testosterone concentrate in the temporal gland during musth in Asian bulls, whilst this occurs in African bulls continually (Brown, 2006). Testosterone metabolites are excreted in the urine and the faeces. In African elephants (Poole et al., 1984) reports the use of sensitive assays for androgen metabolites in urine, meaning that a non-invasive technique can be used to monitor and check for testicular function. Measurement of testosterone levels provides a marker for testicular function and therefore reproductive health.

Lutenisng hormone (LH) controls the production of testosterone by stimulating the testes to produce the hormone. LH is released in a pulsatile fashion at a similar rate during non-musth and during musth, however the amplitude is greater during musth (Niemuller and Liptrap, 1991). Androgens and glucocorticoids are also produced by the adrenal gland (Yon et al., 2007). The role of the extra-testes androgens is yet to be elucidated. It is suggested that injections of a GnRH agonist, such as leuprolide acetate, would reduce/stop all behavioural signs of musth. For example, (de Oliviera *et al.* 2004) reported cessation of all behavioural signs of musth after injections of leuprolide acetate after three days. However this only occurred after the 10th of 12 injections given over six years. Therefore, GnRH agonists cannot be recommended as a technique for managing musth in Asian bulls, especially as the reproductive effects are not known.

REPRODUCTIVE PATHOLOGY AND BARRIERS TO CONCEPTION

Female elephant suffers from multiple reproductive pathologies that combine to result in a decreased reproductive health that manifests as relatively poor conception rates, and possible calf survival. Despite similar husbandry systems, males, although males are not without problems, do not seem to be as affected (Hildebrandt *et al.* 2006). These problems, despite being considered separately, are likely to be related to early puberty and the asymmetrical reproductive aging that is now recognised to affect elephants.

Asymmetrical (or asynchronous) reproductive aging: this is well described in (Hermes et al., 2004). This is not limited to elephants, but is seen in other species such as rhinoceros. In wild elephants, the oestrus cycle is a rare event in an animals' reproductive life. In captivity, this is reversed, exposing the body to excessive sex steroidal hormones. Evidence suggests that prolonged exposure to endogenous reproductive hormones combined with long periods of non-reproductive periods induces asymmetrical reproductive aging (ARA) in elephants. The average inter-calving interval in the wild Asian elephant is taken to be 2 years (Sukumar 2003) but has been reported as low as 18 months (Mar 2007). In an average lifespan a wild elephant would experience, therefore, approximately 10-15 oestrus cycles in a lifetime. A captive cow, reaching puberty at 4 years old, will have had between 24-32 cycles before she reaches the age that she should be bred from under current EAZA recommendations, almost double of that of a wild elephant. Premature senescence occurs around the late teens to mid twenties, just when an elephant should be in their reproductive prime. (Hermes *et al.* 2004) states that the ARA process consists of multiple pathological effects; including progressive development of genital pathology, subsequent reduction of fertility, and presumably the utilisation of the limited follicular stock. They go on to recommend that pregnancies should be established earlier in life to provide natural protection against ARA and premature senescence.

Reproductive pathology: several reproductive tract pathologies have been recorded in the elephant including uterine leiomyoma (Asians) (Hermes *et al.* 2004), uterine cystic hyperplasia (Africans) (Hermes *et al.* 2004), vestibular polyps (Africans) (Miller 2006)(Miller, 2006), vestibular cysts (Asians) (Hildebrandt *et al.* 2006), vaginal cysts, and ovarian cysts (African>Asians) (Hildebrandt *et al.* 2006). These pathologies detected by ultrasound clearly conincided with sub- or infertility. It is a generally held belief that though reproductive tract pathology has been reported in the wild the increased level of pathology, especially at an earlier age is likely to be a result of asymmetrical reproductive aging. This is highlighted by the fact that nuliparous cows tend to have higher incidences of reproductive pathology and reduced fertility as a result (Hildebrandt *et al.* 2006). The different pathologies are often benign, however they led to infertility through mechanical, physical or discomfort at breeding effects. For details, see 3.15.4 THE UROGENITAL SYSTEM.

Acyclicity in females (flatliners): many reproductive age females are not cycling (Brown 2000). Serum progestins are constantly at baseline levels, indicative of ovarian inactivity. The cause of this was unknown because elephants within the same herd could exhibit normal cyclicity, suggesting that it was not a husbandry problem. (Freeman *et al.* 2009) surveyed facilities housing African elephants in the SSP population. Initial data indicates that animals with a higher body mass index and higher in the dominance hierarchy (19/21 facilities) were more likely to be acyclical. However (Hermes *et al.* 2004) highlights cases where low ranking animals become acyclic, the picture is not clear and it is likely that there are multiple factors at work. Other causes reported include hyperprolactinaemaia (Brown 2000), ovarian follicular cysts (Brown 2000), and animals under intense physical activity (Hermes *et al.* 2004). See (Brown *et al.* 2004) for details of endocrine comparison between acyclic and cycling females.

Male infertility: reduced libido and poor semen quality have both been described (Hildebrandt *et al.* 2006). It is possible that these are linked to dominant bulls or even handlers. It is suspected that multi-bull social structures may cause reduced fertility in subordinate bulls and in captivity this may sometimes affect all the bulls. Changing these environments can have a positive effect on bull fertility (Hildebrandt *et al.* 2006).

3.6.3 Breeding: Copulation and conception

It is obviously preferable to breed elephants by natural matings. However, even when a collection keeps a stable group of females and a fertile male, conception does not always occur at the expected rate. Females show behavioural changes when in oestrus and collections should monitor behaviour with a view to collating behaviour with endocrine and other measures (Langbauer 2000). Behavioural profiles (see section 3.8.1), should they be maintained for each individual elephant and updated regularly, would be a way of tracking behaviour changes. The use of hormone analysis (with or without ultrasonography) can determine the anLH surge that occurs 21 days prior to ovulation, and therefore time the mixing of a bull that is not routinely mixed with the herd with females during the time of oestrus and ovulation. If a bull is not used for breeding often then the initial ejaculate may contain large amounts of dead sperm and it is recommended that semen is collected prior to natural mating to ensure fresh semen to be deposited (Olson 2004).

There is a better chance of conception if bull(s) and cows are run together and if cows are kept in a stable established group (Kurt and Hartl 1995). Some zoos mix cows and bulls outside every day, some keep them separate, only introducing bull to cow when the cow is in oestrus. However, mature bulls require separate quarters i.e. an area in which they can be safely isolated, and these may be of two types: (a) completely separate from the herd i.e. not within sight and (b) in the neighbourhood of the cows with eye and trunk contact. Both systems have advantages and disadvantages and it is not known which has the greater breeding success.

Older cows may prefer older bulls, and evidence from the field suggests that there is an element of female choice in whether she will allow a bull to mate (Poole 1989b). Cows have been seen refusing to mate with a specific bull in a captive situation (Mellen and Keele 1994) and it has been shown that matings that led to conception at the Pinnawela orphanage in Sri Lanka were instigated by females (Poole *et al* 1997).

For this reason it has been suggested that it is better to keep more than one bull in an institution (Poole *et al* 1997) but not enough is known about the dominance effect on reproductive development and competition between bulls. In Pinnawela the subordinate bull was observed to mate oestrus females only when the dominant bull was not present (Poole *et al* 1997). It has also been suggested (Taylor and Poole 1998) that one bull cannot or will not mate successfully with a group of more than five females. There appears to be no evidence from European collections that keeping more than one bull increases the chances of conception. In fact there is one example where the opposite might be happening; Howletts, with two bulls, had not bred African elephants for several years, but conceptions resulted when one bull was removed to another collection. (Hildebrandt *et al* 1998) and (Hildebrandt *et al.* 2006) suggests that dominant males suppress subordinate males and that if to be used for breeding then it may be prudent to move the animals away from multiple male groups.

Most European collections do not keep males and females together continuously, only 10% of the collections examined in Taylor and Poole’s survey (Taylor and Poole 1998). It has been found that the rate of pregnancy is enhanced when males are left with a female for 24 hours per day during the oestrus period (Taylor and Poole 1998).

Of the monitored elephants in Europe only one third of the cyclic animals experienced pregnancy, 27% of Asian and 29% of African animals. It should be noted that the majority of cyclic cows (54% Asian and 84% African) do not have access to a proven breeding male, if a male at all. It is apparent that a considerable amount of data, including observations on behaviour are still required in order to provide answers to some of the problems associated with elephant reproduction. Females display behavioural and physiological changes when in oestrus and this can include swelling around the vulva and a white discharge (Poole *et al* 1997). Courtship behaviour observed in captivity is similar to that described in the wild with precopulatory behaviour including olfactory cues, flehmen in the male, trunk wrestling, driving, neck biting and attempted mounts. For copulation to be successful the female has to remain stationary during the mount. Intromission is then achieved rapidly, lasting from 8-45 seconds.

ARTIFICIAL INSEMINATION (AI)

Proportionally there are fewer males then females in captivity. With advances in male reproductive health monitoring, male fertility problems have been identified in this limited pool of males which further reduces the bulls available for breeding (Hildebrandt *et al* 1998). One solution to this problem is the use of artificial insemination (AI).

From the onset, it should be stressed that AI is not a substitute to natural breeding, but is a tool that can be utilised in situations where it is required. Not only does it augment captive breeding, and as techniques develop for freezing elephant semen then, it may become practical to bring in semen from wild elephants, increasing the genetic diversity of the captive population without the need to bring in wild animals.

In 1998 the first successful AI attempt occurred, with two African nuliparous females at Indianapolis Zoo. This was followed, the same year, with a female Asian elephant at Dickerson Park Zoo. The first success in Europe was an African female at the Vienna Zoo in 1999 (Schwammer *et al* 2001) and the first birth from AI in the UK was at Colchester in 2002.

There are two techniques available for artificial insemination; surgical and non-surgical. Both techniques require three components (Olson 2004);

- Ability to predict ovulation: with current endocrine monitoring techniques, in combination with ultrasonography this is relatively straight forward, and discussed elsewhere.
- Semen collection: this currently is preferred from non-sedated bulls
- Insemination techniques that place semen close to the site of fertilisation

However, both the bull and the cow must undergo vigorous assessment prior to entering an AI programme to ensure reproductive health and function.

Semen collection manually has been well described (Portas *et al.* 2007) (Schmitt and Hildebrandt 1998). It is useful to prepare the bull prior to collection; urine from cows in oestrus can be used for this. This can be stored for a year at -30°C, shorter time at lower temperatures. Alternatives include electroejaculation (Howard *et al.* 1984) or the use of an artificial vagina, but manual is the preferred method as it allows fractional semen collection. The quality of elephant semen varies, the factors for this are discussed in (Thongtip *et al.* 2008). There is considerable difference in the structure of African and Asian elephant spermatozoa, which explains the difference seen in post thaw sperm survival described by (Hildebrandt *et al.* 2006) occurs: African elephants 78%, compared to Asian 40%. Almost all of the AIs performed to date have used fresh semen, inseminated on the day of collection. Fresh semen can be stored for 2-4 days (Hildebrandt *et al* 1999). However frozen semen has been used to produce one pregnancy (Schmitt 2006) and as our knowledge advances in this area frozen semen is likely to become the norm. The management of semen is discussed in (Graham *et al.* 2004), (Portas *et al.* 2007), (Sa-Ardrit *et al.* 2006; Saragusty *et al* 2009a), (Thongtip *et al.* 2004).

Non-surgical artificial insemination: requires considerable training and a compliant cow (Schmitt 2006). A large bore cannula (approx 30mm in diameter) is placed into the vestibule, through this a 3 metre endoscope is guided to the hymen or the cervix (depending on the parity). An insemination cannula is threaded through the endoscope, to allow placement close to the cervix, depositing the semen at or on the cervix. In some cases it is possible to actually enter a uterine horn and deposit semen there (Schmitt 2006). It is useful, and sometimes essential, to have another operator concurrently ultrasound the vaginal os in nuliparous cows to assist in the passage and directing of the cannula into the vagina.

FIG. 30: NON-SURGICAL ARTIFICIAL INSEMINATION IN FREE CONTACT AT ZSL WHIPSNADE ZOO

Surgical artificial insemination: it may be used in cows where urogenital manipulation or distal reproductive tract pathology prevents manipulation required for non-surgical AI. It is cheaper and requires less technical expertise, however it does require a small (1cm) vestibulotomy just below the anus. The technique is then undertaken in a similar fashion to the surgical technique, replacing the endoscope with the human eye and a light source. Closure requires three to four sutures and the incision takes 4-6 weeks to heal. The disadvantage is the long aftercare required when compared to the non-surgical technique.

(Schmitt 2006) reports the success rate between 30-40% for each AI attempt, which is comparable to the apparent success of 50-60% of natural matings.

However, the success of AI requires viable, breeding animals and it is important that full reproductive health assessments are undertaken for any elephants, whether in AI or natural breeding programmes.

(Thitaram 2008) describes a technique that maybe beneficial to AI programs: the synchronisation of the ovLH surge. The use of a GnRH agonist (buserelin acetate) 13-22 days after the decline of progestins is seen during the oestrus cycle will result in an immediate anLH surge with the ovLH three weeks later. This technique is cycle dependent and does not appear to be effective during the late follicular phase or early luteal phase.

3.6.4 Pregnancy and birth

PREGNANCY

Gestation in elephants is approximately 640-660 days (20-22 months) (see Table VI), with single births predominant. Twins occur in about 1-2% of births. The age at first conception is generally reported at 10-12 years of age in free ranging elephants (Schmidt and Mar 1996), (Schmitt 2006), yet can be considerably lower in captivity.

TABLE IX. GESTATION DATA ON ASIAN FEMALES

Group	**Gestation length (days)**	**Sample size**	**Reference**
Asian elephants (*Elephas maximus*)			
EAZA zoos	671	81	(Oerke, pers comm.)
EAZA zoos	600-692	26	(Flügger et al., 2001)
Zoos	610-720	32	(Whalley, 1994)
Zoos and circuses, mainly EU	644	-	(Kurt and Mar, 1996)
Pinnawela	618	-	(Poole et al., 1997)
Pinnawela	585-618	-	(Dastig, 2002)
Myanmar logging camps	598	-	(Kurt and Mar, 1996)
African elephants (*Loxodonta africana*)			
Zoos	624-663	-	(Oerke, pers comm..)

The majority of hormonal data regarding pregnancy is from Asian elephants. That from African elephants is generally from animals culled in the wild. The physiology described below discusses the Asian cow unless otherwise stated.

Post-conception the progestin pattern is similar to that of the non-pregnant luteal phase for the first eight weeks. Initially decreasing the progestin levels increase to exceed that seen during non-pregnancy (Brown 2006). Transitory decreases in progestins also occur at two and 12 months, this is thought to be related to changes in luteal or placental activity. The corpus luteum is most active between two to 14 months of gestation (Hodges J.K. 1998). The source of gestational progestins is unknown, it is possible that it is placental in origin but this is yet to be proven.

African elephant progestin concentrations are high during the first half of gestation and then they dramatically decline mid-gestation and remain lower then that of Asians until parturition. In Asian elephants the progestin levels are higher when carrying male calves, which is not seen in African elephants (Meyer *et al.* 2004). Prolactin increases markedly after 5-7 months in both African and Asian elephants, and can be used for pregnancy diagnosis from approximately 20 weeks. This maybe important for sustaining the CL activity, stimulating foetal growth, or preparing the mammary gland for lactation (Brown 2006). Free oestrogens are low throughout pregnancy but conjugated oestrogens can be quite high and appear to be linked to prolactin secretion.

Serum relaxin increases for the first 10 months and then declines until just before parturition where it sharply rises. It is likely that relaxin plays a role in parturition by softening the cervix, relaxing the pelvic ligaments, and co-ordinates the uterine muscles once labour is initiated (Brown 2006).

There is great variation in the length of pregnancy and making an individual prediction of parturition is necessary (Hermes *et al.* 2008). Progestins drop to baseline 2-5 days prior to parturition and this is the most useful predictor available currently. This allows adequate preparation for imminent birth as well as monitoring for dystocia.

Ultrasound is a useful monitoring tool for monitoring the healthy development of the foetus (Drews *et al.* 2008).

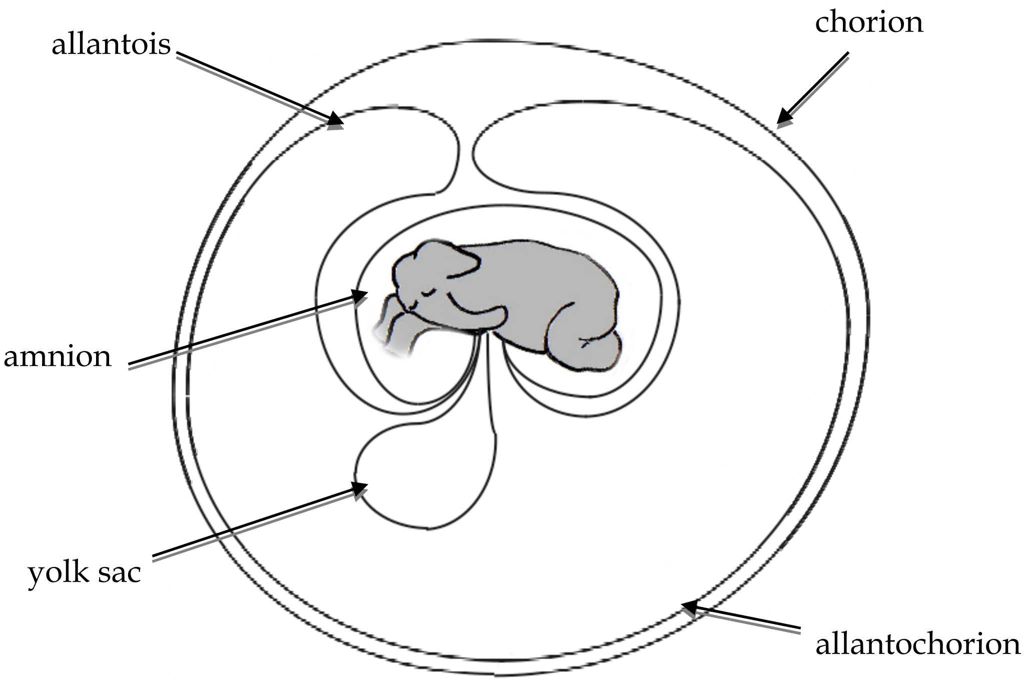


FIG. 31: ELEPHANT FOETAL MEMBRANES

BIRTH

Monitoring of imminent birth is essential for any elephant reproductive programme. There are several methods available;

- **Behavioural:** with the aid of video the cow can be monitored at night and this should occur a month before the expected due date.
- **Progestins:** a drop in progestins occurs 2-5 days prior to parturition and should be monitored for daily, starting one month prior to parturtion. The drop, in rare cases, can be as early as 14 days.
- **Mucous plug:** 10 x 15cm in size and can be lost anywhere up to 2 weeks prior to parturition but more usually 24 hours before.
- **Colostrum/mammary gland development:** occurs around parturition but is not reliable to predict parturition.

Several weeks prior to parturition, the cow may begin to show signs of discomfort as its system prepares for cervical and pelvic relaxation. These manifest as stretching of the body, lordosis, and the cow pressing her hind legs against the wall (Hermes *et al.* 2008). Immediately prior to labour, females may become agitated and restless, increase activity, or deviate from their normal behaviour. Other signs include increased urination and defecation (small sized faecal boluses), beating the vulva with the tail, reduced sleeping time, loss of appetite, throwing things at the belly, and, if permitted, seek soft ground (Hermes *et al.* 2008).

Once labour begins, the cow becomes restless and attempts to change position, sidekicks, lies down and stands up, and generally alters from normal behaviour. It is recommended the cow is left untethered, or at least on long tethers (Hermes *et al.* 2008).

The chorio-allantoic sac acts as a hydraulic dilator of the cervix as it passes through, and then as a natural lubricant following rupture, protecting the calf against pressure from the surrounding tissues. As labour progresses the chorio-allantoic sac may rupture, leading to the discharge of a large volume of fluid. This should be removed (if saw dust is used if not on a sand floor the distribution should be managed as need to be careful with calves) to prevent the area becoming slippery (Schaftenaar and Hildebrandt 2005). A bulge under the tail, initially containing the fluid filled amniotic sac, will appear and this will steadily become larger. In nuliparous cows, the calf will slide back and forth in the pelvic canal until the hymen ruptures. Eventually the calf will pass the caudal rim of the pelvis, and with the aid of gravity slide down the vestibule to pass out between the hind limbs of the cow. The actual expulsion of the calf can be fairly rapid and be completed within a few minutes (Hermes *et al.* 2008). The amniotic sac (which covers the calf) usually ruptures during the final passage through the vestibule, if not the mother will actively remove it (Schaftenaar and Hildebrandt 2005). Schaftenaar and Hildebrandt state that if the calf is not born within two hours of the rupture of the chorio-allantoic sac then intervention is needed. However, there have been a few cases were there has been a much longer period from rupture to delivery of a healthy calf. At Twycross a female gave birth 42 hours after rupture of the chorio-allantois, and elephants in a European survey ranged from 0.25-55.5 hours, 75% were within the two hours recommended (John Ray, pers. comm.). Longer calving periods are often an indicator of reproductive problems though, and in the case of the 55 hour labour, the dam was hypocalcaemic. In Pinnawela parturition time is given as 90 minutes (Dastig 2002).

Both anterior and posterior presentations are possible but posterior is thought to be more normal as it is thought to reduce the likelihood of dystocia (Schmidt 1999). All 24 calves at the Metro Washington Park Zoo were born tail first (Mellen and Keele 1994) and this is considered the most common presentation. Mellen also records the mother scuffing the floor with her front feet next to the recumbent calf, similar behaviour to that observed in the wild (Moss 2000). Similar behaviour is noted with untethered cows kept on sand, one example of this has been seen with births at Chester (see **www.biaza.org.uk** / members area/ resources/ animal management/ management guidelines).

The placenta is passed some 5-7 hours after the birth (Mellen and Keele 1994). In an European survey the placenta was passed within 3-40 hours with 87% of the elephants having passed the placenta within 10 hours after birth. The calf is helped to stand by the mother and other females and usually stands within 30 minutes with a range of 8-60 minutes. Suckling usually occurs within three to five hours after birth although it can be as much as 10 or even 18 hours

(Flügger *et al* 2001). Meconium is passed anything from four minutes to three hours after birth.

Twins are possible and occur in 1-2% of pregnancies (Schmitt 2006). Typically gestation is shorter for twins (Schmidt 1999), and the two can be born up to three months apart (Hermes *et al.* 2008), especially when still born. For example, at Port Lympne, one calf had a gestation of 682 days and the other 718 days (they were both still born) (Kurt and Mar 1996).

(Kurt and Mar 1996) suggest that there is a correlation with long gestations and the likelihood of stillbirths. A correlation is also apparent between length of gestation and infant birth weight; 600 day calves have a mean weight of 60kg, those born after 650 days have a weight of 110 kg and after 680 days of 130 kg, the last having a survival rate of only 20%. (Whalley 1994) carried out a survey on 32 Asian elephant births from 22 collections and found that calf weight varied from 80-172 kg with a mean of 116kg. However, with this data, there was no correlation between birth weight and gestation period.

A positive correlation has been shown between maternal birth weight and weight of calves, and heavier calves are more likely to be stillborn (Kurt and Mar 1996) (Clubb *et al.* 2009) though other studies have found this not to be the case. For example, a stillborn Asian calf at Chester Zoo weighed a massive 180kg (Spooner and Whitear 1998). It is essential that zoos record the weight of dams and young at birth, and monitor pregnancy so that sufficient accurate data can be collated.

Neonate weights for Asian elephants vary between 49-159 kg (mean of 100kg). Mean birth weight in Asia was found to be 74kg as against 106 kg in Europe. In Pinnawela weights of neonates ranged from 54-70 kg (Dastig 2002). (Mellen and Keele 1994) report the weights of four calves born in Metro Washington Park Zoo, ranging from 79kg to 102kg.

Primiparous dystocia: another aspect of asymmetrical reproductive aging is that there is an increase in primiparous females developing dystocia, especially if over the age of 15 years old. This is a multifactorial problem, principally the hymen becomes more rigid in older nuliparous animals, compounded by the fact that due to a high plane of nutrition the calf is often oversized.

Dystocia: over 50% of dystocias cases occur in primiparous females over 20 years of age (Hermes *et al.* 2008), but can occur in any cow, even multiparous. Previous vestibulotomy scares may have a negative effect on fertility. Medical management is discussed in Section 3.15.4.

Birthing plan: it is MUST that a collection formulate a birthing plan well in advance of parturition complete with logical justification for it and keep detailed records of each birth, from the onset of labour to the calf standing and suckling. This can be considered as a risk analysis of the parturition event and highlights all of the concerns that may occur and implement strategies to deal with them. Consideration should be given to the dam, the calf, the other elephants, and the keeping staff. A birthing plan starts from the confirmation of pregnancy and ends soon after parturition. It should consider, but not be limited to, the following points;

- Contact numbers for all staff involved, including emergency specialist, personnel for dystocias.
- Expected date based on matings or artificial insemination.
- Monitoring the end of parturition: techniques, where and what values based on the collection's experience with their own lab.
- Logistics: ensure capacity of staff, equipment, treatment protocols, etc prior to parturition.
- Monitoring protocol at the time of parturition: techniques and logistics required.
- Dystocia planning: needs, techniques, when to intervene, and how to intervene, emergency drug dosages and supply for calf and dam.
- Dam management at time of birth.
- Calf management after birth.
- Dam reproductive and general health (as well as that of the herd).
- Research samples (if required).

The birthing plan should be an evolving document that builds on the experience of each birth and the experience of other collections. It should reflect current knowledge and not become stale.

BIAZA strongly recommends that collections with pregnant females and imminent births contact the EAZA Elephant TAG, review the Veterinary Guidelines for reproductive management guidelines (Schaftenaar and Hildebrandt 2005), as well as papers detailing obstetrics in elephants (Hermes *et al.* 2008). The EAZA Elephant TAG have collected video footage of births and a DVD is available to review prior to birth. Review of these births has indicated a preference for cows to be left unshackled and with familiar females (Schaftenaar and Hildebrandt 2005).

Sand floors: The few births on sand floors have all been successful in regards to speed of calf recovery and standing (under six minutes and in first or second attempt). The immediate drainage of birthing fluids appears to help the calves stand up much quicker and without sliding and flopping around, that can cause stress and anxiety in the mother, which in turn can lead to horrendous scenarios. In one case that has been written up (see BIAZA Resources/Elephant) and anecdotally, the cow pushing the calf on sand, helped it stand up rather than send it sliding across the floor. No collections consulted for these guidelines regrets changing to sand floors for birthing. It must be noted that these births have occurred in well established herds and/or multiparous females. As herd births are also relatively new, success of the births cannot be put down to sand floors alone.

Use of chains during births: In a situation where a calf is born to a nulliparous cow, one that has not previously witnessed a birth to another cow, one that has a history of aggression towards her calves or dystocia, or if it known in advance that the calf is undersized or there are any other health concerns, it might be a good idea to *plan* to remove the calf immediately after birth for a rapid clinical examination and drying off, so it can stand without slipping as soon as possible, and any necessary treatment. If the calves are removed, it should occur within sight, sound and smell of the cow but safely out of her reach. Staff should all be familiar to the cow and kept to an absolute minimum. They should work as carefully, quietly and quickly as possible to ensure early return to the cow and to allow bonding to begin at once.

This management can only be achieved without compromising the safety of the keeping staff if the cow is adequately restrained. Chains (of varying number and attachment) make this possible. If a cow is made familiar with their use in the months preceding a birth, they do not appear to produce any additional stress at the time of parturition. They can be kept under no tension, unless the cow moves to the extremity of their length, and winched tighter only if necessary to assist with the separation of a neonatal calf, should the cow become aggressive. A recent birth at Twycross Zoo (2009) would have resulted in a very badly injured calf without the mother being in chains (loose then tightened) enabling the removal of the calf (N. Masters pers. comm.).

The decision to use chains should not be taken lightly as evidence continues to be gathered that restraint free births are less stressful and have a higher success rate than those chained. Each case is different and a cow with an apparently healthy gestation, in the right social environment, with birthing experience (hers or others in the group) and housing should be left to get on with parturition without restraint. See also the discussion on **infanticide** below.

Obesity: is a considerable problem in captive elephants (Kurt and Mar 1996) (Ange *et al* 2001), with 75% of captive elephants in the UK considered to be obese or massively obese (Harris *et al* 2008). Obesity is thought to be related to poor reproductive output and performance (Dierenfeld 2006), in particular to be a contributing factor in low fecundity, long labours, dystocias, stillbirths, and ultimately deaths of both cow and calf in many instances (Clubb *et al.* 2009), (Olson 2004). The relationship of obesity and reduced fertility and increase risk of stillbirths has been proved in many species including humans (Clark *et al.* 1998) (British Nutrition Foundation 1999) (Kristensen *et al.* 2005) (Baur *et al.* 2006). (Dastig 2002) reported that relative body weight in elephants was positively correlated with reproductive output at Pinnawela Elephant Orphanage.

Stillbirths and juvenile mortality: although the mortality of captive born elephants in European and North American zoos tends to be high, this is not the case for African elephants born in Europe. Most of the data on this subject comes from Asian elephants. (Keele 1996) analysed data from all Asian elephant births from N.A. up until 1996. Of those born between 1962 and 1996, animals that were stillborn or died on the day of birth comprised 20% of the total. Using a more recent data set, 1986-1996, this statistic increased to 25%.

Data from European collections was compared to South Asian elephants. A stillbirth rate of 16.5% was found in Europe, against a rate of 4% from working animals in Myanmar (Kurt and Mar 1996). Of 141 Asiatic calves born in Europe up to 1996, 37% died within their first year, compared with a population in south India of 4% of deaths in the same period (Schmid 1998a). Of the deaths within one year 48% were stillborn calves, 27% were killed by mothers and 25% died from other causes. A comparison between three Asian establishments and zoos in Europe and North America again showed a 35% occurrence of stillbirths in the zoo animals as against 3% in the animals in Asia. Similar results are shown for Asian elephants in Europe (Stevenson 2004; Stevenson 2004).

(Saragusty *et al* 2009a) reports that Myanmar and captive European African elephants have juvenile mortality rates of 21-23%, whilst that for captive Asian elephants in Europe and North America is almost double (40-45%).

The reasons stillbirths occur are not clear and it is likely that there are multiple factors at work including nutritional, obesity in cows and calves, infectious causes such as salmonella or EEHV, genetic, hormonal, stress, and many others. This is an area that further research is required, areas are suggested in (Clubb *et al.* 2009).

Infantcide: females have killed youngsters by kicking and standing on them. This has been interrupted as an aggressive action, but is more likely an extension of the natural behaviour of digging with the front feet and trying to help the calf to stand. This behaviour not be carried out on concrete floors but has been clearly seen in a birth on sand floors (see **www.biaza.org.uk** /members area /resources/ animal management/ management guidelines). Because of this, females, particularly primiparous ones, are often shackled for birth (see **Use of chains during birth** above). However, this process in itself may be stressful as it inhibits movement and social interactions with other females (Stevenson 2004). It has been suggested that females that have experienced birth in a natural i.e. breeding, group are less likely show this behaviour, this also applies to females who have always lived within one stable group (Kurt and Mar 1996).

It has been suggested (Schmid 1998a) that human intervention during birth and disturbance may have a negative effect on the behaviour of the cow, resulting in her killing the calf. A paper describing births of some calves at Chester Zoo gives an example of a female who was aggressive to her first two calves but good with the third born in with the rest of the females (Spooner and Whitear 1998) and there are some who firmly believe that elephants should never be shackled prior to giving birth (Bengt Holst, pers comm.). However there are also examples which show, that if the female had not been shackled, she would have certainly killed the calf (John Ray, pers. comm.). There is a school which maintains that elephant births should be managed with females being shackled and the calf removed immediately following the birth and reintroduced in controlled circumstances (Olson 2000). Others feel it is probably best to prepare for shackling with a primiparous female and then judge from the behaviour of the cow whether this will be necessary (Schwammer, pers. comm.). Others suggest that a cow should remain untethered, when possible (Hermes *et al.* 2008); (Schulte 2000).

Skewed birth sex ratios: artificial insemination and European Asian elephant births are predominantly male (Saragusty *et al* 2009a). It is possible that, using flow cytometry, that elephant semen can be sexed in the future, allowing selection of calf sexes (Hermes *et al.* 2009).

ULTRASONOGRAPHY

Ultrasonography is a relatively new modality for use in veterinary medicine. It is only in the last 20 years that it has been seen to be of use in zoo and wildlife medicine. Ultrasonography has now revolutionised elephant medicine and has become an essential part of any elephant medical or reproductive programme. Ultrasound I principally used in the assessment and monitoring of reproductive health and pregnancy (Hildebrandt *et al.* 2006). However, ultrasonography is not limited to this field alone and in the elephant it has application in most veterinary disciplines. The limiting factors for applications in the elephant is that the machine ideally should be portable (there are many available on the market), imaging viscera is limited by the depth of penetration of the probe (usually 30cm or so) and the length of the operators arm when used transrectally (although extensions can be utilised). When using transabdominally or transpalpebrally the skin/air contact makes imaging difficult, even when using ultrasound gel. This can be easily overcome with the use of running water over the area under ultrasound examination.

The following lists some of the documented areas where ultrasound has been applied successfully and in some cases lead to massive developments in our understanding of elephant medicine and physiology.

Reproductive health assessments: ultrasound is an essential modality in the assessment of normal reproductive health in both the female and the male elephant, especially as Asian females can develop sever reproductive pathology following on from asymmetrical aging of the reproductive tract (Hermes *et al.* 2004). Excellent reviews are found in (Hildebrandt *et al.* 2006; Hildebrandt 2006) with a focus on females in (Hermes *et al* 2000) (Hildebrandt *et al* 2000) and males in (Hildebrandt *et al* 2000). Reproductive tract pathology in elephants can be found in (Hermes *et al.* 2004; Hildebrandt *et al.* 2006).

Pregnancy: monitoring foetal health as well as aging foetuses is easily applicable. Transrectual techniques in the first trimester are especially useful and transabdominal possible later on in pregnancy. See (Drews *et al.* 2008; Hermes *et al.* 2008; Hildebrandt *et al.* 2007).

Dystocia: ultrasound is an essential tool in the management of dystocia and other obstetrical assessment. Knowing whether the cervix is open or not is mandatory when dealing with any elephant dystocia. See(Hermes *et al.* 2008; Schaftenaar and Hildebrandt 2005).

Artificial insemination (AI): is a specialist technique involving simultaneous endoscopy and ultrasonography in the female. Ultrasonography is also useful for assessing the male prior to ejaculate collections, as well as confirming female reproductive status. See (Hermes *et al.* 2007).

Ophthalmic: assessment of the eye and intraocular structures requires assessment with ultrasonography in conjunction with other techniques. A transpalpebral approach is utilised which overcomes the need to open the elephant's eyelids. See (Baproda 2008).

Other: applications for ultrasound in elephants will continue to develop, limited only by our imagination and knowledge of elephant anatomy. Currently ultrasound has also been documented in the use of retropharayngeal lymph node biopsy (Hildebrandt *et al.* 2005), the assessment of renal anatomy and disease (Hildebrandt 2006), confirming ventral oedema (Luikart & Stover 2005) as well as proving useful in the assessment of foot disorders (O'Sullivan and Junge 2001).

HORMONAL ANALYSIS

(Brown 2000) states that:

"considerable information is now available about the basic reproductive biology of elephants, especially females. However, as important as this knowledge is, it no longer is enough to simply compile it into a database. The potential exists for using endocrine monitoring techniques to solve real problems".

Endocrine monitoring is an essential part of assessing and monitoring reproductive health, as well as pregnancy monitoring and predicting parturition. It is possible to monitor the principle female reproductive hormones using serum, urine and faeces (Fieß *et al* 1999). Different hormonal analyses are available and the suitability of tests used in other species should be discussed with the individual laboratory used, in addition to their application in elephants.

Oestrus cycle: monitoring the oestrus cycle is essential for timing of natural matings, artificial insemination, and to assess the reproductive status of aged or nulliparous cows. The principle hormone utilised to monitor the oestrous cycle are the progestogens: namely serum or urine 5 α-pregnane-3, 20-dione (5αDHP). There can be considerable difference between individual's cycle lengths, but each cow typically has a consistent inter-oestrus period (Brown 2000). Oestrus synchrony is thought not to be common but is being more frequently reported (Weissenbock *et al* 2008).

The elephant is unique in that the major circulating progestogen is 5 α-pregnane-3, 20-dione (5αDHP) and others. Progesterone assays developed in other species give results due to cross-reaction of the various anti-sera, used in the test, with the elephant pregnanes. The degree of cross-reaction is not comparable between other tests, but is thought to be consistent with the same test. This means that despite the results for progesterone concentration being as much as twenty times higher than in reality, the qualitative nature allows monitoring of luteal activity to still occur. Problems arise when trying to compare data between different labs or when a collection changes testing facility.

Flatliners or non-cycling females frequently occur (see Reproductive Pathology and Barriers to Conception). These animals have serum progestogens levels that remain at baseline showing no ovarian activity.

Monthly sampling is recommended as soon as possible, increasing to weekly sampling when an animal reaches four years of age (Brown 2000). The EEP recommends fortnightly samples during the luteal phase and weekly when in the follicular phase. Testing should occur throughout life in combination with ultrasonography to establish when and why changes occur as the animal ages, and to compare these reproductive changes between individuals in the population.

Recent advances with the sensitive technique of headspace solid-phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS) have allowed the measurement of urinary androgens that can be used to characterise the luteal activity during pregnancy and the oestrus cycle (Dehnhard *et al.* 2003). The advantage being that the test is non-invasive and rapid, capable of being carried out within 1.5 hours. This test may be able to predict ovulation, but more data is needed for this to be confirmed.

Oestrogen measurements are possible in elephants but the circulating serum levels are low making it difficult to assess or correlate them with physiological changes. The use of oestradiol-3-glucuronide radioimmunoassay on urine oestrogen metabolites has produced interesting results (Czekala *et al.* 2003). The use of this assay supported the findings of the two follicular waves occurring in the follicular phase, and the likelihood that raising oestrogen levels stimulate the LH surge. Interestingly the urine data appears to be more reliable then the serum oestrogens.

Measurement of Lutenising Hormone (LH) is especially useful for prediction of ovulation, and when combined with ultrasonography provides optimal timing for matings or AI. Both spikes are similar quantitatively and qualitatively, yet one produces ovulation (ovLH) and one does not (anLH). Daily blood collections are required to detect these surges as LH is only elevated above baseline for one day. The anLH surge is typically 21 days before the ovLH surge. LH assays typically take 2-3 days to run and cannot be used to detect actual ovulation (i.e ovLH surge) if required for matings or AI: practically a retrospective test.

Pregnancy diagnosis: elevated progestogens beyond the normal luteal phase, i.e. 12 weeks, are diagnostic for pregnancy. An alternative is the mesurement of prolactin. This hormone is likely to be produced by the placenta and is responsible for mammary development and lactation amongst other things. The serum levels of prolactin increase considerably around 20 weeks of gestation (Brown 2000). A more rapid pregnancy diagnosis, available in Asian elephants, can be obtained by comparing the 17 α-hydroxyprogesterone (17 α-OHP): progesterone ratio, ≤ 0.7 indicating pregnancy as early as 2-7 weeks after ovulation. It should be noted though that variation with this test can occur with different assays depending on differing antisera specificities (Brown 2000).

(Duer *et al* 2002) showed that it is possible to sex foetuses from cow sera during pregnancy. The foetal testes produces testosterone in early gestation and cows that produced male calves had significantly higher levels of serum testosterone then those with female calves. The difference is not detectable until the second or third trimesters. (Brown 2006) points out though that the corpus luteum does also produce androgens.

Parturition: progestogens decrease 2-5 days before birth (range 1-10 days) (Brown 2000). Progestogen secretion is variable and a low cut off value is difficult, however if values fall to follicular phase levels then problems should be suspected if birth does not occur within a few days.

Daily monitoring of progestogens in the last month of gestation is recommended. It is essential to allow staff to be prepared for imminent birth and to assess when dystocia is occurring.

Measuring urinary androgens using headspace solid-phase microextraction (SPME) and gas chromatography-mass spectrometry (GC-MS) is a potentially useful, non-invasive method for predicting parturition. A steady decrease prior to parturition with a sudden drop to baseline 4-5 days prior to parturition has been reported (Dehnhard *et al.* 2003).

Cortisol can also be used to assess imminent parturition based on development and maturation of the foetal endocrine system. However, other stressors can result in increased levels of cortisol, levels can increase after parturition, and it is considered not to be useful assay when others are available.

Postpartum period: lactational anoestrus lasts approximately 46 weeks and is characterised by low progesterone concentrations. This period can be as short as 8 weeks if problems occur such as retained placenta, reduced milk production or death of the calf.

Male hormonal analysis: less is known about reproductive endocrinology in the male then the female (Brown 2000). Most of the work carried out on males is associated with musth.

Circulating androgens, including testosterone, dihydrotestosterone, and androstenedione are low during non-musth. Levels of testosterone dramatically increase in early musth by 5-10 times, with a peak of an increase of up to 25 times baseline levels. Androgen secretion is under the control of LH, with peaks in LH approximately four weeks prior to musth.

Assessing testosterone serum levels is important in bulls and is dependent on social rank, age, and correlates well with testicular weights (Brown 2000). There is considerable variation in testosterone production and multiple androgen analyses should be undertaken before assessing the reproductive health as good or bad. Testosterone assays should be combined with ultrasonography and semen collection as part of bull reproductive health assessments.

3.6.5 Development and care of young

It is important that calves are brought up in a herd situation (see CALVES in Section 3.3.1) and all effort should be made to this effect. Cows are extremely protective of their calves and may become dangerous. Asian elephant calves have been observed to suckle from females other than their mothers, but only when those cows had no calves of their own. Allomothering in African elephants is shown in captive groupins and follows as similar pattern to that observed in the wild (Douglas-Hamilton and Douglas-Hamilton 1975) (Moss

1988). This experience is probably of great importance to nulliparous females (Schulte 2000) and more studies on social interactions in a group post-partum are needed.

For milk supplements for handreared young, please see section 3.4.3 and note that a plan of reintroducing the calf to the dam and the herd as soon as possible should be drawn up. Young elephants start eating solids at about 11 weeks of age but usually continue to suckle for some years, often until the next calf is born. Young African elephants fed alfalfa as the major dietary constituent can develop inward buckling of the tibio-tarsal joints, probably arising from too rapid a growth rate. This is treated by reducing dietary protein intake (Schmitt 1986).

Training of the calf is very important, particularly in herds that have been exposed to herpes (EEHV) (see section 3.15). Until the spread and causes of infection are better understood, and particularly in these instances, it is imperative that the calves are able to give blood as this is the only diagnosis available for herpes. Appendix 1.1 is a document on calf training in free contact at Chester Zoo.

3.6.6 EAZA recommendations

It should be noted that managing captive populations involves the movement of animals between EAZA collections. Importation from elephant range counties would be considered by the EAZA Elephant TAG on a case by case basis[1].

The **EEP RECOMMENDATIONS FOR BREEDING MANAGEMENT (which are mandatory) are**: (Dorresteyn and Terkel 2000b) (Dorresteyn and Terkel 2000a):

- To bring all potential breeding bulls into a breeding situation.
- To exchange breeding bulls in a situation where they have sired a relevant number of (viable) offspring in one institution.
- To bring all potential breeding females, especially those under 25 years old, into a breeding situation. [*added 2002: check cyclicity in every case*].
- To encourage the development of matriarchal family units and that these should remain together i.e. with the intention of keeping female offspring within their family unit. [*added 2003: However it is important to ensure that young females are not bred with their fathers, and it may therefore be necessary to move sibling and half-sibling units for this reason*.] [*There is also anecdotal evidence that pre-pubertal African animals may be easier to integrate – note from BIAZA*]
- In those facilities that are unable to house a bull and have decided to send potential breeding females to a bull in another zoo, they should send the whole group or a relevant unit of that group temporarily to the breeding situation.
- Further development of AI techniques should be encouraged but not promoted as the most important method of reproduction. [*added 2002 AI must be carried out only upon recommendation and approval of the studbook keeper, just like any other breeding recommendation*].
- All zoos that rebuild elephant facilities should design new enclosures with the potential of keeping bulls and more than two cows [*n.b. see below*]. If a zoo is not able to start keeping a bull within a reasonable period of time, the EEPs will treat that zoo as a non-breeding facility and will promote that the zoo houses only females who are not able to reproduce. These females have a significant and important role in education. [*n.b. B&I recommendations state that this should be four or more cows, EAZA recommendations due to change*].
- It is of the utmost importance that a bachelor herd facility for several adult bulls be developed. That facility could and should act as a genetic reservoir but also as a stimulant for the development of relevant social behaviour between bulls. Bulls should be kept in the facility when they are temporarily not in a breeding situation or before reaching that stage. The facility should not primarily function as a surplus-male facility, but as a component of the genetic reservoir of the population.
- Young animals should be kept within their family group for several years and should not be transferred before five years of age. If this should happen they should be accompanied by at least one other member of the herd in which they were born. [*n.b. there are now incidences of young bulls disrupting the herd before the age of five. Therefore*

[1] Clarified and mention made of imporation.

this may need to be reviewed on a case by case basis.] [*Added 2003 – institutions* ***MUST*** *exchange keepers before and after moves to ensure continuity of management.*]

- When designing new facilities, consideration should include a fall-back position of protected contact. [*added 2002*].
- The situation in Europe is not very different from that in other regional breeding programmes, therefore close cooperation with other regions is essential e.g. the exchange of bulls.
- Although further research is needed, it seems clear that herpes-infections are a very important cause of death of young elephants in the EEP. Rotterdam is preparing a protocol of successful treatment. [*A protocol is being prepared on herpes and other transmissible diseases.*]
- Dissemination of information (veterinary, behavioural, management) is essential for the success of this programme.

Each individual animal should be categorised using the following definitions:

- ***No breeding future***: these animals should be moved to zoos that have no breeding facilities or kept in a breeding group for social reasons.
- ***Potential breeding in the future***: follow-up examinations required annually.
- ***Breeding future***: close monitoring is required.
    - Isolated bulls in this category should either be moved to a breeding facility or be used for AI or, if applicable, females can be brought to the bull for breeding.
    - Cows in this category which are in institutions with a non-reproductive bull should be used for AI or the institution should acquire a reproductive bull, or the cow should move temporarily to an institution that keeps a reproductive bull.

From these guidelines it is apparent that central to the success of the programme is the methodology for correct identification of the reproductive potential of bulls and cows. The main methods are:

- Behavioural records.
- Ultra-sonographic examinations.
- Hormone profiles (from blood, faeces or urine).
- Semen quality in males.

[The purpose for which semen is being collected ***MUST*** *be clear in all cases and no AI should take place unless recommended by the TAG species coordinator.]*

EAZA RECOMMENDATIONS RE: MANAGEMENT PROTOCOLS

Because of the many problems associated with keeping and breeding elephants in captivity, **members of EAZA are expected to follow certain protocols as detailed below** (Dorresteyn and Terkel 2000b) (these are mandatory):

- *Cystic malformations*:
  - The intercalving interval should be restricted to a maximum of five years.
  - Cows should start breeding at the age of approximately 12 years.
- *Herpes virus*:
  - Asian and African elephants should not be kept in mixed groups.
  - Each young (<10 years) elephant showing symptoms of undetermined illness should be suspected of a herpes virus infection. Diagnosis by PCR should be carried out immediately (samples to Berlin or Rotterdam). Early treatment with famciclovir is highly recommended.
- *Anaesthetic death*
  - Proper restraint devices are essential to reduce risk.
  - Further research into anaesthetic procedures is required.
- *Neonatal death*
  - Maternal neglect or aggression can be a problem and is helped by improvement in group management. Old facilities, where the animals are chained or kept isolated, should be transformed into group accommodation in order to give young females the opportunity to learn maternal behaviour from herd mates.
- *Monitoring of oestrus cycle*
  - During the luteal phase, females should be sampled at least every two weeks. During the follicular phase, weekly sampling is required.
- *Monitoring during pregnancy*
  - During pregnancy monitoring should take place every two weeks.
  - Ultra-sonographic examinations in early pregnancy are recommended to identify twin pregnancy and to monitor the pregnancy.
  - At the end of pregnancy i.e. from week 89 samples should be taken x3 per week.
  - Accurate veterinary assistance during the calving process. Many institutions wait too long before intervening in a dystocia.
- *Monitoring the bull*
  - Every potential breeding bull should be examined using ultrasonography around the age of eight years and annually thereafter in order to determine the development of the reproductive organs. A semen sample should be collected and examined at the same time.

If a collection is not prepared to comply with these EAZA recommendations then it should be planning not to keep elephants in the future as it will not be able to receive animals or take part in the EEPs. European zoos are fortunate in having Thomas Hildebrandt and his team based in Berlin and the Reproductive Biology Department at the German Primate Centre in Göttinghen. Protocols have been developed for zoos to send urine, faecal and blood samples there for hormone evaluation (Oerke *et al* 2001).

Areas in most need of further research to aid our understanding of elephant biology and breeding have been identified by EAZA as:

- The influence on reproduction when two bulls are kept in the one enclosure, effects of dominance behaviour.
- Preservation of semen.
- Cause of the development of cysts in the female reproductive organs and leiomyomas (tumours).
- Medical treatment of cysts.
- Influence of hormones (prostaglandins, etc,) on the reproductive cycle in females.
- Pregnancy and foetal development.
- Analysis of specific circumstances of post neonatal survival and death, with the goal of setting up a protocol for neonatal management.

It is also worth noting that lack of production of surviving offspring from one Asian bull in was attributed to a chromosomal centric fusion (i.e. the fusion of two chromosomes), resulting in a reduction in fertility (Kurt and Hartl 1995).

3.7 Population Management[1]

3.7.1 Overview

As has been pointed out, captive breeding of elephants in zoos has not been good (Clubb and Mason 2002) (Mason and Veasey 2009), and the majority of births have taken place since 1980. Although the birth rates are increasing, so is are juvenile deaths although at a slower pace (Saragusty *et al* 2009a). None of the captive zoo populations are self-sustaining and it is interesting to examine the reasons for this. The EAZA Elephant EEPs initiated a 'Forward Planning and EEP Management for Elephants in EAZA Institutions' in 1998 (Dorresteyn and Terkel 2000b). The annual birth rate subsequently increased to ten per year (Dorresteyn 2004) implying that management factors are as important as the biological factors mentioned below. This birth rate should increase as more cows become muliparaous - the probability of calf survival increases dramatically with a cows second, third etc calf (Belterman 2004) (Clubb *et al* 2008).

However, (Clubb *et al.* 2009) demonstrate that zoo born Asian female elephants have a lower survivorship than wild born Asian female elephants. This is irrespective of how long the elephants have been in captivity. They show that Asian elephants are moved between zoos five times more frequently between European zoos than female African elephants and are separated from their mothers at half the age seen in African elephants. The

[1] This section has been updated (2009).

main causes of infant mortality are dystocia, infanticide, maternal neglect and especially for Asians, herpes virus (Clubb and Mason 2002). Adult deaths reportedly stem from cardiovascular disease but frequently for reasons unknown. (Clubb *et al.* 2009) propose that the two main candidates are obesity and stress, not necessarily exclusively. Neonatal problems and obesity are discussed elsewhere (Sections 3.4, 3.6, 3.15).

Chronic and acute stress has been seen, in many species including humans, to reduce adult life span and fertility and increase the rates of still born, impairs maternal care and infant survivorship and can induce senescence. Zoo elephants are subject to a number of known or likely stresses throughout their lives such as chaining and more specifically to Asian elephants, repeated moves and early separation from mothers. (Clubb *et al.* 2009) strongly suggest that the stress during an elephant's life time in captivity, together with the stress hormones zoo born Asian elephants may have been exposed to *in utero* (perhaps their own mothers are stressed) and/or inadequate parental care may disrupt stress responses throughout life (therefore able to cope less), elevate stress-related disease and shorten lifespan which would explain the effect that birth origin has in Asian elephants. Therefore the EEP recommendations (see above) on transferring the whole maternal group rather than splitting it up **MUST** be adhered to. However, stress and the causes and effects of moving elephants needs much more research (see Section 3.17) and due to the long generation time, it will be some years before the result of current practices believed to reduce stress and increase welfare, will become apparent.

3.7.2 African Elephant

NORTH AMERICA

The population continues to decline, the reasons for this include; lack of reproduction, poor calf rearing, a perceived shortened reproductive and total lifespan in captivity, small percentage of males who are proven breeders and an aging population [Olson & Weise 2000 #1840]. Only 25 calves had been born as of 1.1.1999 (the first one in 1978) and of these only six remained alive by the end of 1999 (although two calves were born in 2000 as a result of AI). (Wiese and Willis 2004) showed that the African elephant average life expectancy in North America was 33 years.

A similar picture to that discussed for Asiatic animals exists in that 33% of calves died within the first month of birth. However the population is relatively young and has the potential to become self-sustaining if reproduction and juvenile survivorship increase. Nineteen elephants contribute to the living descendents with 94.7% genetic diversity. However, this can not be maintained long term unless a significant number of the 70 potential founders are brought in to breeding situations and produce living offspring (Keele and Olson 2004).

As of 11 February 2008 there were 219 (32.187) African elephants of which 156 (25.131) in 45 collections participate in the SSP. Seventeen calves (10.7) have been born since January 2003 and survived until February 2008 (Olson 2008).

Predictions suggested that immediate action is required to achieve pregnancy in as many cycling females as possible.

EUROPE

All information on the European programme was provided by Amelia Terkel, Ramat Gan, the EEP coordinator and studbook keeper and updated through ISIS. In September 2009 there were 204 living animals (50.154), a negligible rise from the data published in the 2nd edition of these guidelines (data current to October 2005), the oldest being a female aged 55. Since 1980 88 have been born in European collections, of which 73 survived for more than one year, a survival rate of 83%. The survival rate for calves to a year old born between January 2003 and December 2008 drops to 77%. Although not as good as it was, it is still much better than the North American region for both species and Europe for Asians. The population is relatively young, with the bulk of females aged under 40 and males under 30. The number of young born each year is increasing (see graph, Fig. 32). However the population is not yet self-sustaining (Hulbert 2004): in order for this to occur fecundity would need to be considerably increased and at least six surviving calves to be born per year (Terkel 2004). The main problem is that there are not sufficient females in breeding situations. The number of founders to the living population has increased to 46 descendents (of which 24 are alive) retaining 94.9% of the genetic diversity (Terkel 2004). There are a further 100 potential founders, though a significant number of these will be non-reproductive. Fifty one (12.39) elephants have bred and there are a number currently pregnant and others coming in to breeding situations. Thus although the population appears to have faltered in the recent years, there is an excellent potential for this population to become sustaining. However it should be noted that unless the survivorship and fecundity increase, there is not a sufficient genetic base for either population to retain 90% of genetic diversity for 100 years.

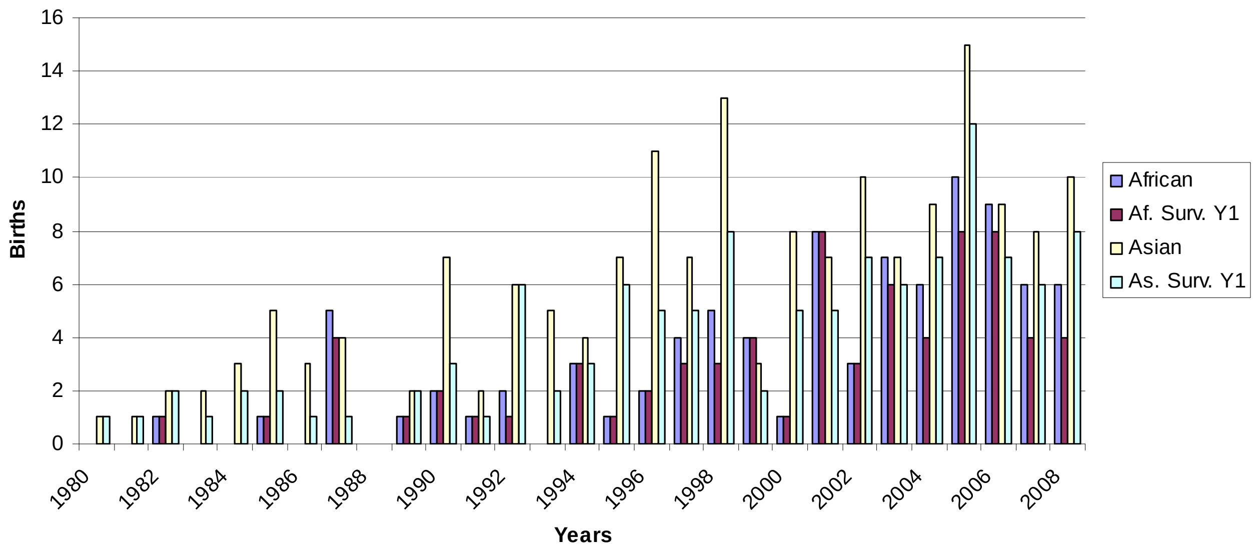


FIG. 32: ELEPHANT BIRTHS IN EUROPEAN COLLECTIONS

3.7.3 Asian Elephant

Survivorship of Asian elephant calves is not good – infant mortality rates for North American and European populations are almost double (21-23% (Saragusty *et al* 2009a)) that in Myanmar timber camps (24% - (Mar 2002)). Calves in Myanmar tend to be over 6 months old and die due to insufficient milk intake, snake bites and accidents. In contrast, 68-91% of calf deaths in zoo populations occur in the first month due to stillbirths, lack of mothering, stress imposed by captivity, obesity, primiparous females and infectious diseases (Clubb *et al.* 2009) (Saragusty *et al* 2009a). (Saragusty *et al* 2009a) argue that the zoo populations should aim for an infant mortality rate of 10%.

NORTH AMERICA

The situation is not good, and the population is not self sustaining. Fecundity is poor and first year mortality is almost 30%. The analysis was carried out on the regional studbook current to January 1999. The oldest breeding cow was 32, again highlighting the problem that captive females in North America become reproductively senescent in their mid 30s (Wiese 2000). Recently it has been shown that the average Asian elephant life expectancy in North America is 35.9 years (Wiese and Willis 2004). Using current fecundity and mortality figures the female population of 241 will dwindle to 13 animals at the end of a 50 year projection; however with a realistic increase in fecundity and drop in mortality the population could recover. One major problem was that there were only 18 bulls in 12 institutions. Thus a similar picture emerges with a need for an increased conception rate in fertile females and a reduction in infant mortality. However recently (Faust *et al* 2006) it has been shown that the population is not self-sustaining and is declining at 2% per year due to insufficient birth rates. A large increase in the number of births is required to reverse this trend.

EUROPE

Ton Dorresteyn and Martin van Wees (the EEP coordinators), and Rob Belterman (the studbook keeper), at Rotterdam Zoo provided all the information and was updated through ISIS. The population in the studbook in September 2009 is 335 (78.257). There are 108 founders to the living population, of which 42 are living founders. Although young being born per year has increased substantially since the mid 1990s, the mortality rate in the first year (taking data from 1980-2008) for animals born in Europe is 32% with most of these being within 24 hours of birth (26%), and 82% of these being still births. Data for 2003-2008 shows 19% of calves die within 24 hours. Significantly more bulls were born than cows, particularly in births following artificial insemination (Saragusty *et al* 2009a).

The Asian population shows that the number of births has increased, but not to the twelve births per year needed to make the population sustainable (Belterman 2004). The key therefore is to improve survival rates of young elephants. The population is older than the African one. Within the EEP population of 257 cows, (in 2009) 68 were proven breeders, but there are still some potential breeding animals that are not in a breeding situation. Stillbirth is a significant factor in infant mortality in Asian elephants in Europe and an increase in the reduction of these would help significantly (See Section 3.6.4: stillbirths).

An analysis by Wilcken (unpublished report, 2005) on the European population, using data up until the end of 2004 is encouraging. He points out that since 1999 the percentage of institutions holding both sexes has increased by 9% and the proportion of females with access to males has increased from 43 to 59%. He also calculates that females with access to males gave birth to an average of 0.097 calves per year, figures which compare well for elephants camps in India, Sri Lanka and Myanmar (of 0.1). He calculates that the breeding population i.e. those housed in potential breeding situations the population has achieved a growth rate of 2% per year. This is not sufficient to compensate for non breeding animals. He suggests that if all females had access to males the population could grow at a sustainable rate.

INDIA

It is interesting to compare these data with that from animals in logging camps in Tamilnadu, India (Sukumar *et al* 1997) (Sukumar 2003) and Myanmar (Mar 2002). It should be noted as that animals went into the forest to feed at night, matings could be both from wild and captive bulls; it is thought that the majority may have been from wild bulls. Data from 261 captive births from 1925 showed a birth rate of 0.095 young per cow per year (as against 0.21 for wild animals). However the 20 years from 1969-1989 (28 cows, 55 births) showed a birth rate of 0.155 young per cow per year; a growth rate of 1.8% per annum. There was a slight indication of maximum conception occurring after the onset of the monsoon giving a birth peak of December to February. The mortality rate in year one was 24% for males and 16% for females reducing in subsequent age classes until age class 60-80 when all remaining animals died, the oldest cow reached 79 years of age.

3.8 Elephant Handling and Training

3.8.1. ELEPHANT TRAINING: RATIONALE AND JUSTIFICATION

The principle aim of zoo management MUST be to optimise the welfare, education and conservation utility of their animals within the constraints of the facilities, staff ability and the elephants held. Elephant management should result in a net benefit to, or at least not compromise, the welfare of captive elephants. Additionally management practices MUST ensure staff safety, without unduly compromising the conservation potential and welfare of zoo elephants. It is important to note that traditional methods of 'breaking' and other aversion practices as described in the Clubb and

Mason report are never used in BIAZA collections. Methods used to train captive born animals are explained in the text[1] and Appendix 1.1.

For the purpose of this document training can be defined as the teaching of new behaviours that facilitate subsequent handling, and handling as the ongoing management of elephants through the use of trained behaviours. Handling and training will overlap since ongoing handling will reinforce previously trained behaviours.

Elephant training should be planned so that it comes close to representing the needs of the elephant in the captive environment and should encourage normal behavioural activity.

Elephant training and handling is carried out in British and Irish zoos for the following reasons:

- To facilitate the safe handling, movement and routine husbandry procedures, carried out by keepers, such as washing and basic foot care.
- To facilitate essential veterinary procedures such as blood sampling and injection.
- To facilitate the demonstration of educational aspects of elephant biology and of natural behaviours where it is considered appropriate, for the promotion of a greater understanding of elephants and their conservation.
- To facilitate transport of elephants in support of aconservation reproduction programme.

For all these purposes the guiding principles are *safety*, of both elephants and people, and *animal welfare.* There **MUST** be a clearly identified net welfare benefit before any sort of training regime is commenced and relevant safeguards **MUST** be observed and records maintained. For these reasons the following are required:

- Risk assessments **MUST** be carried out for staff/elephant interactions and public/elephant interactions (see Appendix 3)
- A full protocol of the elephant management and training methods used by the institution with a manual for staff to include Risk Assessments **MUST** be available. A copy should also be sent to BIAZA so that copies can be made available to other collections.
- A full Elephant Profile should be carried out on each animal over six months and updated at least annually (see Appendix 4 for an example). This should include individual differences in elephant behaviour with different members of staff.
-
- Any animal that has attacked a keeper **MUST** be put into protected contact until a full review of the situation surrounding the attack has been carried out. After this review, if the decision is to put the animal

[1] This sentence has been added due to the description in the Clubb and Mason document of breaking and other aversive methods of training.

back to a free contact situation this **MUST** be fully justified in combination with renewed risk assessments.

RISK ASSESSMENTS

In the UK help and guidance can be obtained through the Health and Safety Executive [Health & Saftey Executive 1998 #2470] and (**www.hse.gov.uk**).

The five recommended steps in carrying out a risk assessment is:

- Look for the hazards
- Decide who might be harmed and how
- Evaluate the risks and decide whether the existing precautions are adequate or whether more should be done
- Record your findings
- Review your assessment and revise if necessary

Risk assessments **MUST** be carried out regarding elephant staff safety, and staff/elephant/public safety. These assessments should include all aspects of enclosure design. These assessments should result in the development of better protocols and improved and safer design of elephant facilities for staff and animals. Risk assessments are necessary for all management situations and MUST include the following; radio contact MUST be maintained at all times when working with elephants and when in free contact keepers MUST carry an ankus.

An example is given in Appendix 3, Section 6.3. This should be completed for each individual keeper for each elephant and reviewed regularly.

ELEPHANT PROFILE[1]S

There are a number of reasons for creating an elephant profile

1. To facilitate the training of new staff
2. To help tailor management to individual elephants
3. To assist in the risk assessment process

In essence the document should be used to guide and tailor the management of elephants whereby individual welfare can be optimised in a manner that maintains keeper safety. Whilst the document is a guide, changes to management should be made at any time according to new information or incidents as appropriate. To facilitate this ongoing review process, collections are encouraged to collate daily records in a manner in which information can be usefully extracted. Categorising comments in ARKS, for example, can be particularly useful in this regard such that aggressive, reproductive notes etc, can be readily identified. A bi-annual review of the profile should incorporate

[1] This section has been updated.

a review of these daily keeper records, which should in turn be used to identify ongoing changes in management and husbandry on a real time basis.

The recommended format for the elephant profile is as follows:

1. **Taxonomy**:
2. **ID**: House name, studbook number and ARKS ID
3. **Sex**
4. **Date of Birth and Birth Location**
5. **Sire and Dam ID**
6. **Physical description**: To include distinguishing features.
7. **History**: This should include details of previous management, holding facilities and all known misdemeanours.
8. **Disposition**: A particular emphasis should be paid to areas which may have H&S implications, such as, 'this elephant is nervous around strangers', or 'this animal has a tendency to lash out with his trunk' etc. The description should include a description of the animal's nature (accepting that this may seem subjective) and an estimate of how predictable, tractable etc the animal is.
9. **Relationship with other elephants**: This should cover the animal's status, the way the animal behaves in the presence or absence of other animals, whether the animal bullies or is bullied by other animals etc.
10. **Medical summary**: This will include any ongoing medical conditions, and areas requiring ongoing attention. Once again where medical conditions may impact upon H&S or elephant welfare, these points should be highlighted.
11. **Training methods and handling strategy**: This should include a list of commands the elephant has been trained to do, together with a description of how the elephant responds to handling, and a proposed handling strategy to include which staff are able to handle the elephant and to what level. A statement of ongoing training plans (if any) should also be included, together with the rationale behind the proposed plans.
12. **Health & Safety points**: This is an opportunity to highlight all potential points relating to H&S management that may or may not have been previously described into a section where this information can be readily extracted.
13. **Other comments**:

See Appendix 4 for an example of a filled in profile and a condition score sheet for Asian elephants.

3.8.2 Elephant Management Systems

BACKGROUND

There is a continuum of methods for keeping elephants in captive environments. These range from the ***no contact*** situation where elephants are not handled unless restrained or under chemical sedation. In this situation elephants are treated as other zoo animals with very limited training. In Europe a minority of collections operate this form of management – in Britain Howlett's keep elephants under this sort of regime.

Elephants are more commonly managed through more intensive training and contact with keeping staff. The two basic systems for managing elephants this way have been termed, ***protected*** and ***free contact,*** which entail two different forms of training and management (Olson *et al* 1994). Free contact (FC) involves staff being in with the elephants in their enclosure and in protected contact (PC) the staff are outside the elephants' area. Although there is a diversity of approaches, even within specific management systems, all share the common training method of operant conditioning. A full explanation of terms used during training and handling is provided in the section on training and in Appendix 1, Section 6.1.

TRAINING METHODOLOGY AND TERMINOLOGY

It is useful to clarify the training methodology and terminology used in elephant training before giving details of how they are applied in free and protected contact. A useful background to the topic is given by Karen Pryor (1999) and by Dineley (1990). Elephant training relies upon the use of classical and operant conditioning.

Classical conditioning
Conditioning is a process involved in learning in which an animal forms an association between a previously *significant stimulu*s and previously *neutral stimulus* or response.
In *classical conditioning* an association is formed between a significant stimulus such as the sight of food and a neutral stimulus such as a flashing light. It is used to train, pair, condition or create an association between a stimulus that normally would not have any effect on the animal and an animal's response. A well-known example is Pavlov's dogs that would begin to salivate upon hearing a bell, in anticipation of receiving food. Initially the bell meant nothing to the dogs. After successive feedings immediately following the sound of the bell, the dogs began to associate the bell with being fed. Thus the dogs began to salivate immediately upon hearing the bell, regardless of whether food was present. Classical conditioning thus causes an animal to learn the association between two autonomous stimuli.

Operant conditioning
In operant conditioning a relationship is established between an aspect of the animal's own behaviour – *response* - and the occurrence of an external event - *consequence*. Thus a bird may associate turning over a leaf (response) with finding an insect (consequence) and each time he finds one the response is reinforced, i.e. the association is formed between a behaviour – *response* ***R*** - and a consequence–*stimulus* ***S***.

There exists a *contingency* between the **R** and the **S**. This means that whether the stimulus is administered depends upon the occurrence of the response: behaviors not being performed can NOT have a consequence.
Any behavior can be followed by 4 different consequences

1. a pleasant event can start or added
2. a pleasant event can end or taken away
3. an aversive event can start or added
4. an aversive event can end or be taken away

In operant conditioning a behavior can be strengthened or weakened depending on the stimulus being associated with the behavior.

Anything that strengthens a behavior - *increases* it occurrence or makes it more likely to occur - is termed a ***reinforcer***

Anything that reduces a behavior - *decreases* it occurrence, makes it weaker, or makes it less likely to occur - is termed a ***punisher***

The 'reinforcement' and 'punishment' can positive or negative. The words ***'Positive'*** and ***'Negative'*** are used as technical terms and are not to be confused in the common sense. The term 'positive' reveres to 'add' or 'start' something; 'negative' means to 'remove' or 'end' something.

	Reinforcement (behavior increases)	**Punishment** (behavior decreases)
Positive *(meaning adding something)*	***Positive Reinforcement*** **R+** Something 'good' is added	***Positive Punishment*** **P+** Something 'bad' is added
Negative *(meaning removing something)*	***Negative Reinforcement*** **R-** Something 'bad' is removed	***Negative Punishment*** **P-** Something 'good' is removed

Some examples of each consequence:

+ reinforcement

Definition: *The **adding** of a **pleasant** event contingent on a behavior with the goal of **increasing** the likelihood of the behavior in the future.*

Example: the elephant lifts it foot and the keeper gives him/her food.

+ punishment

Definition: *The **adding** of an **aversive event** contingent on a behavior with the goal of **decreasing** the likelihood of the behavior in the future.*

Example: the elephant tries to grab keeper performing foot care and the elephant handler becomes physically firm.

- reinforcement

Definition: *The **removal** of an **aversive** event contingent on a behavior with the goal of **increasing** the likelihood of the behavior in the future.*

Example: A technique for teaching to present the ear in FC involves using the ankus hook behind the ear and releasing the ankus hook at the moment the elephant opens its ear.

- punishment

Definition: *The **removal** of a **pleasant** event contingent on a behavior with the goal of **decreasing** the likelihood of the behavior in the future.*

Example: The elephant is performing an unwanted behavior and the food rewards are stopped

Primary reinforcers

A primary reinforcer is a stimulus that satisfies the biological needs of the animal and is not dependent on learning. Primary R+ often includes food, water, social interaction, mating...
Food rewards are the most common used primary reinforcers in elephant management systems.

Secondary reinforcer

To liaise the consequence to the behaviour clearly, the consequence has to follow *immediately* after the behaviour. To overcome this time lapse, a secondary reinforcer – *bridge or conditioned reinforcer* - is created. A secondary reinforcer is a stimulus that the animal has to learn to like, thus is created using classical conditioning (an association between 2 independent stimuli).
A bridge is a term for the association between a stimulus such as a whistle, clicker or a vocal praise and the *primary reinforcer*, a tangible reward, such as food. Creating a bridge is very important as it is often very difficult to present the actual reward at the correct time in order to reinforce the behaviour. The secondary reinforcer will 'bridge' the time between when the elephant executes the desired behaviour and when it gets its reward.

Elephant trainers establish a connection by pairing a primary reinforcer (food reward) with a secondary reinforcer (clicker, a whistle, or a vocal marker as "good", etc). Initially these signals are meaningless but once this bridge is known by the animals, they react to it as they would to the primary reinforcer. The association is established by applying the secondary reinforcer and delivering the food reward at the same time. This is repeated many times in a row with pauses in between the trials. After a series of trials, the elephant begins to associate the sound with an upcoming treat. The sound becomes a signal for the upcoming reinforcement.

Bridging is also essential for *shaping behaviours.* Training an elephant to execute any given behaviour is essentially an exercise in problem solving. The elephant has to figure out what the trainer wants in order to receive a reward. The clearer the trainer can communicate the goals to the elephant, the quicker the goals can be obtained. This is done through *successive approximation* or *shaping*. Successive approximation is teaching a behaviour by dividing it into small steps and teaching one step at a time until the behaviour is achieved. Shaping is improving with positive means, a series of steps to get the required end result. The trainer primarily uses *positive reinforcement* to teach the elephant each step of the behaviour.

Negative reinforcement can also be used in a mild form. However, it can not function as a tool for learning new behaviours in a protected contact situation.
The difference between negative reinforcement and (positive) punishment is often very subtle and therefore often confused. As explained earlier, the terms do not

mean the same thing. Negative reinforcement *encourages* the repetition of a behaviour by removing something aversive in conjunction with the performance of the desired response. Punishment on the other hand is used to *extinguish/decrease* a behaviour.

In the case of R-, the trainer must be able to control the aversive element that is being taken away. In order to remove the aversive event, however, it had to have been initiated by some point. But administering an aversive event might reduce whatever behaviour was performed when the aversive event was applied. Also reducing a behaviour by adding an aversive event is positive punishment. Thus in order to use R-, P+ is employed as well.

The use of an ankus to *cue* a behaviour can be an example of negative reinforcement. An ankus is a tool used by many elephant handlers in FC (not applicable in PC situation!) and a *cue* is a stimulus where the response is reinforced. An example of negative reinforcement is applying pressure when placing the tip of the ankus against the back of the elephant's leg to communicate to the elephant to move its leg away from the pressure. This action can then be rewarded with food and praise using positive reinforcement to further communicate to the elephant that the behaviour of moving its leg was correct. Conclusion: R- and P+ are interrelated and not applicable in a PC management.

To reduce undesirable behaviour, the reward used in positive reinforcement is withheld and a different behaviour is demanded immediately after the undesirable behaviour is presented to avoid any notice is given to the unwanted behaviour. If the elephant persists being uncooperative or even shows signs of aggression, a *time-out* is implemented which will decline uncooperative behaviour of the elephant. This is where the trainer stops the session immediately and leaves the training area. All impulses are removed from the elephant for a short period of time, so the elephant has no influence or impact on the trainer/session at all. A time out is only effective in protected contact system.

Influences on training

There are many variables that affect the elephant's response while being trained; the social structure of the herd, the surroundings where the trainer is working, the number of trainers teaching a behaviour, the elephant's health, and the elephant's demeanour to name a few. Recognizing these variables is crucial to success. Training can be more productive if some of the variables are eliminated or controlled.

One variable that can easily be controlled is the number of trainers teaching a behaviour to an individual elephant. It is highly recommended that only one trainer be given the responsibility of training a new behaviour. The trainer has to have knowledge of every aspect of the training process: the elephant's demeanour, its daily response to the training sessions, its response to the shaping procedure and its day to day level of understanding of the training process. More than one trainer may introduce inconsistencies to the training process, which may unintentionally cause confusion and anxiety on the part of the elephant.

In protected contact another variable that can be controlled is removing the elephant being trained from its herd mates during a training session. By having only one elephant in the enclosure when initially training the elephant, will eliminate the problem of other elephants affecting the response of the elephant being trained. Although a lot of thought needs to be taken into consideration here. It is important to create a circumstance for behaviours to be achieved without interfering with the herd dynamics. Splitting off one individual from the herd can have a negative effect on its psychological wellbeing and can be detrimental as prolonged visual separation will increase anxiety in all parties. (More on this in section Protected Contact)

An additional critical element that influences the psychological well-being of the elephants is achieving a meaningful human/animal relationship. In protected contact the trainers/keepers are still allowed to create a close relationship with their elephants in a positive way but without the barrier of sustained domination.
Although it is wrong to assume that the exclusive reliance on positive reinforcement methods automatically assures the well-being of the elephants. Inconsistent, incorrect and incompetent use of positive reinforcement technique can create frustration and confusion to the animals and ultimately result in aggression.
Recognising when to stop the training session is equally critical. Too often a handler making progress on a behaviour goes for 'just one more' only to find everything fall apart. In this case it is often beneficial to go to another, already established behaviour. By doing so the handler takes the elephant back to something it understands and creates an opportunity to positively reinforce the animal, ending on a positive note. Ultimately, it is more beneficial to stop and leave the animal wanting more than to satiate the animal's interest or lose its motivation. Likewise, knowing when to discontinue a *time out* or other punishment is equally as important.

Developing a training protocol, or a plan of action outlining the steps to be taken when training or shaping a behaviour, is recommended. Recording the incremental steps in the shaping of the behaviour is a sign of a good trainer since the trainer is constantly evaluating the behaviour comparing what it was to what the trainer wants it to become. A plan of action helps the trainers evaluate their progress in reaching the goal behaviour. This progression is often noted by trainers in personal journals or training logs.
Training should be a rewarding experience for the animal and build its confidence. Poor training methods can cause an animal to suffer emotional and physical distress, make it anxious, confused, aggressive and unreliable. Once done, this emotional damage is difficult to correct.

Poor training methods include:

- Too many people training a single behaviour. It is much easier for one individual to evaluate the progress of a particular behaviour in the training process.
- Not following a training protocol. The protocol should consider variations to the shaping of a behaviour, but training a behaviour without a protocol can create confusion and undermine the elephant's learning.
- Not breaking a behaviour down into small enough increments. Difficult or new behaviours should be segmented into smaller units. These small successes provide the animal the confidence to try solving more difficult problems.
- A situation may occur when the elephant is not 'listening' to the handler and not performing the correct responses to commands. When this occurs it is best to terminate the session and repeat it again later or the following day. It is not constructive to start the animal on a different chain of commands i.e. telling it to do something different, when this situation occurs.

- Training the next level of the behaviour before the previous level is well understood and/or training the more difficult behaviours before the basics are well understood. Training basic behaviours builds confidence and creates a pattern of learning. If the basic behaviours such as standing still, move up, back up, move to the left or right, are not established, then the handler and the elephant will be distracted by just getting into position.
- Improper reinforcement of behaviours. It is important that the elephant understands which behaviour is being reinforced. Superstitious behaviours develop when the elephant perceives that it is being reinforced for one behaviour while the handler is actually reinforcing another.
- Improperly timed reinforcements. Timing is essential to provide the correct information to the elephant.
- Overuse of a bridge or a reinforcement (positive and negative) will diminish its effectiveness by desensitising the elephant to its use.
- Accidentally reinforcing inappropriate behaviour, i.e. behaviour which is not desired by the handler.
- Improperly using punishment, correction techniques and time-outs.
- Inconsistency of understanding from handler to handler of the parameters of the behaviour. The parameters of the behaviour, or level of performance including the timeliness of the response, should be clearly defined and well understood by each handler so the elephant will be rewarded or corrected consistently to conform to the parameters of that behaviour.
- Using punishment as a primary training tool. Training is an effective tool that should have a positive effect on the elephant.
- Not taking care of the elephant's basic needs before the elephant is trained. If the elephant is not physically healthy and secure in its surroundings it cannot be expected to concentrate during the training session.
- make certain the psychological requirements of the individual are met: separation from its conspecifics could create nervousness to the individual with the result that training will be associated with something negative and a (good) training session is unfeasible .

Regular daily training sessions are recommended as they are an effective and reliable means of maintaining behaviours. An elephant, in any management system, should look forward to these training sessions due to the rewards, including the attention it receives. If this is not the case, then something may have gone wrong in the training process. It is important to maintain and create an elephant friendly environment where the handlers have knowledge of each animal’s wants and needs.

Apart from the opportunity to reinforce learned behaviours and teach new behaviours, a daily routine provides:

- A constant in the relationship between the handler and the animal.
- An opportunity to evaluate the general health of the elephant as it will be easier to notice subtle changes.
- A scheduled time to reinforce to all of the handlers the parameters of a behaviour.
- An opportunity to introduce a new staff member into the elephant programme in a stable environment. It is extremely important for a new employee to succeed in their initial encounters with the elephant.

One of the more controversial aspects of elephant training is *punishment/behavioural correction* (Physical disciplining is only possible in free contact and completely prohibited in protected contact). It is given as a response in the following circumstances:

- to eliminate an unwanted behaviour.
- in order to elicit a desired behaviour.
- to enhance trainer safety.

The mode or degree of the correction should be compatible with, and recognisable to, the elephant's natural mode of social discipline i.e. within the elephant's normal behaviour repertoire, and **MUST** [1] not exceed the natural correction that elephants in a herd perform. The amount and type of correction **MUST** take into consideration both the physical and psychological requirements of each species, as well as age, health, sex, and so on. All corrections should enhance or create a situation of benefit to both animals and humans involved, such as increasing safety and social compatibility. For a correction to be effective, it **MUST** be timely so the elephant can understand what behaviour is not desired and why it is being corrected.

Unwarranted or extreme corrections and the continuance of a correction after the unwanted or harmful behaviour has been eliminated and/or the desired behaviour has been achieved, and or harsh or severe treatment in a context neither recognizable by, nor beneficial to, the elephant is considered to be abusive. A correction or abusive treatment is not always, or only, physical in nature. Incorrect use of time-outs and reinforcements, and failure to provide the essential physical and psychological necessities required by the elephant can cause physical and psychological damage as well.

It is counter-productive and therefore unacceptable to the goals of training to use inappropriate training methods (and see Section 3.8.1. Elephant Training: Rationale and Justification). Inappropriate training methods at best destroys the bond of trust between the trainer and the elephant and at worse, risks the general physical and psychological health of the elephant. Examples of unacceptable training methods are:

- the routine use of high amperage electricity for training, discipline, or punishment (see Section 3.13: Standard Operating Procedure: Use of the Electric Goad or Hotshot),
- physical corrections causing severe and/or permanent injury,

[1] Must added

- inserting any implement into any bodily orifice as a part of training (unless part of a veterinary protocol),
- withholding or reducing the elephant's daily recommended amount of food and/or water except under the direction of a veterinarian,
- failure to provide necessary veterinary care,

MANAGEMENT SYSTEMS

INTRODUCTION

Elephant management systems in zoos are based on the traditional methods of training that emerged over centuries in Asian countries. Techniques have evolved and changed over the years and now that zoos are taking on the serious task of keeping elephants in natural groupings, with the aim of establishing self-sustaining captive populations, elephant managers and handlers have been looking for new methods and/or modifying old ones. Methods and techniques are still changing and this will be reflected in updates to this document. Collections differ and each one should develop its elephant programme based on its own circumstances and decide on the management methods to be used. Protocols and plans need to be developed to clearly identify the management technique that has been adopted by the collection. This section of the guidelines aims to explain the rationale behind the different methods and provide guidance to collections.

The traditional method of managing and training elephants in zoos is by ***free contact***, techniques which have evolved from the training methods used in Asia and further refined in circuses. In this environment handlers/keepers/trainers are in the same enclosure with the elephants. The use of chains does not alter this definition. The keepers work in close proximity to, and sustain physical contact with, the animals and maintain a position of social influence in the herd. Behaviour is controlled by psychological means, operant conditioning, manipulation, and restraint. Both positive and negative reinforcement are used, as is punishment. Tools such as an ankus or elephant hook are used to aid an elephant to respond to verbal commands and compliance on the part of the elephant is mandatory.

FIG. 34: TRAINING A BABY ELEPHANT IN FREE CONTACT

Free contact puts the elephant in immediate contact with, and next to the handler, allowing the elephant to be handled outside of its enclosure and holding area. The handler carries an ankus. Through repetition and positive reinforcement the elephant is taught to stay with the handler and respond to all commands given. If the elephant disobeys a command, the handler administers a correction in order to gain the appropriate response. This correction can be as simple as repeating the command or cueing with the ankus, followed by a reward for the correct behaviour. Disobedient or erroneous behaviour is corrected to reduce the likelihood of its being repeated.

It is important to note that within this method of management there are different degrees of control; a continuum exists from extreme domination with more frequent use of negative reinforcement to more frequent use of positive reinforcement methods.

Compliance from the elephant is mandatory. Ankus training involves negative reinforcement, i.e. when the elephant is trained to move its leg forward to avoid the hook at the back, it exhibits avoidance. Basically the frequency of a behaviour may increase to avoid the onset of an aversive stimulus.

Being in close contact with the elephant requires a high level of skill and ability from the handler. The handler maintains a space around himself or herself that the elephant respects because there is no barrier between the elephant and the handler as in protected and confined contact. This space is only to be compromised at the request of the handler. The elephant is taught not to push, strike, or displace the handler with any part of its body. Although this is also true in all management systems, the handler in free contact cannot ignore the behaviour, or allow the elephant to walk away without being told it may.

Working with elephants in free contact entails a risk to handlers. Lehnhardt (1991) calculated that in North America elephant handling was the highest risk occupation, this risk being four times greater when working with male elephants. It was three times more dangerous as a profession than coal mining which came next on the risk list. It is felt that part of the reason for increases in accidents between elephants and handlers may be due to changes in staff, partly due to staff having more time off, and the creation of more stable groups of elephants allowing for more natural matriarchal group formation and the presence of bulls (Ruhter and Olsen 1993). Some collections find this risk factor unacceptable and because of this a system of protected contact was designed, firstly in the San Diego Wild Animal Park, in 1991. This type of programme, which focuses on operant conditioning, was developed from the training and management techniques used with captive marine mammals (Guerrero 1997) and has been termed protected contact.

FIG. 35: WELL TRAINED ELEPHANTS IN FREE CONTACT CAN BE TAKEN OUT OF THEIR ENCLOSURES ON LONG WALKS

POSITIVE REINFORCEMENT BASED PROTECTED CONTACT SYSTEMS

Text from pg 123-127 is rewritten by following: (different structure added plus content more updated; some paragraphs have been kept and included in this section)

The Protected Contact management system of elephants is more then just a technique; it is a philosophy, one totally distinct from Free Contact. It is important that all staff involved in the development of the elephant management program realize that Protected Contact is NOT Free Contact from the other side of the barrier! Both systems are completely different and tools are not interchangeable. To develop a successful PC program, a different way of thinking and approach towards elephants is required and the need for a common philosophical line amongst different institutions is necessary. It is more complex than merely implementing a barrier between the elephants and trainers/keepers. It involves a holistic approach and great deal of forward planning around the biological, physical and social needs of elephants, the husbandry requirements and the institutions' goals. These elements will determine the infrastructure and details of the training technique and –tools applied which will ultimately result in an institution specific PC program based on the fundamental principles of protected contact.
Similar to Free Contact, a Protected Contact Program will not be successful without the necessary resources. What follows is a list of different elements that define a good PC program.

Goals of the program

It is important to clearly outline the institutional goals at the onset of the elephant management program. These goals generate the foundation of the program and will give a clear understanding and explanation of why and how elephants are held in the institution. The goals should include the type of species, the maximum amount of individuals wanted to keep, breeding/non-breeding, bachelor group, the institutions' husbandry and medical requirements, its welfare standards and safety policy. All the different aspects of protected contact are orientated by the institutional goals.

Facility design

The development of the infrastructure may be the most significant element to achieve a successful PC program. The design of the facility has a great impact on how effective the program becomes. Well conceived habitats orientated by the institutional goals will bring the program forward. Careful thinking and preparation in the development of a new facility or facility modifications is crucial: what are the needs of the elephants; how will the animals be moved around between the different enclosures; how to provide sufficient and safe access and view points to facilitate movement of elephants between enclosures; how to implement sufficient areas that provide multiple options to carry out all necessary husbandry and medical procedures in a safe manner for elephant and keeper and according to the highest welfare standards.

Training wall:

Husbandry behaviours are developed at a training wall made of metal. The design of the wall may vary amongst different institutions but must satisfy particular criteria. It must be able to withstand significant pressure from the elephants both currently in the collection and potentially brought in the collection in the future.
It must have clear visibility for both elephants and humans: an important aspect of a successful training is that the elephant can see the trainer and what he does throughout the training session.
The wall must be of appropriate dimensions allowing the elephant to be moved and positioned to suit the behaviour that needs to be obtained; a minimum of 9m is the recommended length of the wall (Roocroft 2007). This allows trainers to move the elephant and create different circumstances, which will enhance bonding and trust as well as create a behavioral understanding as training progresses. Multiple walls will give more flexibility.

Safe and reliable access for general husbandry behaviours and more specific medical needs is crucial. Trunk versatility should be taken into account: African elephants are more versatile with their trunks and will pass through relatively tight areas. Asian elephants are less flexible with their trunks so behavioural accessing space can be wider. Areas to which the elephant can reach must be clearly marked and only fully trained staff should be allowed in those areas in the presence of an elephant.

The elephants must be accessed through ports in the PC wall. The design details of these access ports are equally important. Specific details to take into consideration are: the type of species, different sized elephants and the location of the ports so the animals can easily and safely be accessed but also that positioning the elephants is comfortable while presenting a bodypart.

Ideally the frame of the wall should consist of vertical bars thin enough to secure the best visibility but strong: 10 cm square bars with 1 cm thickness of the metal for the verticals is sufficient for most elephants; for bulls it might need to be upgraded by filling the up rights with concrete and make connections to standing facilities such as walls and other bars. The space between the verticals is filled up with diagonal bars at 15cm apart and set up at a 45° angle. It is important to start from the bottom upwards to avoid any open space at the bottom of the wall where the elephant could reach through to the trainers (Roocroft 2007).

The design details start from the middle area of the wall where the foot ports are located, to the sides where the ear ports would be installed. Here again PC wall design has two different applications for African and Asian elephants. Asian elephants historically and as they get older are prone to foot abscesses and need regular foot soaks, so access ports for both feet and mouth access are best installed into the middle area. Foot ports, foot soak ports and mouth access opening are 70 cm wide all the way up. The bottom foot port door height can be calculated at 1 meter. A foot soak tub can be passed through this opening and retrieved after soaking. The middle foot port should be 70 cm high up to the mouth inspection port. All ports need to either locked open or close depending on the application in progress. The mouth inspection port can be the same size of the foot port or the ear port can be used for this purpose as well.

FIG. XX: PC WALL WITH HIGH VISIBILITY AND SAFETY FOR BOTH KEEPER AND ELEPHANT (CHESTER ZOO)

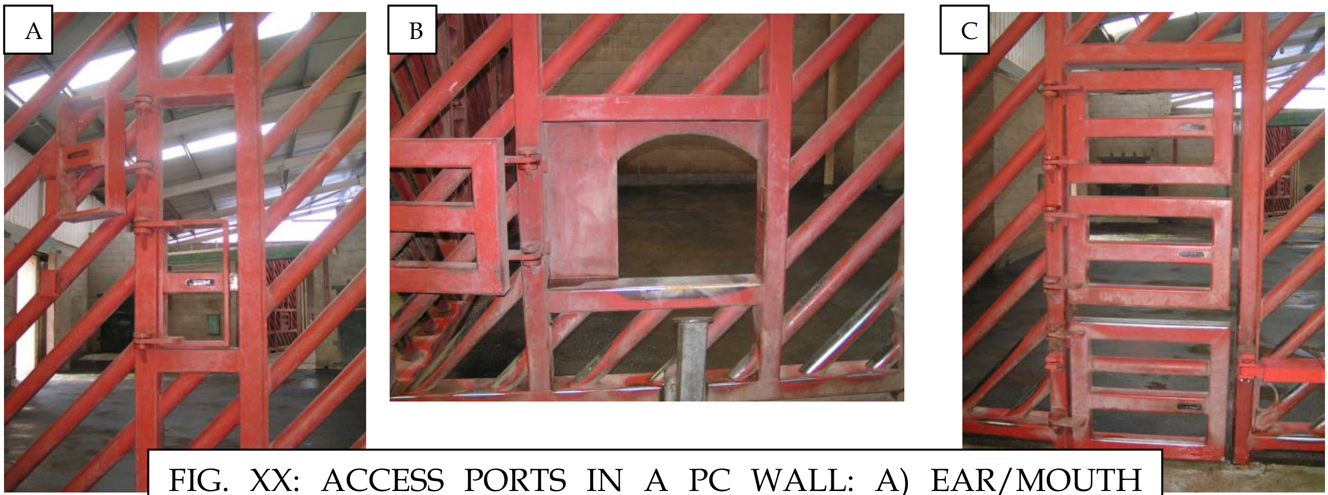


FIG. XX: ACCESS PORTS IN A PC WALL: A) EAR/MOUTH PORTS; B) FOOT PORT WITH STIRRUP; C) FOOT PORTS ON DIFFERENT HEIGHTS (CHESTER ZOO)

Enclosure design:
Part of the facility design is creating different enclosures that offers animals mental stimulation, encourages physical activity and provides a rich repertoire of enrichment. But in a protected contact facility a lot of thought must also be given on how the elephants will be moved around in the enclosures, how to separate them for husbandry purposes, how to load them for transfer, etc. It is important to provide sufficient safe, shielded access to the elephants to conduct all these procedures. In a protected contact situation, a maximum control over the elephants from outside the enclosure is needed in all enclosures. This includes: safe access points for targeting elephants; preferably hydraulically controlled gates or at least easily manual operated doors that are controlled from outside the exhibit; sufficient space between staff and animal areas so there is no risk of being grabbed; several view points to facilitate the movement of elephants between enclosures; gate operation and communication protocols. Controlled movement of elephants should be achieved by sending them from one stationing point to another. Allowing a stable family of elephants to flow in a herd nucleus also improves the control the keepers have in the direction the elephants take around the habitat.
When separating one elephant for husbandry purposes, it is important to create a situation in which no anxiety is caused on either part of the elephants. Therefore it is advised to provide some potential for visual and even physical contact between the enclosures where the elephants are separated off. Especially in case of a close herd nucleus, prolonged separation from other herd members is not desirable and should be avoided. Infrastructure should be developed to achieve husbandry goals and reduce the social anxiety between elephants as much as possible.

Behavioural goals:
The development of a PC training program should be based on maintaining a stable social structure in the elephant herd as well as between elephants and trainers. It is a fundamental responsibility to create a comfortable and reasonably stress-free environment for all elephants. The goal should be to generate training and husbandry circumstances without interfering with the herd dynamics and at the same time provide a safe access to the elephants. An advanced PC training must provide a flexible approach of positive reinforcement technique with several variables taken into account: the herd dynamics, the individual animal's physical and psychological potential, sensitivity to social and environmental circumstances, the knowledge and expertise of the trainer are all important aspects in a successful training.

PC is designed to allow elephants to exercise a high level of choice and control, to experiment, cooperate and even to make mistakes without negative consequences. The trainers are not part of the social structure and therefore can not dominate. Because in Protected Contact full and voluntary cooperation of the elephants is crucial, positive reinforcement is the primary technique to be applied in training the elephants and increasing desirable behaviours, with using a secondary reinforcer to bridge to the primary reinforcer, FOOD. The correct timing of reinforcement is crucial to associate it with the desired behavior.

In case of undesirable behaviour, simply ignoring the behaviour, like non-compliance is most effective and advised.
Implementing a *Time Out* declines uncooperative behavior of the elephant. This is the only form of *"punishment"* that is allowed in a true PC system. Time-out takes away the opportunity to earn a reward and all impulses are removed for a short period of time, dependant on the individual elephant: the trainers stop the session immediately and leave the training area, so the elephant has no influence or impact on the trainer/session at all. Physical punishments in any form are prohibited in PC unless in a life threatening situation.

The elephant and the keeping staff must enter into an arrangement where the elephant will adopt different behaviours on request from the trainers in order to receive a positive reward. The elephant's cooperation depends upon its drive for this positive reward, ie. food and attention. If the elephant is physically or psychologically not feeling well, it will be very difficult to manage them in protected contact since their lack of interest for food will be greatly diminished. Therefore the utmost attention must be given to the physical but also mental wellbeing of the animals. On the physical level the animals must be trained and checked regularly. Recent data suggest that elephants well trained in protected contact prior to becoming ill, will often maintain their established behaviours. But in case of more invasive husbandry or medical procedures, an elephant restraint device is essential. For this reason, all protected contact facilities should have an ERD.
To avoid any psychological distress it is crucial to respect the social relations in the herd. The separation of a calf from its mother for training or any husbandry procedure is for instance a no go! Even if very short, it will have a big impact on the psychological wellbeing of both and will result in a negative experience with very low results and lack of trust in the future.

FIG. XX: FOOT CARE IN PC A) VIEW FROM KEEPER'S SIDE OF THE PC WALL; B) VIEW FROM ELEPHANT'S SIDE OF THE WALL (CHESTER ZOO)

Training tools:

Behaviours are developed by using five visual access tools: the first one is part of the facility design – the PC wall; secondly target sticks: neutral objects – preferably wood, exclusively associated with positive reinforcement, and used to move and hold the elephant in position; thirdly a positive reward, which is usually food based and a food pouch; fourth: bridge (verbal, clicker or in some cases whistle); and last but not least: body positioning of the trainer: this should not be underestimated, as the elephant will use a variety of ways to predict desired behaviours. Elephants will try to keep focus on the person who is in control of the treats. A precise body position of the trainer around the wall is an important tool to communicate with the elephant and is used to position the elephant comfortably and safe for the keepers to apply the necessary care.

Safety procedures:

The term protected contact is somewhat misleading. Although the keeper is behind a barrier, it does not eliminate the risk of serious injury. The elephant can still reach the keeper; therefore a set of safe working procedures and clear protocols MUST be in place. Areas where elephants are still able to reach through the bars must be clearly indicated by a line on the ground. In the presence of elephants, this line can only be crossed in attendance of minimum of 2 trained staff members and when complete focus is on the elephant. Trainers must step back into the discussion zone when focus is no longer on the elephant.

FIG. XX: CLEAR INDICATION OF THE SAFETY ZONES AT THE TRAINING AREA (CHESTER ZOO)

Displacement of the keeper from the PC wall is a common occurrence in many institutions, operating in open spaces with only a couple of cross bars or verticals for protection is playing danger. With any PC wall no matter how it is built it can be dangerous, but what runs in unison with any wall design are protocols, things that one can and cannot do while at the wall. An elephant that can displace its caregiver at its own whim will chase the keeper as a game and even make it as part of the routine, taking away from the true reason for training, welfare access.

It has been shown that all elephants will respond to this sort of training, even very difficult bulls (Maddox 1992). Since the San Diego Wild Animal Park started to implement protected contact with their bull elephants in the mid-eighties (Maddox 1992), it has been shown that all elephants will respond to this sort of training, even very difficult and potentally dangerous ones. San Diego staff have considerable experience in using both free and protected forms of training and have developed a methodology to enable a transition to be made between the two systems (Priest 1992). Although protected contact is not to be confused with hands-off or remote handling of elephants. And it is important the elephants can discriminate between the two systems and different staff should be used. Priest gives an example of a cow that appeared to prefer the protected contact system and states that, although free to choose, animals almost never choose to terminate a training set. Other zoos have also had positive experiences in moving between one system to another (Kinzley 1994) (Schanbeger 1994)

To summarise the main differences between training methods used in free (FC) and protected (PC) contact:

- In FC keeper operates as a herd member; in PC keepers do not play a part in the social structure.
- In FC keepers share the same space and work in close proximity of the elephants; in PC a protective barrier separates keepers and elephants.
- In FC positive and negative reinforcement and punishment are used; in PC positive reinforcement is the only training technique that can be applied. Physical punishment is totally prohibited.
- In FC the elephants are physically confined by chains and their compliance is mandatory; in PC animals are non-confined and compliance is voluntary.
- Training tools for each system are different and not interchangeable: in FC an Ankus is compulsory and verbal commands are the norm; in PC the facility design is a key element; targets, (food)rewards and body positioning are additional tools and the voice, a clicker or whistle is used as a bridge and to terminate a behaviour.

There has been confusion over the difference in the two methods. Helpful FAQs are listed by Priest (1994) and Desmond & Laule (1993) point out the dangers of mixing the two systems by using free contact techniques in a confined contact setting, continuing with the use of the ankus. This can create the impression that the trainer is trying to dominate the animal when he is no longer in a position to so do and this can be dangerous. However, under certain circumstances an ankus can be used and the institution should document the scenarios when the use of the ankus is beneficial and useful. The elephant needs to be in a small area when the ankus is used in protected contact as the technique will not work when the animal can move away, i.e. the ankus can only be used when the elephant is in a chute (Fig. 11, b).

It is probably preferable to consider elephant management as being a continuum from no contact to elephants being walked outside their enclosures by handlers in a free contact situation. Between the management techniques of a handler working in contact with the elephant to the handler working only through or behind a barrier there are a range of methods used. The foundations of FC as well as PC differ so much and are very significant for each system, that it is important to assess them correctly when choosing either management technique.

There are also a variety of barriers used in management. None are completely safe and training of staff re positioning in relation to the barrier is of vital importance. Some barriers allow physical contact to differing degrees between elephant and keeper. If all basics are not taken into account, this cannot be regarded as true PC. In some cases the elephant can physically interact with the keeper. In this case the elephant can easily injure the handler and strict safety and training protocols have to be adhered to.

Since the PC system was introduced, elephant management and training has developed into a continuum of management techniques, which vary in the amount of, direct or potentially direct, physical contact that is allowed between elephant and handler. Within a facility different variations of the continuum may be used based on the disposition and sex of the elephant and the handler's level of training or relationship to a particular elephant. The management technique, or techniques within the continuum, that a collection uses is important but more important is the ability of the handlers to safely achieve or exceed the established minimum standards of elephant care.

In some cases the elephant can physically interact with the handler, with differing degrees, through barriers. Reasons given for this are: temperament of the elephant, the ability of the handler to use the additional techniques and tools, opportunity to demonstrate affection and greater ability for research and education. However, these ranges of systems do compromise the safety of the handler to varying degrees.

Skill levels and staff training are required to manage elephants in both systems. The form of elephant management chosen will be dictated by the facility and the aims of its elephant programme, its philosophy, staff ability and the number, type, gender and demeanour of elephants held. A zoo MUST have a written elephant management protocol. All bulls should be managed in a protected contact situation as should cows that are insecure, fearful or have a predisposition towards aggression. In both situations it is important to have consistency in commands and training methods (Guerrero 1997) (Alexander and Reid 1992). Much of the management methods in free contact have been passed on from generation to generation (and may differ between institutions) and still lacks a coherent system than can be accurately and objectively transferred from one keeper to another.

Elephant Restraint Devices **(ERD)** are an essential part of any elephant management programme. The animal is handled through some type of barrier while being restrained from walking away, with the use of an Elephant Restraint Device (ERD) or an Elephant Restraint Chute (ERC) (Schmidt *et al* 1991). There are many varieties of ERDs, from a simple aisle reducing the elephant's space side-to-side, and front and rear, to the elaborate device with movable walls and gates. However, both effectively restrict the elephant's movements while allowing handlers access for routine husbandry and medical care. Experience has shown that elephants tend not to resist treatments when they are confined in an ERD.

An ERD restricts most—but not all—of the animal's mobility. Movement of the trunk, feet, and tail is limited but these extremities can still be used aggressively. Therefore, although the access for husbandry and medical care is safer, it is not risk free and handlers do come into contact with the elephant. All facilities should have some form of ERD regardless of how the elephants are managed. Changes in elephant behaviour, herd dynamics, elephants, and personnel, along with the potential of a catastrophic illness or injury, make an ERD a necessary piece of equipment.

The first ERD was produced in 1980 by the Oregon Zoo (Schmidt 1981). This device was designed so that it could accommodate sexually mature males and aggressive females. The design used two steel bar walls placed eight feet apart, one on a centre pivot and the other completely movable. The pivot wall creates the angle to hold an elephant regardless of the direction the elephant is facing, and the movable wall closes to within close proximity of the pivot wall. Remote hydraulic controls allow the handler to move an elephant safely into the ERD. There are various designs which may be stationary or movable; hydraulic, electric, or manual and some even have the ability to lay an elephant over on its side.

Despite the many variations in design, there are a few basic elements shared by all ERDs. An ERD should allow safe access to all four feet, tusks, trunk, face, ears, both sides, hindquarters, and back by moving the animal or parts of the ERD. The ERD has to open easily and quickly to free an elephant that has collapsed. It should also be able to comfortably contain an elephant for extended periods of time should the need arise for an ongoing or long-lasting medical or husbandry procedure.

The ERD should be located in an area of the holding facility easily accessible to the elephant and where its use is not dependent on the weather. Preferably, the ERD should be placed in an aisle, so that the elephant has to go through the restraint chute in order to access its outside yard. A by-pass ought to be available, in case an elephant be confined for an extended length of time. The ERD that functions as a walk-through, allowing animals to enter from either end, increases the likelihood of the animal re-entering the chute after an uncomfortable procedure. Daily familiarity of moving through and spending time in the ERD will aid in the process of training the animal to enter the device on command. Additionally, to ensure the continued successful use of the ERD, it should be used daily and routinely, not solely for uncomfortable procedures. In fact, in order to maintain the behaviour long term, the majority of the animal's experience in the ERD should be positive.

The ERD should be constructed in such a way as to provide enough space for staff to safely work on all sides of the ERD when an animal is entering it and when it is confined. The safe operation of an ERD requires trained, skilled staff (Schmidt *et al* 1991). It is important that the staff completely understand the fundamentals of training. An ERD is a tool to complement a sound management programme; it should never be viewed as a replacement for well-trained staff. It is important that the elephant's experience in the ERD should be as enjoyable as possible so that the elephant does not associate it only with a negative experience.

FIG. 36A: AN ELEPHANT RESTRAINT DEVICE

FIG. 36B & C. AN ELEPHANT RESTRAINT DEVICE

Training captive born elephants

When a calf is born a collection decides on the main trainer. The first part of training is accustomising the young animal to recognise its name and receive a reward by responding to the trainer calling its name. A full account of calf training is presented in Section 6.1.1. Calves **MUST** be trained using kindness and patience and it should be an enjoyable experience for both elephant and trainer.

CONCLUSION

A minimum of two qualified elephant keepers **MUST** be present during any contact with elephants. A qualified keeper is a person the institution acknowledges as a trained, responsible individual, capable of and specifically experienced in the training and care of elephants, (see next Section 3.9 Staff Training).

3.9 Standard Operating Procedure: Staff Training

BACKGROUND

Staff training and the use of set procedures is of importance when working with any exotic species, for the welfare of both staff and animals. It is particularly important for elephant staff for two main reasons:

- More keeper deaths and injuries are caused by elephants than any other area in zoos (Roocroft and Zoll 1994) (Mellen and Ellis 1996) (Lehnhardt 1991). This is due to a variety of causes but particularly: the keeping of bull elephants, which can show particularly aggressive behaviour; inadequate facilities; individual elephants of unreliable temperament; trauma invoked in an individual elephant as a result of an unexpected event; inexperienced handlers and momentary lapses in judgment amongst usually competent personnel; inadequate staff training.
- Allegations of elephant abuse, such as prolonged punishment after the occurrence of an undesirable behaviour (Mellen and Ellis 1996).

A useful preliminary survey has been carried out on elephant incidents on keepers in European collections (Ray 2002) (Ray 2004) and in North America and Europe (Gore *et al* 2006). These surveys provide support for the proposed training regime and also the mandatory condition that a minimum of two trained keepers **MUST** be present during any contact with elephants. Cow elephants were responsible for the majority of attacks, but this could be due to the fact that females are more often worked in free contact situations.

It is therefore essential that a collection keeping elephants manages these risks effectively. This should be carried out through the process of risk assessments and should include the installation of elephant facilities that are appropriate for the bulls and cows managed by the institution. Risks to staff should be reduced by the implementation of a staff training programme which should ensure a proper succession of handlers and trainers within the collection and also within the region’s zoos. Risk assessments **MUST** include all management procedures used e.g. free, protected and confined contact and take into account the working of each staff member with each elephant. (Additional information is given in Appendices 3, 4 and 5).

Elephant management, especially free contact management, is very different from other forms of wild animal management. Elephant handlers, therefore, require specialist skills and as institutions managing elephants are dependent on the level of skill of their handlers. Elephant keepers MUST be properly and consistently trained for the duties and tasks they are expected to undertake.

OPERATING THE TRAINING PROGRAMME

A collection **MUST** have a monitored and written down training programme (Keele 1993). This **MUST** encompass training of new staff and training reviews of existing staff and **MUST** include the outcomes from all the risk assessment that have been carried out. In order to establish the correct monitored training programme, a complete and independent audit of the existing elephant programme needs to be carried out. This should be done by expert auditor in conjunction with the trainer and the zoo's health and safety officer.

The audit should include:

- Existing staff ability.
- Individual elephant's health and behaviour (i.e. the elephant's profile).
- Facility design.
- The goals, structure and protocols of the in-house elephant programme in relation to the needs of the institution.
- Zoo management and its relationship with the elephant team.
- The outcomes of all relevant risk assessments.

Once this audit has been completed, actions and recommendations put in place then the training programme and elephant protocol can effectively be processed, written out and implemented. The training programme should include a list of targets (task achievements) which need to be obtained and the trainee would be marked against these at each assessment. These tasks would vary from cleaning, feeding and basic husbandry and routine skills, to more specific elephant handling and training skills. As well as husbandry and management, training should include the biology of elephants and the basis of operant conditioning, theories behind it and the correct way to apply the theory and techniques to animal training. It is also essential that the Health and Safety implications of the work are included.

It is envisaged that the staff training programme would include the following:

- There **MUST** be a recognised 'group' of elephant handlers, who work as a team. This team **MUST** have a structure which includes a team leader, who would be responsible for ensuring that agreed protocols, procedures and training are correctly carried out and implemented.

- Theoretical training on biology of elephants, animal behaviour and operant conditioning.
- Good record keeping on all aspects of elephant and staff management and training is essential, as is good communication between team members and with the team and zoo management.
- All staff should be subjected to peer review at regular, agreed intervals, preferably by staff from another establishment.
- A structured training programme should be in place in each collection for all new staff, which follows logical learning sequences; this should include:
    - An induction programme (e.g. lasting one or two weeks) which would include observation and understanding of the in-house elephant programme and written procedures and protocol.
    - The trainee **MUST** work alongside two fully trained members of staff until they are deemed competent when working with elephants The trainee **MUST** NOT be in full free contact until deemed competent when working with elephants.
    - At the end of this first three months, if it has not been done so already, the keeper will have a review which will determine whether they proceed with the programme, i.e. whether the trainee and trainers agree with progression.
    - The length of the programme will, to a large degree, depend on the previous experience of the new team member, but a review should take place at least every three months.
    - Once the trainee has reached an agreed standard they should be issued with a 'Permit to Work'. This would normally classify them as a trained keeper. Some institutions may prefer to issue several levels of permit to work, as the trainee moves through skill levels. This procedure is recommended (see Appendix 5, Section 6.5).
- A review of each staff member should take place at least once per year. This could be in the form of a peer review of training methods with a senior member of management staff present.
- It is advisable for members of the team to attend a course at one of the acknowledged elephant training schools where more advanced and independent training can be given covering aspects of elephant biology, anatomy, nutrition, handling skills, rope and chain work, environmental enrichments and other aspects of elephant management. It is important that the course operates under the principles of creating an elephant friendly environment.

It has been suggested that a grading system be adopted of various levels ranging from no elephant contact to contact under supervision to contact for training.

At the very least, elephant keepers should be encouraged to attend the annual Elephant Focus Group meetings and any training schools (as occurred in 2005 and 2007) or workshops that they organise as well as have access to relevant publications and literature. Staff should also be encouraged to attend meetings and workshops of the EAZA Elephant TAG and European Elephant Keeper and Manager Association (EEKMA).

Part of the training programme for all staff **MUST** include familiarisation with this document, and the Standard Operating Procedures.

3.10 Standard Operating Procedure: Use of Chains or Shackles on Elephants

BACKGROUND

Historically elephants in zoos and range countries have been restrained, chained by the legs to fixed points for extended period of time. A typical regime has entailed diagonal chaining of one foreleg and one hindleg overnight. The main stated rationale has been to avoid aggressive interactions between animals in the absence of human supervision. Other reasons given were to reduce the likelihood of escape and to condition animals to being restrained in order to facilitate safe practice of routine husbandry activities. For information on correct methods of chaining see Appendix 2, Section 6.2.

There are a number of concerns that relate to unrestricted chaining. The first is that a chained animal cannot escape from any excessive physical discipline, although this should not occur with good staff training and supervision. The second concern is that an extended period of inactivity leads to boredom and stereotypic behaviours. Such chaining practices are indefensible on welfare grounds.

There are some acceptable justifications for limited periods of chaining. Veterinary procedures clearly may necessitate some physical restraint to ensure human safety and to obviate the possible risks of chemical sedation. Another example, which depends very much on individual animal characteristics and management judgement, would be whether to opt for some restraint during parturition (see Section 3.6.4). Chaining is also recommend during transportation (see Section 3.14). The current EEP guidelines place a limit of no more than three hours chaining out of 24, under normal conditions. This limit is currently being met by all BIAZA zoos and there is a trend towards further reduction. In some situations (particularly transportation) webbing is used in preference to chains. In all situations it is important that compatible equipment in terms of strength and resilience is used (details of methods used are given in Appendix 2, Section 6.2)

OPERATING PROCEDURE

Ownership: all chains and shackling equipment **MUST** be acquired and maintained to a specification agreed by zoo management. Any wear and tear which might cause weaknesses in equipment and therefore a safety risk, or possibly lead to injury to elephants **MUST** be avoided.

Authorisation for use and prohibitions: written, generic approval of routine chaining **MUST** be given by senior management in a zoo. In addition the parameters of exceptional chaining **MUST** be defined and full compliance with the EEP draft guidelines **MUST** be observed and demonstrable

Elephants MUST not be routinely chained for periods in excess of three out of 24 hours.

Accountable individuals and records: only named, trained persons may carry out chaining. This may include elephant experts brought in for staff training and/or elephant transportation. Any unplanned variations from routine practice **MUST** be documented and management notified.

Training: Keepers **MUST** be adequately trained in the procedure and safety aspects followed.

BIAZA audits: BIAZA may require zoos to report the level of chaining, or equivalent physical restraint, at any time.

Document revision: the use of chains, shackles and this procedural document will be reviewed at least annually.

SUMMARY

Physical restraint of elephants through the use of chains and shackles **MUST** be minimised. There are sound safety and husbandry / welfare management reasons for its continuation at present but the consequences of bad practice are significant and severe. Looking to the future, alternative methods of physical restraint, such as restraint chutes, may at least partially substitute for chaining. Much will also depend on the degree of human-elephant contact achievable through preferred training regimes and a foreseeable trend of reduced need for washing and foot care, with provision of more suitable environments.

3.11 Standard Operating Procedure: Voice Control

BACKGROUND

Whilst means of non-verbal communication by conscious or sub-conscious use of posture, hand and arm gesture and facial expression are undoubtedly used in interaction between keepers and elephants, possibly far more than is generally realised and reinforcement of instructions can be achieved by use of the ankus as a standard item of equipment, the main mode of communication is verbal. The actual list of understood and used words will vary between zoos (and see Appendix 1, Section 6.1) and the degree of responsiveness between individual elephants and keepers will vary. Some key principles and points of advice are listed below to maximise uniformity of approach between zoos and, hopefully, to guide new elephant keepers as they learn their craft.

OPERATING PROCEDURE

- Voice control as the fundamental medium of human-elephant communication supersedes any other forms including non-verbal and tactile.
- Voice control and body language together project confidence and self-control.
- Voice-signals can be used not only to direct commands but also to calm and reassure
- In a specific zoo, and ideally within a region, all the commands employed should be standardised. A consistent tone and pitch of voice should be used and, if relevant, postures and gestures. In time, as elephants may increasingly have to be moved to different centres to achieve conservation breeding, wider standardisation through a unified training approach would be very beneficial and should be worked towards.
- If an elephant does not respond promptly to a command, repeat the term once and then apply the correct use of the hook, if used. Time out will work equally well in this situation. Measured consistency and self-control are absolutely vital and cannot be over-stressed.
- Anger, hostility and shouting should be avoided as it ultimately damages a trusting relationship and lessens control. A consistently used sharper, stern voice should be reserved for appropriate situations as should reinforcement of a behavioural command by use of the ankus.

3.12 Standard Operating Procedure: Use of the Ankus or Hook on Elephants

BACKGROUND

The ankus is a tool used to cue the elephant to maintain commands. It **MUST** be used with sensitivity and understanding. The ankus can be made in metal, wood or plastic, the points are made of metal (Fig. 13). The shaft is 60-100 cm in length, top point is 2-3 cm, shank point 3-6 cm and the curve 2-4 cm in diameter, depending on the area to be reached (see below). Hook points are demonstrated in Fig. 13. Verbal commands, body language and use of the ankus are inextricably linked; all relay messages from handler to elephant. Understanding the personalities, characteristics and moods of individual elephants is of paramount importance.

OPERATING PROCEDURE

- The ankus should be carried under the arm with the hook facing to the rear, not dangling from a belt loop (which is frequently observed) or stuck in a waistband.

- Cueing should be done decisively in a controlled manner.
- Avoid quick, jerky movements that take the animal by surprise.
- Allow time for the animal to assimilate and comply with command, but not too long.
- Make the first ankus cue the last one, this goes back to being emphatic in your action e.g. not too hard, not too soft.
- Different (elephant) body regions have different sensitivities and therefore require different pressures. Most sensitive would be any area around the ear, ankles and toe nail beds. (Certain areas e.g. belly, temple, urogenital area and front ankle joints are ***out of bounds***).
- Any area where one hooks downwards should be approached with caution, e.g. top of the ear, apex of back. It is easy to transfer simple arm/shoulder pressure in to entire body weight and cause puncture wounds.
- Additionally, some handlers hook their elephants around the lower edge of the ear (where the pinna meets the side of the face) to lead them. This is an extremely sensitive region and with a correctly honed hook requires minimum pressure.
- Be aware that virtually all 'hooking' sites act directly on nerve centres.
- If natural trauma occurs at a cue site (hook point), this area should not be used until completely healed.
- Occasionally, the handle of the ankus may be used to 'smack' an elephant, never use the hook end.
- Needless or over use of the hook will nullify its effectiveness. Many elephants become 'hook shy', flinching and becoming nervous the moment they see a hook.
- Maintain self-control at all times.

UNACCETABLE USE OF THE ANKUS

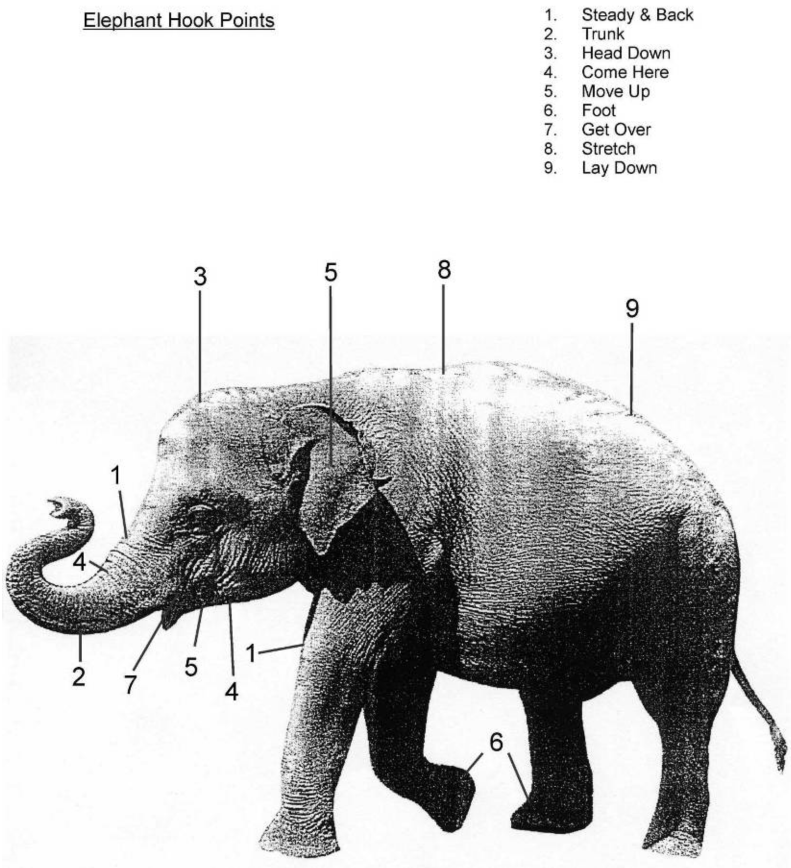
This **MUST NEVER** occur[1] and is defined when the handler goes beyond an acceptable level of discipline, correction or admonishment, as understood within the agreed context of humane elephant management in BIAZA zoos.

Severity limits have been, or be in danger of being, breached when:

- The discipline becomes disproportionate to the infraction.
- Blood has been drawn.
- Double-handed use of the ankus has replaced normal single-handed use.
- The mode, application and pressure of the ankus becomes uncontrolled and severe.
- The keeper repeatedly strikes the elephant with any part of the ankus.

[1] Additional clarification added to emphasis that severity limits must never be breached.

- The elephant becomes frightened, confused and possibly aggressive. Once an elephant becomes frightened and confused it may assume a conciliatory or submissive stance, but may well have lost sight of the initial command and may also become dangerous.
- A battle of wills replaces rational keeper judgement.



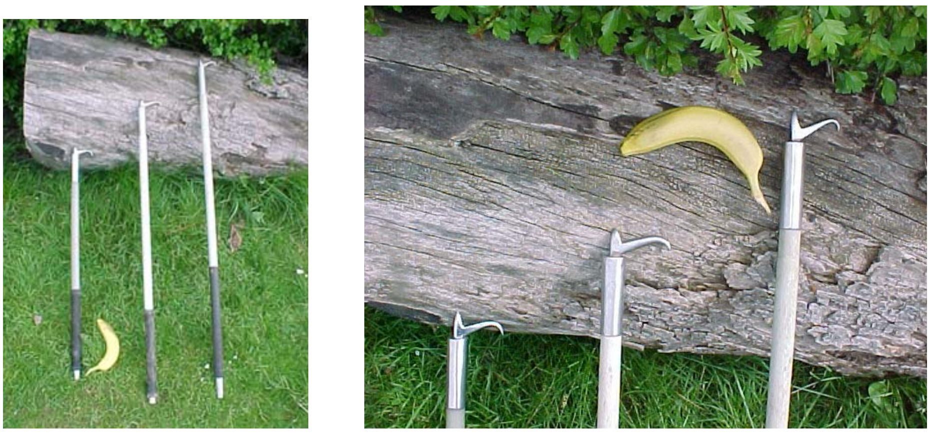


FIG. 37: THREE SIZES OF ANKUS, SHOWING THE IMPORTANCE OF HAVING THE CORRECT HANDLE LENGTH FOR THE ANKUS POINT BEING USED.

3.13 Standard Operating Procedure: Use of the Electric Goad or Hotshot on Elephants

BACKGROUND

The use of electric goads has been extensive in the livestock industry, particularly with cattle. It is now subject to more restricted use, covered by guidelines, and under public scrutiny. The use of electric goads on elephants is apparently quite widespread in Europe and North America and general concerns about their use on cattle are amplified by the different perceptions of the public to a zoo species that is known to be intelligent and socially complex with a predominantly benign image in books and films.

There are virtually no scientific data on the physiological and longer-term behavioural effects of the use of the electric goad in elephants. This makes any debate into its justification very subjective. It is felt that a goad can be extremely effective in ensuring keeper safety in difficult situations and it is in this mode of action that justification for its use can currently be found. A review of alternatives to use of electric goads needs to be conducted with some urgency and identification of safe and practical alternatives will allow their use to be discontinued.

As more information and objective insight is collated it will become possible to review the conditions of use of electric goads on elephants. Until such a time the following points **MUST** be observed:

OPERATING PROCEDURE

Ownership: the ownership of an electric goad by a zoo or safari park **MUST** be declared to the BIAZA. All equipment **MUST** conform to the established specifications.

Authorisation for use and prohibitions: the authority to use an electric goad **MUST** be given by management in writing, in advance of any anticipated use. This authority should relate to specified conditions of use such as movement of an animal to another zoo, a veterinary procedure or other circumstance in which, in the opinion of a veterinary surgeon and the most senior elephant keeper, the animal's temperament may be adversely affected. ***It is not for use in any form of training or as part of a standard husbandry regime. It is not to be carried as a routine unless clear written authorisation and justification is provided by management. A written code of use MUST be drawn up at each zoo to reflect local operating circumstances.***

Accountable individuals and records: only named, trained persons may use an electric goad. Any use **MUST** be recorded in a log book, pre-signed by a named, accountable, senior manager. Training should follow standard procedures.

Storage: when not carried by an authorised individual, electric goads **MUST** be kept in a locked cabinet with strict key control, analogous to controlled drugs and firearms, i.e. with restricted numbers of keys and named keyholders.

Unauthorised use: if, for any compelling human safety reason, an electric goad is used by a named, trained person who is an authorised keyholder, without prior authority, a full log-book entry **MUST** be made at the earliest opportunity and then counter-signed by a named, accountable senior manager. The manager will then inform the BIAZA office and indicate actions agreed to avoid a repeat occurrence.

BIAZA audits: BIAZA reserves the right to conduct a full and detailed audit of every aspect of use of the electric goad at BIAZA zoos, at any time. Named managers and directors may be asked to account for recorded use of electric goads on elephants.

Document revision: the use of electric goads and this procedural document will be reviewed at least annually.

SUMMARY

The use of electric goads is currently only justifiable in the extreme situation where human or animal safety is seriously at risk and voice control and use of the ankus has failed. Whilst there is, and has to be, a high level of trust entailed in the care of all zoo animals the electric goad as an instrument that leaves no marks, is open to abuse. For this reason, and given uncertainty about longer term stress and behavioural effects, accepting a stated, humane doctrine of 'giving animal welfare the benefit of the doubt' it follows that current use of the electric goad **MUST** be restricted and accountable to BIAZA and the public.

SPECIFICATION AND SITES

It is vital that voltage is checked and is not excessive through faulty or non-standard equipment. Models of commercial cattle prods which are also battery powered can operate with varying voltages up to 10,000 volts and 9 joules: these are considered too high.

Sites of use for electric goads that have been used are the feet, trunk and area around the base of the tail. It is unclear whether these are sites for general use or in emergencies, but as an instrument of self-defence in a 'last resort' sense it is more likely that any site would have to be used.

3.14 Transportation of Elephants

Elephant Welfare During Transportation

All elephant movements should be in accordance with the "On The Welfare Of Animals (Transport) Order 1997" available from the Department of Food and Rural Affairs (DEFRA) and the latest BIAZA Animal Transaction Policy (British and Irish Association of Zoos and Aquariums 2009).

Elephants **MUST** be transported only for breeding, movement between zoos and veterinary purposes and with TAG/EEP approval. Movement for any other purposes **MUST** be cleared by the TAG and BIAZA. Collections **MUST** inform BIAZA of any pending animal movements, so that the office can be prepared for media or other interest.

During transportation, elephants should periodically be given access to food and water. Hay can be given as appropriate to occupy them throughout the journey. Elephants should always be given water, food or branches within the same period as the drivers' compulsory rest period.

Route Planning

It is essential prior to any move that the route is planned. Time of travel can be estimated this way and likely delays can be accounted for. All relevant bodies and authorities should be informed of the planned route. This is especially important if any country borders are to be crossed, so that time is not lost at a border, by either customs or veterinary controls. When crossing borders it is essential that the originals of all permits are carried.

If the journey is likely to exceed 10 hours (drivers' hours/tacho regulations) in length, a suitable place to stop should be organised prior to the journey so that the driver and elephant can be rested. If possible night stops should be planned at a zoo, for supplies of fresh food and water and for security reasons. A regular removal of dung and wet material is essential in longer trips. Consideration should be made of the likely prevailing weather conditions, especially with regard to heat and cold. Telephone numbers of suitably experienced vets en route should also be prepared and a reliable mobile telephone is essential.

Preliminary Considerations

If appropriate it would be strongly advised that the places of loading and unloading be assessed prior to the move.

Factors to be considered at the time:

- Access to zoo/collection.
- Access to elephant house/yard. (It is good policy to access the loading and unloading facilities in advance to check for unforeseen access problems with vehicle or crane, and also to check for security problems).
- Suitability of elephant house/yard for loading and unloading elephants i.e. elephant and keeper safety. Adjustments to the facilities might be necessary prior to the move.
- Assessment of elephants, factors to be considered refer to loading and unloading elephants. This should be carried out in advance of transportation by those personnel destined to move the elephant/s. The extent to which the elephants are trained for loading may be critical.
- Current equipment should be assessed for suitability in the assistance of loading and unloading elephants i.e. chains etc.

- Consultation with the collection's veterinary surgeon, especially if the elephant will require sedating for the movement. It is perhaps obvious that the veterinary surgeon should have had considerable experience of elephant work, and be aware of the suitable drugs used for transportation.
- Acclimatisation: it is preferable that where possible elephants are given time to accustom to the mode of transport (Melens 1994). However, in most cases, this is not possible as few zoos have their own transporter.
- From his considerable experience in elephant transportation Roy Smith of Interzoo recommends that all elephants should be sedated prior to loading and that large bulls and particularly nervous animals should be given a long acting tranquilliser.

Transporter

A purpose built elephant transporter is available to all EAZA members on a cost basis[1 2]. It can house three young, trained elephants. For less trained elephants the transporter would only be suitable for accommodating two. The transport can also accommodate the following:

- 1 bull elephant.
- 2 trained cow elephants.
- 1 aggressive or untrained cow elephant.

Good transporters should have all equipment on board so that they can load in nearly any situation and also have the essential cleaning and emergency tools and equipment to accompany the transport. It has to be possible to heat the transporter when necessary.

Loading and Unloading Elephants

The time, equipment and personnel required for the loading and unloading of the elephants will vary depending on a variety of factors:

- The elephant – temperament, degree of training, sex, size, fitness, age and health.
- Number of elephants to transport. Roy Smith only loads juvenile animals together in a container or mothers with calves.
- Surrounding infrastructure i.e. elephant house/yard.
- Experience of staff handling elephants.

A veterinary surgeon should always be present when elephants are loaded.

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[1] Contact Woburn Safari Park at **office@woburnsafaripark.co.uk**, 44 (0) 1525 290 407. The transporter trailer size is: length 13.64m x width 2.55 m x height 4m, maximum gross weight 36,000kg.

[2] Roy Smith of Interzoo is possibly the most experienced elephant transporter in Europe. He is available at 101725,2417@compuserve.com

3 EKIPA are an altenative transport company for moving elephants 0031524571032 (Mareille Kip – Office)

Winches

The Woburn elephant transporter has been fitted with two winches that can be used to load difficult or untrained elephants. The winch chains would normally be attached to each front leg. The elephant would then be encouraged to move up and with each step the slack is taken up. This restricts the elephant from backing up. It is important that the rear of the elephant is kept under control. A method in doing this would be to attach rope/chains to the elephant's rear legs, keeping the rope/chain taught at all times. A winch or a steel post can be used to help achieve this. Winches should only be used as an anchor and NOT literally to pull the animal into the crate. It is advantageous to load the animal backwards as it shows less resistance in this position and can see the new exhibit on arrival when the doors are opened.

The elephants also need to be unloaded safety. When unloading an untrained or difficult elephant it is imperative it is kept under control. The winches can be used to help achieve this. Separate winches might be needed to unload the elephant. Assuming the elephant is facing forward, attach the rear chains to an external winch. The elephant can then be encouraged to unload while the front of the elephant is controlled by the transporter winches. It is better to unload the elephant forwards for reasons stated above. Difficult animals may also need to be tranquillised for unloading.

Use of Restraint

Elephants in the transporter should be restricted at all times. This is accomplished by attaching chains or webbing to each leg of the elephant (see Appendix 6.2). If chains are used they should be covered with plastic pipe to avoid damaging the skin. These should be at the correct length and be tight enough to restrict the animals but not uncomfortable or so tight that they interfere with the elephant's balance**.** When using chains it is important that they are suitable. Factors to be considered are:

- Chain strength.
- Texture, should be smooth with no rough edges that are likely to cause sores.
- Link size (suitable for attaching shackles).

Females are normally chained front and rear on opposite sides, i.e. on two feet. Males are best chained on all four legs.

Staff Safety

Even long-term elephant keepers may not have had much experience in actually transporting animals, therefore a full briefing **MUST** be carried out prior to moving the animals. All risk assessments **MUST** be carried out and detailed for each staff member and each elephant.

- Only trained, experienced staff to be present in the transporter, if appropriate, while elephants are being loaded or unloaded.
- Staff should be aware of all escape routes.
- Staff should always ensure they are not in a position where they do not have clear access to escape.

Firearms

When elephants are being moved, the transporter should always be accompanied by an appropriate firearm. All appropriate authorities **MUST** be informed of the movement of the firearm with the transporter when moving elephants. It is imperative that all risks are analysed when moving elephants. The firearm certification holder's responsibility is to protect human life and they should take whatever action necessary to achieve this. Only firearm certification holders trained in the use of the weapon, including live firing range practice and authorised in writing by the Director/CEO of the collections responsible for the elephant, will accompany the transporter. However it should be remembered that it may not be possible to carry a firearm in some countries, and it may cause delays at border controls. It may also not be possible to shoot an animal in an urban situation. Sedation of the animals may lessen the need to carry a firearm.

Training

It is recommended that elephants be given time to acclimatise to the transporter /container to minimise stress during transport and loading. It is recommended that keepers try feeding elephants in the container to that end. Trained elephants are more amenable to transporting and provision for using handlers of those elephants throughout the transport procedure should be considered. However even trained animals may become frightened due to being in an enclosed space with strange noises. In situations where it is not be possible to acclimatise the animals prior to transportation, for example if the transporter has to come from a distance away from the collection, sedation is recommended. Respective elephant staff should work with elephants to be moved in both collections, i.e. it is important that staff work with animals in both the donating and receiving collections.

3.15 Medical Management[1]

Elephant medicine can be challenging. Our knowledge of elephant diseases, and our ability to implement medical or surgical therapies is limited at present. Over the past few decades major advances have been made in our understanding of elephant anatomy and physiology, and these developments have been used to broaden our knowledge and application to elephant medicine. This is an ongoing process and readers are advised to keep up-to-date with the literature regarding best practice in elephant medicine. The following is a brief overview of important considerations in medical management of elephants, with references to allow more detailed discussion on relevant aspects.

3.15.1 Husbandry systems

Much of this section assumes that veterinarians can get in close contact with the elephant and that it will accept intervention without moving. Historically this has been done in free contact but more and more collections are moving to a protected contact or hybrid system (see Section 3.8.2). If elephants are not trained to a level that has historically been maintained in free contact, then the

1 This section was rewritten in 2009.

use of an Elephant Restraint Device (ERD) or anaesthesia may be required if any meaningful medical management is to take place

The training of elephants will facilitate the management of many elephant diseases or disorders. It is important that behaviours that allow a physical examination and blood collection are taught early in the programme. It is particularly pertinent in herds that have been exposed to Elephant Endotheliotropic Herpes Virus (EEHV) that elephants are taught this as soon as they are ready. The ability of a collection to implement the essential components of a preventive medicine programme will always be limited by the quality of that collection's training programme and facilities.

3.15.2 Health checks

Whatever management system the elephants are in, assessing general health should be part of the daily routine. At the very least, these should be a visual assessment of physical health with particular notice paid to the gait and feet. The consistency of faecal boluses should be monitored. Any deviation from normal behaviour or condition should be reported immediately. Where the management system includes a level of individual training, oral examinations, temperature taking (using IR temperature guns aimed at the hard palate or a thermometer in a faecal bolus immediately (5-9 mins) post defaecation) and a closer inspection of feet, including nails and sole, should be included. Blood samples should be taken regularly to establish normal parameters for each animal and to detect abnormalities.

Weight and body condition scores (see scoring method in Section 6.4: Appendix 4) MUST be taken at least annually for adults, more frequently for young elephants. A complete review of each animal's medical history (including vaccinations) and that of the herd, taking in to account haematology, biochemistry, faecal parasitology and bacteriology results, should occur annually. Ongoing orthopaedic and reproductive health issues should also be assessed at this time.

Health care programmes should be documented and regularly reviewed for their suitability and to ensure that they are utilising current knowledge and best practice. These programmes should be a holistic enterprise developed by the veterinary, keeping and curatorial staff. It is recommended that a weekly health check is devised between your organisation and vet, including the monitoring of teeth, feet, weight and anything additional that is relevant to your department.

Normal physiological values for elephants can be seen in Table IV.

TABLE X: NORMAL PHYSIOLOGICAL PARAMETERS FOR ELEPHANTS

Parameter	**Value**	
	Elephas m. maximus	***Loxodonta a. africana***
Height (m)	2.0-3.5	3.0-4.0
Weight (kg)	2,000-5,000	4,000-7,000

Life span (yrs)	50-70	65-70
Heart rate (beats/min)	**25-30 (standing)** **72-98 (lateral)**	
Respiratory rate (breaths/min)	**4-6**	
Rectal temperature (°C)	**36-37** **(fresh faecal boluses are thought to be accurate to within 0.5°C)**	
Systolic blood pressure (mmHg): standing	178.6 +/- 2.94 (n=7 Em, 8 La) (increases in lateral)	
Mean arterial blood pressure (mmHg)	120	
Diastolic blood pressure (mmHg): standing	118.7 +/- 3.10 (n=7 Em, 8 La) (increases in lateral)	
Dental formula	1033 0033	
Number of chromosomes	56	
Frequency of urination*	5-10 times/24 hours	
Volume of urination*	25-53 litres/ 24 hours	
Frequency of defecation*	12-20 times/ 24 hours	
Number of boli/defecation*	5-8	

Data from (Olson 2004), except for those marked with an * which were taken from (Mikota 2006c)

3.15.3 General considerations

ADMINISTRATION OF MEDICINES

The administration of medicines to elephants can be challenging. There are several routes available, each with advantages and disadvantages. These are;

- **Oral (or *per os*)** Elephants have a very keen sense of taste and can detect drugs hidden in food items readily. Strongly flavoured items such as chocolate, mint, molasses, fruits, and fruit juices can be used as carriers, and specifically flavoured drugs can be obtained. Elephants can be readily conditioned to accept a bite block for the direct administration of oral medications using syringes or by hand.
- **Rectal administration** has been reported in several cases (Schmitt et al., 2000), and the pharmacokinetics have been described via this route for metronidazole and some of the anti-tuberculosis agents (Gulland and Carwardine, 1987; Maslow et al., 2005a; Maslow et al., 2005b).

Adequate rectal absorption leading to therapeutic serum levels via the rectal route for all drugs should not be assumed.

- **Injection** The administration of therapeutic agents can be achieved using the standard routes of injection, namely intramuscular, intravascular, and possibly subcutaneous.
  - **Intramuscular (IM)** A minimum needle length of 4cm (1.5") is advised for the forelimb, and 5-7cm (2-3") for the hind, with no more than 20mls being injected at any one site to avoid swelling and inflammation. 18-20 gauge needles are normally sufficient, with thicker gauges being reserved for antibiotics and thicker agents.
  - **Intravenous (IV)** can be given in posterior auricular, cephalic, or saphenous veins. Perivascular injection should be avoided as it may lead to local necrosis & sloughing particularly when using flunixin meglumine (Finadyne) or some of the other NSAIDs (R.McCort, personal communication). Intravenous cannulae can be placed in the auricular or saphenous veins for the administration of fluids or large volumes of drugs. Maintaining these lines can be difficult as elephants can easily remove them.
  - **Subcutaneous (SC)** is not recommended in elephants as absorption is questionable and has not been studied. Morphine has been administered SC and a clinical response to the agent was noted (J. Cracknell, pers. comm. 2009). In general it is not a recognised route.
  - **Regional digital intravenous perfusion (RDIP)** has been recorded in the treatment of digital abscesses and phalangeal osteitis (Ollivet-Courtois *et al.* 2003) (Spelman *et al* 2000).
- **Nebulisation** has potential in the use of treatment for elephant respiratory disease, including tuberculosis. It has been used in horses but has not, at the time of writing, been documented in elephants.
- **Topical therapy** can consist of medication or the use of compresses (either cold or warm). These can be useful adjuncts to systemic therapy but maintaining them can be difficult with inquisitive elephants, which will readily remove them. Lavage is also useful in reducing contamination and bacterial load to any external wounds or abscesses. Lavage solutions are available including sterile saline, chlorhexidine, and povidine iodine. Ophthalmic therapies can also be administered topically: this is difficult in most elephants and the choice of creams or drops is down to the individual and the choice of therapeutic agent required.

For more detailed descriptions on routes of administration readers are directed to (Mikota 2006d).

PHARMACOLOGY

In very general terms, antibiotics and other drugs are given at the same dose rates as for horses (EQ) and cattle (Schmitt 1986) unless specific pharmacokinetic data are available for the elephant. Such data are unavailable for the majority of drugs but the numbers are increasing. There are many useful resources for elephant therapeutic dosages and regimes and readers are advised to review current literature, (Mikota 2006d), and **http://www.elephantcare.org**.

TABLE XI: A TABLE OF KNOWN EFFECTIVE DOSE RATES FOR SOME ANTIBIOTICS . (Olsen 1999) gives details of weight estimation and dosage calculations, whilst (Mikota 2006d) provides comments on criteria for selection and use.

Drug	Dose (mg/kg)	Route	Frequency	Comments
Amoxycillin	11	IM	sid	(Olsen 1999)
Ampicillin	8	PO	bid-tid	(Olsen 1999; Olsen 1999)
Amikacin	6-8	IM	sid	(Mikota 2006d)
Chloramphenicol	55	PO	qid	(Mikota 2006d) EQ
Enrofloxacin	2.5-5	PO	sid	(Mikota 2006d) EQ
Erythromycin	25	PO	sid	(Mikota 2006d) EQ
Gentamycin	4.4	IM/ IV	sid	(Olsen 1999)
Isoniazid	5	PO	sid	(Mikota *et al* 2001)
Metronidazole	15	PR	sid	Give iron supplement
Oxytetracycline	20	IM	Every 48-72hrs	(Mikota 2006d)
Pyrazinamide	25-35	PO	sid	(Mikota *et al* 2001)1
Rifampicin	7.5-10	PO	sid	(Mikota *et al* 2001)
Tetracycline	20	IM	Every 48hrs	(Olsen 1999)
Trimethaprim-sulphamethoxazole	22	PO	bid	(Olsen 1999)
Tylosin	12	IM	sid	(Schmitt 1986)

Analgesia is also an important consideration for any procedures that may be painful or for the treatment of chronic disorders such as arthritis. There are many analgesics that can be considered, however actual pharmacokinetic data are unavailable for most. Acupuncture has been described and has the potential to be a useful modality in the future. The doses in the table below have been documented.

TABLE XII: A TABLE OF DOSE RATES FOR ANALGESICS

Drug	Dose (mg/kg)	Route	Frequency	Comments
Aspirin	25	PO	bid	followed by 10mg/kg sid. EQ (Elephant Care International 2008)
Flunixin	1	IV, IM, PO	sid	(Mortenson 2001)
Ibuprofen	6	PO	bid	Asian elephant, pharmacokinetic data (Bechert & Christensen 2007)
Ibuprofen	7	PO	bid	African elephant, pharmacokinetic data (Bechert & Christensen 2007)
Ketoprofen	1-2	PO,IV	sid or every 48 hrs	Asian elephant, pharmacokinetic data (Hunter *et al.* 2003)
Phenylbutazone	3	PO Not IV	Every 48hrs	Asian elephant, pharmacokinetic data (Bechert *et al.* 2008)
Phenylbutazone	2	PO Not IV	sid	African elephant, pharmacokinetic data (Bechert *et al.* 2008)
Morphine	0..03-0.06	IM	qid	(Schmitt 1986)
Pethidine	0.75-1.5	IM	qid	(Elephant Care International 2008)

Other agents have been used, and documented, in elephants and readers are advised to review current literature, including (Mikota 2006d).

ANAESTHESIA AND SEDATION

This section provides general information on the topic. It is not intended to be a comprehensive guide and for more detailed information reference should be made to the veterinary texts listed in the reference list e.g. (Fowler and Mikota 2006), (Fowler *et al* 2000), (Steffey 2006).

General considerations:

- Determine whether anaesthesia or sedation is required - several procedures can be carried out under trained behaviour and local anaesthesia.

- Maintain the ability to chain if this is required.
- It is helpful if the animal has been trained to lie down.
- It is best to arrange the position as the animal is being induced as repositioning afterwards can be very difficult.
- It is important to be able to supplement with oxygen (Heard *et al.* 1986).
- Elephants are predominantly nose-breathers and the trunk MUST be kept clear.
- Ventilation is possible (Horne *et al.* 2001) (Steffey 2006) but not essential.
- Monitoring is important as with any animal (see (Isaza *et al.* 2003) (Osofsky 1997).
- If sedating an animal for the first time, be prepared for side effects to the sedative agents used that may result in full anaesthesia.

Sedatives

(Fowler and Mikota 2006)

Alpha-2-agonists:

- Xylazine is a sedative, analgesic and muscle relaxant but causes bradycardia and first-degree heart blocks, so should not be used in cardiac cases. Dose: 0.04-0.08 mg/kg (Asian adult).
- Detomidine is longer acting and more potent then xylazine. As with xylazine high doses can lead to light anaesthesia. Duration can be over 6 hours if not reversed. Dose: 0.0055 mg/kg (Asian adult).
- Medetomidine is the most potent alpha-2-agonist. It is rarely used on its own as higher doses increase side effects which include bradycardia, hypotension, and hypothermia (which can all be seen with all of the alpha-2s). Dose: 0.003-0.005 mg/kg (Asian adult).

Opiates

- Etorphine can be used at low doses for standing sedation but more generally it should be used for induction of anaesthesia
- Butorphanol is very useful, especially in combination with detomidine (Neiffer *et al.* 2005)
  - Dose: 0.01-0.03 mg/kg (Asian adult, used on own at this dose) (J. Cracknell, pers. comm.)

Short-acting neuroleptics

- o Acepromazine. R/arely used on its own, and often combined with opiates or cyclohexamines as premedication.
  - Dose: 0.004-0.06 mg/kg (Asian/African adult)
- o Azaperone. Useful as a sedative or as a premedicant prior to anaesthesia. Duration 2-3 hours.

- Dose: 0.024-0.038 mg/kg (Asian adult)
- Dose: 0.056-0.107 mg/kg (African adult)

Long-acting neuroleptics

- Haloperidol (lactate). Similar to azaperone but lasts longer (8-18 hours). A decanoate ester is available but its use is not recommended due to much longer action and reports of severe anorexia occurring.
  - Dose: 40-100mg total dose (Asian elephant)
  - Dose: 40-120mg total dose (African elephant, based on height)
- Others are available

Anaesthetics

(Fowler and Mikota 2006)

Opiates

- Etorphine. The drug of choice, on its own or in combination for induction of general anaesthesia. Ideally in combination with acepromazine (Immobilon). Recovery within 3 hours if no antagonist is administered. Recovery within 2-10 minutes following antagonists. Hyaluronidase can be used to increase speed of induction.
  - Dose: 0.002-0.004 mg/kg (Asian adult)
  - Dose: 0.0015-0.003 mg/kg (African adult)

Combinations

- Xylazine (0.12 mg/kg) and ketamine (0.12mg/kg) (Asian adult)
- Xylazine (0.2 mg/kg) and ketamine (0.14mg/kg) (African adult)
- Other alpha-2-agonsits can be combined with ketamine for induction of general anaesthesia.

Volatile anaesthetics

- These are inhaled via an anaesthetic machine and can be used for maintenance of anaesthesia. They include isoflurane, sevoflurane, desflurane, and halothane
- Isoflurane is the agent of choice at present based on cost, known safe degradation products, and access to specialised vaporisers needed for use.

COMMON PROCEDURES

Arterial pulse can be appreciated from the auricular arteries on the posterior surface of the ear or the facial artery as it crosses the ventral border of the mandible.

Auscultation of the chest is of limited use in anything but the youngest elephants. It can be used for heart rates if not able to palpate a pulse.

Blood samples are taken most easily from the veins on the posterior aspect of the ear; the internal saphenous vein or the cephalic vein. This is an essential part of the clinical exam as well as for monitoring reproductive health and screening for infectious agents. It is paramount that in any training programme, blood collection is taught from an early age. Haematology of the elephant is unusual in that the red cells are very large, the platelets numerous and monocytes with bi-lobed or even tri-lobed nuclei known as 'elephant cells' are present in large numbers (these cells have also been classified by some as lymphocytes). For a detailed description of the haematological and serum biochemical parameters of the elephant, see (Mikota and Kahn 2000) (Mikota 2006a).

Dental examination of tusks and molars should be carried out at regular intervals. Examination of the molars requires that the elephant be trained to open its mouth and relax the cheek muscles and tongue.

Electrocardiography (ECG) can be performed in elephants and best results are achieved using needle electrodes. A detailed description of the technique and interpretation of results is given in (Bartlett 2006).

Faecal examinations. Annual faecal parasite screens are recommended as a minimum, and should include direct, floatation and sedimentation techniques. More frequent examinations will be necessary where a particular problem exists locally. Faecal bacteriology screens should also be carried out at regular intervals with particular attention being paid to culture for Salmonella spp. As Salmonella can be shed intermittently, culture from 3-5 samples taken on consecutive or alternate days is advised.

Radiography. Elephant calves can be radiographed as for horses, but it is only practical at present to radiograph the extremities of adult elephants. This includes distal limbs, tails, trunk, and some aspects of dentition. Suitable exposure factors and details of positioning are available (Gage 1999) (Schmitt 1986) (Siegal-Willot *et al.* 2008). Note: basic radiation safety and protection rules should be followed at all times.

Records. It is crucial that elephant keepers keep accurate records; it is not easy for a veterinarian to assess changes in appetite, water-intake, and other important husbandry-medical issues when normal baseline data are not available.

Surgery. The scope of routine surgical procedures for the elephant is very limited. It is difficult to keep surgical incisions clean and wound healing is generally poor with considerable post-operative swelling and oedema. Superficial surgery often heals by granulation. For a review of surgical procedures in elephants, see (Fowler 2006e).

Temperature taking. Rectal or fresh faecal bolus temperatures (within 5-9 mins of excretion) can be used although comparison between individuals is advised. Faecal boluses temperatures are thought to be 0.5 0C higher then rectal temperatures. There is some evidence that body temperature alters with ovarian activity (Kusuda *et al.* 2007).

Thermal Imaging. Thermal imaging (or infrared thermography) offers great diagnostic possibilities in elephants as no immobilization or animal contact is required. A good review has been published by (Hilsberg-Merz 2007).

Transponders. These microchip transponders should be fitted subcutaneously behind the left ear.

Ultrasonography. Ultrasound is an extremely useful/essential modality for any elephant collection; it is used primarily for reproductive assessment and pregnancy and parturition monitoring but can also be used for general diagnostic procedures including lameness ,ocular or cardiac conditions.

SIGNS OF ILL HEALTH

General indications of ill health in elephants include the following:

- Generally less alert.
- Reduced movements of trunk, ears, tail, and legs.
- Localised lameness.
- Altered water intake and urinary output (trunk tip should be moist if water intake is adequate).
- Reduced food intake and alteration in faecal quantity & quality (including diarrhoea & constipation).
- Loss of weight/reduction in weight gain or growth rate.
- Changes in respiratory depth & pattern.
- Respiratory discharges – from trunk.
- Temperature of 38°C or more.
- Hyperaemia of mucous membranes (eye, mouth, vulva).
- Signs of pain - including groaning, biting tip of trunk, abnormal postures.
- Non-specific colic signs – as for a horse.
- Dependant oedema.
- Neurological signs such as shaking, or loss of balance.
- Localised trauma – especially tusks.
- Epiphora – excessive lacrimation of the eye. Caused by pain and could be related to infections and/or a foreign body.
- Blepharospasm – spasm of the eyelids resulting in the eyes being closed. Caused by pain and could be related to infections and/or a foreign body.
- Changes in behaviour - A useful review of behavioural changes and clinical examination can be found in (Fowler 2007) (Mikota 2006c).

When undertaking a clinical examination of an elephant it is important to realise the importance of blood sampling. For example, as skin turgor is not easy to assess, hydration is generally measured by reference to the Packed Cell Volume (RCV) and Total Protein (TP). Consequently, it is of enormous value that elephants are trained to accept sampling (and examination) without sedation, whatever the handling system.

3.15.4 Common medical and surgical considerations of the elephant

Medical and surgical management has existed for generations, yet it is only in the last twenty years that real advances in our understanding of anatomy and physiology have been made resulting in improvements in our approach to management and diagnosis of conditions of the elephant. Elephant medicine and surgery as a discipline is in its infancy and the field continues to move forward, as our knowledge increases. Historically captive elephants in Europe and Western countries have been kept in what are now known to be unsuitable conditions and husbandry techniques. In certain cases they have led to husbandry related disorders that, due to the long life of elephants, leave a legacy that continues to raise welfare concerns for elephants. Everything must be done to provide adequate support to these older elephants, whose physical ailments are permanent, whilst ensuring that husbandry changes are made to provide a more suitable captive environment for the next generation of calves. Patience is imperative as it will be several years before changes made can be truly assessed on whether they are for the better or worse: this requires good record keeping and constant vigilance.

Due to their size elephants pose a considerable challenge to the veterinarian attempting to diagnose and manage certain conditions. This is especially true with surgical conditions. Technology has allowed some difficulties to be overcome but only to a certain degree and often diagnosis can be difficult, let alone suitable therapeutic regimes to be implemented. The following provides a brief overview of some of the common medical and surgical considerations of the elephant. Body systems are dealt with, followed by nutritional and infectious diseases.

CARDIOVASCULAR SYSTEM

The elephant heart is relatively small for its size, making up only 0.5% of their body weight. It also has a bifid apex, and there are several other anatomical differences when compared to other mammals. Auscultation of the heart is difficult in adult animals but possible with the use of digital stethoscopes. Normal values are described in Table IV and for more information see (Bartlett 2006). The following disorders have been described;

Arterial lesions: are usually seen at post mortem as incidental findings. This is true of captive and wild elephants (Lindsay *et al.* 1956) (McCullagh & Lewis 1967), with both intimal arthrosclerosis and sclerosis of the tunica media being described as principle lesions (McCullagh 1972) (McCullagh 1975).

Cardiomyopathy: describes chronic disease of the heart muscle. This can manifest as lethargy, ventral oedema, mild anaemia, weight loss, and cardiac disease should be considered in any aged animals with lethargy and weight loss over a protracted time course. Vitamin E deficiency in young animals has also been suspected in some cardiomyopathy cases.

Elephant Endotheliotropic Herpes Virus (EEHV): results in several cardiac dysfunctions either directly on the heart or peripherally on the vasculature. This condition is discussed in detail below.

Encephalomyocarditis Virus (EMCV): has been reported in wild and captive African elephants (Grobler *et al.* 1995) (Simpson *et al.* 1977). Although EMCV has not been diagnosed in Europe to date, but needs to be considered if importing elephants. Rodents are thought to be the reservoir host, and it isn't thought to pass from elephant to elephant. Suitable rodent control is imperative as part of a preventative health protocol. Sudden death is the predominant sign, but general cardiac signs can be seen in mild cases. A history of EMCV should be considered prior to anaesthesia as cardiac scarring predisposes to anaesthetic complications.

Oedema: has often been documented in association with cardiac disease, EEHV infection, hypoproteinaemia, anaemia, pregnancy, liver disease, and other conditions. If seen a full work up should be undertaken to determine the underlying cause.

Sudden death related to stress. Sudden death can occur following a complex alteration of metabolic processes that lead to peracute-lethal acid base and electrolyte disturbances that result in damage to skeletal and cardiac musculature, the so called exertional or capture shock syndromes. Usually these occur after a severe stressor, such as restraint, and follow from a massive release of catecholamines. Severe stress should be avoided and considered in any procedure, the use of premedication or long acting neuroleptics maybe useful. Cardiac disease, infectious causes etc. also cause sudden death and must also be ruled out at post mortem.

DIGESTIVE SYSTEM

The digestive system starts with the dentition and ends at the rectum, incorporating the liver, pancreas, stomach, and intestines. The tusks and maxillary secondary incisors, are a prominent feature in elephants, being much reduced in female Asians. An elephant will have 24 molar teeth during a lifetime, each arcade containing six teeth. These teeth are often referred to solely as molars but in the dental formulae they are differentiated into three premolars followed by three molars. Molar teeth erupt in the caudal jaw and move forward over time, much like a conveyor belt, pushing out the older more cranial molars. The trunk is important for prehension of food items. The stomach is simple with a volume of 60-70 litres (Dumonceaux 2006). The elephant liver has 2-3 lobes, and no gall bladder. The gastro-intestinal tract (GIT) is similar to that of equines, with a large caecum and colon for hindgut fermentation. The digestive strategy of elephants is that of passing large amounts of low quality forage through the gastrointestinal tract in a short period of time. Disorders of the digestive system are relatively common in captive elephants and include;

Choke or oesophageal obstruction: has been recorded in Asian and African elephants, and young elephants seem especially prone. Apples, potatoes and stones have all been described. Surgical and medical management can be employed on a case-by-case basis. Constipation can occur secondarily if water intake cannot occur (Wood 1992).

Clostridial enterotoxaemia: has been reported in the wild and in captive elephants, and should be considered in any cases of sudden death (Bacciarini *et al.* 2001) (Goltenboth & Klos 1974).

Colibacillosis: is caused by Escherichia coli and can lead to either enterotaxaemia or massive infection of the GIT. It is described under infectious disease.

Colic: refers to any abdominal pain and as such can occur through pain from any abdominal organ but, more often then not, it is in the GIT. Spasmodic colic, bloat, impaction, constipation, mesenteric tears, and infectious causes (including EEHV) have all been reported. Colic can occur after sudden dietary changes, but although not common, ingestion of large amounts of earth, sand, or stones can cause problems.

Dental diseases vary considerably and include;

- Deformities of the tusks; usually a result of trauma in early life.
- Excessive or abnormal wear of tusks on bars or cables leads to sharp ends, weaknesses in the tusk shaft, and minor or major fractures. Sharp-ended tusks can cause severe injuries in conspecifics.
- Fractures and longitudinal splits of the tusk; where the pulp is compromised, bacteria can cause infection within the tusk or even into the maxilla. These conditions are not only life threatening to the elephant, but can also be very painful. Simple and recent fractures involving the pulp may be reparable by endodontic treatment, but more severe or chronic cases require extraction. Extraction is a specialist procedure, although basic tusk removal has been described (Steiner *et al.* 2003), expert opinion should be obtained.
- Impacted molars often result from failure of the preceding molar fragments to be shed, which may in turn result from inadequate provision of browse. In extreme cases the author has seen deviation of molars through 90 degrees. Such molar problems can be a cause of chronic weight loss. Molar abscesses do occur and may progress to osteomyelitis and gross swelling of the mandible. Extraction has been described, but again requires specialist equipment and knowledge (Kertesz 1992).
- Sulcus infections occur and are usually secondary to foreign bodies.
- Oral examination is an essential part of the daily routine for any husbandry programme.

FIG. 38: A DAILY ORAL EXAMINATION IS IMPORTANT AT ALL AGES

Diarrhoea: can leads to dehydration, which can occur rapidly and be fatal. Diarrhoea can be a result of enteric dysbacteriosis due to sudden dietary changes, salmonellosis (often considered to be the most important cause), colibacillosis and other infectious agents including viruses.

Gastritis and gastric ulceration: has been recognised at post mortem but they are rarely diagnosed antemortem. Diagnosis should be considered in any animals with signs of occult faecal blood loss, or colic, especially those on long term NSAID therapy.

Intestinal parasitism: is rarely a significant cause of clinical problems in captive elephants in the UK. Protozoa, trematodes, cestodes, and nematodes have all been reported in elephants (Fowler 2006d).

Liver diseases: reported include cholelithiasis (caused by Salmonella london), parasitisim including hydatid cysts and fascioliasis, hepatitis, and damage from toxins and medications such as pyrazinamide (Agnew *et al.* 2005) (Caple *et al.* 1978) (Decker & Krohn 1973). Leptospirosis has also been recorded.

Obesity: although not a digestive system disease per se, it is still one of the most important factors in several of the disease complexes and aetiology of several pathological conditions. Obesity is a major medicohusbandry condition for elephants in the UK and there is no real reason for it to occur (Harris *et al* 2008). See Section 6.4.2 Body Condition Scoring.

Toxicity: GIT signs including colic, or diarrhoea, can be seen with organophosphate poisoning, ingestion of toxic plants (*Nerium oleander, Thevetia peruviana, Rhododendron sp., Taxus sp., Solanum sp.,* and *Aesculus* *hippocastanum* to name a few) or heavy metals such as arsenic or lead. Others exist. For a comprehensive review of toxicology in elephants see (Fowler 2006f).

Volvulus and intussceptions: have been reported, especially following a fall or being rolled under anaesthesia. These conditions are usually fatal and diagnosed at post mortem.

HAEMOLYMPHATIC SYSTEM

In the last five years, knowledge of elephant immunity has moved forward in leaps and bounds. Although very little is known about the mechanics of the immune system and it's response to infectious agents or pathology, more is known about basic elephant haematology, see (Mikota 2006a). Blood collection is an essential part of the basic health check of any elephant and should be one of the earliest procedures that an elephant becomes conditioned to. Conditions of the haemolymphatic system include;

Anaemia: has been reported, either secondary to other disease processes or as a condition in itself. Transfusions have not yet occurred and knowledge of elephant blood groups is currently unavailable.

EEHV: has been reported in lymphoid nodules in the lungs of African elephants but not in Asians (McCully *et al.* 1971), there is some thoughts that it may be present in lymphoid follicular vulvitis lesions.

Haemoparasites: have been reported in wild animals but are not considered to be a problem in captive elephants in the UK.

Lymph node enlargement: can occur in any inflammatory or chronic conditions.

MUSCULOSKELETAL SYSTEM

As with horses, an elephant is only as good as it's foot. Knowledge of basic anatomy of the musculoskeletal system is essential to understand the normal function, disease processes, and supportive therapies that must be implemented to treat some of the most common problems seen in captive elephants. Good anatomical reviews are found in (Benz 2005) (Lamps *et al.* 2001) (Weissengruber *et al.* 2006) and aspects of recent findings in elephant locomotion can be found with (Hutchinson *et al.* 2003) (Hutchinson *et al.* 2006) (Miller *et al.* 2008) (Ren & Hutchinson 2008). One obvious difference is that the fore feet are considerably different to the hind, for example the former having a modified digitigrades stance, whilst the later is semi-plantigrade. Included here under the musculoskeletal system section are disorders of the feet and arthritis, these conditions, along with obesity and reproductive pathology are the most important ailments to compromise captive elephants in the UK. It should be noted that due to failings in the husbandry systems and captive environments historically we have inherited a legacy of elephant musculoskeletal pathology that is irreversible. Arthritis, gait changes and likely nail and other foot problems in older animals need to be supported prior to the point where welfare is compromised and euthanasia is indicated. The future for current calves lies with changes in management and captive environments with the aim to ensure support, without compromise, of the normal anatomy and physiology of the elephant's feet and other body systems.

Arthritis: is one of the most common musculoskeletal diseases seen in captive elephants. The causes are multifactorial as they are in other species, these include; infection, autoimmune disease, conformational or gait abnormalities, nutritional related disease early on in life, mechanical insult (e.g. unsuitable enclosure flooring), or trauma (West 2006). Factors that potentially exacerbate or compound arthritis include; lack of exercise, obesity, and poor conformation. Lameness is the most apparent change seen as a result of arthritis, but regular monitoring of gait and locomotion may provide earlier clues to problems. Often by the time arthritis is diagnosed it can only be managed with analgesics, weight control, nutritional support, and exercise including hydrotherapy. If severe then euthanasia might be indicated.

Infectious disease: Foot and mouth disease (FMD) is rare in elephants, lesions are seen around the junction of the toe nail and pad which can become hot, swollen, and tender, progressing in severe cases to complete sloughs occurring. A similar picture can be seen in Elephant Pox (discussed below). Pododermatitis refers to any infectious process of the foot and is often a sequel to problems of husbandry, neglect, constant exposure to urine or waste, conformational abnormalities (especially older elephants), foreign bodies or trauma, and a host of other factors that we are aware of and others that we are not. Abscesses within the nail, pad, surrounding skin or deeper structures can all be classed under this term. However, it is not a useful diagnosis in itself and it's more useful to define the location or tissues involved, with more specific anatomical terminology being used. Several different bacteria can be isolated, some environmental opportunists, others being more aggressive and specific as aetiological agents in their own right, for a review and good descriptions see (Fowler 2006a).

Nutritional: nutritional secondary hyperparathyroidism has been reported in hand raised calves (West 2006), and it is possible that nutrition has an impact on the development on abnormal cartilage development which may occur in elephants. The biggest factor that compounds musculoskeletal pathology is obesity. See Section 3.4: Nutrition.

Sole or footpad problems: overgrowth can lead to pocket formation which predisposes to infection and abscessation. Animals on concrete can wear down the foot pad which becomes too thin, predisposing to penetration into the underlying structures which is difficult to manage and treat due to the poor vascularisation of this area. Other problems include; foreign body penetration, development of cracks, and maceration of the keratin, all of which predispose to pododermatitis of the sole (Fowler 2006a). Thinning of the sole can be uniform or localised with specific conformational abnormalities, or altered weight bearing due to pathology located elsewhere. Contusions have been reported following trauma. Sub-sole abscesses can extend for some length between the keratin and the germinal tissue and requires careful assessment using ultrasound, and surgical debridement of affected areas (Luikart & Stover 2005). See **footcare** below.

Toenail problems: The macro- and microscopic anatomy of the normal elephant toenail is well described, (Benz 2005), yet the pathology of the abnormal toenail is not. Close attention to nails and the surrounding areas is an essential part of foot care. It is likely that following aggressive trimming that the underlying tissues are compromised, this is compounded by changes in conformation and in weight distribution combined with unsuitable environmental factors that lead to recurrence of toenail problems on the same nails within individual animals. This seems logical but has not been proven, and is hypothetical at present, but would be an interesting research area.

Overgrowth is a common problem, with nails normally growing from 5-10mm/month (Fowler 2006a). The nail can grow downwards, outwards, or laterally into the other nails leading to an inflammatory response termed perionychia. In addition to the nail itself the cuticle can become overgrown, leading to feathering, and cracking, which can be extremely painful. These cracks can provide a route for infection. Fluid filled pockets can occur under the overgrown cuticle, which can become infected or act as a source of pain. Appropriate management of the cuticle is important and attention to trimming is paramount. Toenails are integral with the footpad and pathology often combines with both, in severe cases bone involvement can occur and radiographic assessment is essential. Nail cracks can occur either horizontally or vertically, assessment is important to determine whether they are superficial or extend into the epidermis. Onychia, inflammation of the toenail bed, usually spreads through the route of least resistance, which is usually along the laminae to burst out through the proximal toenail at its thinnest point. Treatment requires trimming out of the necrotic material, which is often black in appearance. Neoplasia has also been described associated with the peri-toenail region (Liu *et al.* 2004).

Trauma: sprains, dislocations, and fractures are frequently reported in the literature (West 2006). Penetration of joints can lead to severe arthritis; this can occur following tusk injuries. Chain injuries can occur and are avoidable.

Trunk injuries. The trunk has a massive blood supply and thus severe haemorrhage may result following trauma. Paralysis of the trunk can arise from motor nerve damage.

Trunk paralysis. Partial or complete paralysis of the trunk with consequent muscle atrophy is occasionally seen in Asian elephants. The cause is unknown, but cranial nerve trauma or infection and arteriosclerosis have all been suggested. Flaccid trunk paralysis is a syndrome in its own right and is seen in African elephants in the wild, the cause of this is also unknown.

Foot care: The elephant community should endeavour to improve on the incidence of foot problems, which can be as high as 50-80% of elephants (Harris *et al* 2008), with the strategic aim to eradicate foot problems from captive elephants.

It should be noted here that prevention is better then cure and that all efforts should be made to prevent foot problems from occurring, rather then dealing with the problem after it has occurred. There is no single element of a husbandry system or foot care programme that will prevent foot problems, the care of elephant's feet should be considered as a holistic approach with a multifactorial aetiology. Each component being addressed individually will bring the collection one step closer to providing an improved, more comprehensive foot care programme.

There has been little definitive research in to what constitutes the ideal environment for African or Asian elephant feet (they appear to have different foot needs). Comparing foot pathologies of captive elephants with wild elephants, or captive elephants in range countries, is difficult as the conditions are different and range country elephants are exposed to different pathologies and aetiologies. There are several audits that identify similar incidences of foot problems between the two populations e.g. (Fowler 2006a) (Harris *et al* 2008) (Keet *et al.* 1997) (Ramanathan & Mallapur 2008) and this is used in some cases to justify the foot problems seen in captive elephants. Looking at the behaviour of wild elephants and the different substrates available to, and utilised by, them can be useful when attempting to improve captive environments, see (Buckley 2001).

The following are some of the areas, which are currently considered to be integral to foot care;

- **Facility design:** the elephant's environment **MUST** be designed with foot health in mind. In addition to appropriate substrates, suitable facilities need to be provided to allow foot trimming to be performed safely for both keeper and elephant. See Section 3.3: ENCLOSURE for more information.
- **Exercise:** exercise is essential for maintaining a health physique, maintaining musculoskeletal health, and aid in preventing obesity. It is considered to be one of the most important aspects of proper elephant husbandry (Roocroft and Oosterhuis 2001). Healthy feet, and a healthy elephant, require a minimum of one to two hours walking a day (Roocroft and Oosterhuis 2001) to exercise of all of the joints, tendons, ligaments, and cardiovascular system.
- **Nutrition:** nutritional needs have several impacts on horn, foot and general musculoskeletal health. The most important, impact is obesity. Managing weight should be a primary focus to support proper foot care (Sadler 2001), as a recent audit determined that 75% of UK elephants were considered overweight (Harris *et al* 2008). See Section 3.4: NUTRITION for more information.
- **Keeper training:** keeper experience is a critical component of proper elephant foot care programme (Fowler 2006a) (Roocroft and Oosterhuis 2001) as inadequate foot care can readily predispose to lameness, local, and even systemic infections. See Section 3.9: Staff Training.
- **Proper hygiene:** In captivity, elephant's feet are exposed to their own faeces and urine much more than they would be in the wild. In order to reduce the corrosive nature of these substances proper hygiene practices should be followed. Where elephants spend a significant amount of time on substrates where urine and faeces collect (e.g.

concrete floors) daily scrubbing of the feet and legs, using soap and water and a hard bristle brush is recommended (Roocroft and Oosterhuis 2001). Pools and mud areas are also useful.

- **Trained elephants:** in herds where there are foot problems, it is helpful if the elephants are able to present a foot for a suitable amount of time, present all aspects of the foot, and allow a complete foot trim. **Reliable equipment:** correct, and well maintained, equipment is essential for efficient and correct foot trims to occur. This includes trimming equipment as well as ancillary supports. Using blunt or unsuitable tools can exacerbate foot problems, lengthen the time of a foot trimming session, and cause pain to the elephant being trimmed.
- **Sufficient time:** an essential part of any elephant husbandry programme that includes foot care is suitable time is provided within the programme to carry out foot care. A little and often approach is more often beneficial and this can add up with larger herds, however short cuts cannot be taken, nor can the job be rushed, without compromising the care for the feet, and the elephant (Fowler 2006a).
- **Record keeping:** record keeping is essential to maintain consistency throughout a foot care programme. Well labelled photos documenting pathology, post-trimming, and changes in response to treatment are useful, not only as a historical record but also for teaching and communicating to other colleagues.
- **Veterinary support:** if foot problems do occur it is essential that veterinary support forms part of the foot care programme. Veterinary support can consist of surgery, analgesia, antibiosis, and general elephant health advice.
- **Locomotion assessment:** new techniques for quantitative and qualitative assessment of gait and locomotion can be used to document musculoskeletal histories.

Good anatomical reviews are found in (Benz 2005) (Lamps *et al.* 2001) (Weissengruber *et al.* 2006) and aspects of recent findings in elephant locomotion can be found with (Hutchinson *et al.* 2003) (Hutchinson *et al.* 2006) (Miller *et al.* 2008) (Ren & Hutchinson 2008).

FIG. 39: ASIAN BULL ELEPHANT HAVING HIS FEET BRUSHED AND CHECKED IN PROTECTED CONTACT

Foot care is a holistic process incorporating a combination of husbandry, trimming, and veterinary changes. The aims of a foot care programme are to either prevent problems from occurring, to return an elephant back to normal function or if this is not possible, the programme should aim to support the elephant, with welfare being the primary concern.

The components of a foot care programme should aim to include;

- Regular monitoring and checks of foot health.
- Regular trimming and foot care if needed.
- Documentation including photographs
- Suitable weight control and nutritional support.
- Regular monitoring of locomotion and gait.
- Minimum of annual veterinary check ups including radiography of digits.
- Realistic goals and assessments that are honest and have welfare as the primary concern.

Radiography of digits and foot baths are useful tools

Radiography of digits: radiography is useful to provide baseline data on the osseus anatomy of the digits as well as for assessing the extent of pathological conditions. It is essential that good radiographic practice is adhered to at all times; this includes radiation safety but also consistent technique and positioning. It is important that standardised protocols are used for repeatability and comparison to previous readiographs of the same animal. Digits should be radiographed individually as positional artifacts can result in misdiagnosis of problems (see Fig. 39). See (Gage *et al.* 1997) (Siegal-Willot *et al.* 2008) for positioning and technique.

FIG. 40: POSITIONING IS IMPORTANT WHEN TAKING RADIOGRAPHS. VARIATION IN TECHNIQUE BETWEEN RADIOGRAPHS OF THE SAME DIGIT RESULTS IN CHANGES THAT MAYBE MISDIAGNOSED AS OSSEUS LESIONS. THIS CAN BE SEEN WITH THE TEN IMAGES ABOVE, ALL OF WHICH ARE THE SAME DISTAL PHALANX (P3).

Foot baths: One aspect of treatment is seen with footbaths utilising various preparations. There are different thoughts on the choice of agents, the reality being that no one agent is better then another and treatment efficacy should be based on individual response and accurate record keeping. However there is evidence in other species that certain popular treatments actually reduce or even kill the healing tissues and may exacerbate the problem, it is likely that the same occurs in elephants (Farstvedt and Stashak 2008) (Fowler 2001) (Farstvedt and Stashak 2008).

Trunk injuries. The trunk has a massive blood supply and thus severe haemorrhage may result following trauma. Paralysis of the trunk can arise from motor nerve damage. Loss of part of the trunk can be a serious problem for an elephant, but some animals adapt better than others.

Trunk paralysis. Partial or complete paralysis of the trunk with consequent muscle atrophy is occasionally seen in Asian elephants. The cause is unknown, but cranial nerve trauma or infection and arteriosclerosis have all been suggested. Flaccid trunk paralysis is a syndrome in its own right and is seen in African elephants in the wild, the cause of this is also unknown.

TABLE XIII: COMMONLY USED AGENTS FOR FOOT BATHS, LAVAGE, OR DRESSINGS
Data from elephant, equine, and human sources (Farstvedt and Stashak 2008) (Fowler 2001) (Farstvedt and Stashak 2008).

Agent	Indications	Directions	Comments
Wound cleansers			
Commercial soaps	Used in the initial preparation and decontamination of heavily contaminated wounds	Contraindicated	Even at dilution so of 1:100,000 these are toxic to fibroblasts and should not be used for wound cleansing.
Commercial wound cleansers	Used in the initial preparation and decontamination of light to heavily contaminated wounds	Dependent on product used.	Check safety data and effect on inflammatory cells, there are some good products available that are relatively kind to cells. Neutral pH solutions should be used, avoid acid based preparations.
Commercial fluids (for intravenous infusion)	Once contamination removed commercial fluids should be used for lavage	0.9% saline, lactated ringer's solution, and other isotonic solutions used neat	In vitro found to be non-toxic to fibroblasts.
Tap water	Decontamination of wounds and lavage.	Turn on tap	Acceptable for early lavage but when granulation tissue starts should be discontinued as hypotonicity causes cell swelling and

			destruction if prolonged use.
Antiseptics			
Povidone Iodine	Broad range of antimicrobial activity, used irrigation of abscesses and topical wound treatment	Solutions should be made to dilutions of 0.1-0.2% (10-20ml/litre): increases free iodine for antimicrobial action whilst reducing damage to cells.	At concentration of 5% it has been shown to inhibit white blood cell migration, resulting in increased wound infection. At 10% actually causes microvascular destruction in lab models but this is not seen clinically in the horse . Has 4-6 hours of residual antimicrobial action. Inactivated by organic material or blood
Chlorhexidine diacetate	Wide antimicrobial activity,	0.05-0.5% solution, 0.5% for baths, lower for lavage.	No effect against *Pseudomonas* or *Proteus*, nor fungi or candida. Some reports state more effective antibmircobial action then povidone iodine. Higher then 1% shown to reduce wound healing.
Chlorhexidine gluconate	Wide antimicrobial activity	Not documented	0.5% toxic to human keratinocytes and fibroblasts.
Hydrogen Peroxide	Narrow antimicrobial spectrum, not	Contraindicated	Solutions of 3% have been shown to be toxic to

	suitable in wound management		fibroblasts and result in thrombosis of microvasculature, as such it should not be used as exacerbates the condition and deals healing.
Dakin's Solution (Sodium hypochlorute)	Broad antimicrobial action, used for debridement of necrotic tissue, should not be used on clean healthy wounds.	0.125% solution for debridement, 0.025% for lavage but others more suitable	At concentrations of 0.025%t toxic to fibroblast and therefore should only be used for debriding necrotic tissue, not lavage unless nothing else available.
Acetic acid	Antimicrobial action	Contraindicated	Solution need to be <0.025% before non toxic to cells, at this level efficacy diminished, not recommended
Magnesium sulphate	Concentrated solution to draw fluid from a lesion	Contraindicated	Cytotoxic to fibroblasts, not recommended
Potassium permanganate	Antiseptic	1:1000 dilution	Cytotoxic to fibroblasts, not recommended
Topical antibiotics **Should be used based on culture of infected wounds: vet prescribed**			
Silver sulfadiazine	Wide antimicrobial action, including *Pseudomonas sp* and fungi.	As supplied	Mixed reports with some saying increases wound healing and others say slowing, if combined with aloe vera then it reverses the inhibitory effects.
Nitrofurazone ointment	Good antimicrobial, not *Pseudomonas sp.*	As supplied	Some delay in wound healing, and listed as a

			carcinogen. Question use.
Gentamycin sulphate	Narrow spectrum of antimicrobial action but good against gram –ve bacteria and *Pseudomonas sp.*	As supplied	Some delay in wound healing and epithelialisation
Antibiotic spray ("blue spray")	Topical antibiotic	Various	Poor penetration and mainly placebo effect for keepers. Not recommended.
Topical herbal and other alternative therapies **There are many, below are some of the potentially more useful ones**			
Aloe vera	Stimulate wound healing, antibiotic properties, antiviral, tissue promotoer, and immune stimulant.	Topical application	Use in elephants or horses not reported but potentially useful.
Comfrey (*Symphytum officinale*)	Natural poltice that draws exudate and waste from a wound. Antimicrobial action questionable.	Poltice	Use in elephants or horses not reported but potentially useful
Propolis	Used in the inflammatory phase as an antimicrobial and anti-inflammatory	Topical application	Use in elephants or horses not reported but potentially useful
Tea Tree Oil (*Melaleuca alternifolia*)	Encourages healing, antibacterial and antifungal	0.2% solution	Can be used uring inflammation and healing phase, use in elephants or horses not reported but potentially useful
Honey	Broad spectrum antimicrobial, anti-inflammatory, and stimulates new	Topical, neat	Manuka honey most efficacious. In vitro studies do not always correlate with in

	tissue growth.		vivo use and efficacy may not be as good as on paper.
Gentian violet	potential wound repair stimulant	Contraindicated	Inhibits the formation of granulation tissue, microangioatphy, and other problems. Not recommended.
Vitamin E	Wound healing stimulant	Oral supplementation or topical	Efficacy not proven, may lead to contact dermatitis, works well in rats.
Dressings **Many are available, a selection is described**			
Gauze	Debridement of heavily contaminated wounds	Wet to dry, or if copious exudate can be applied dry. Can be used wet with commercial fluids, povidone iodine or chlorhexidine: see above	Change every 24 hours or so, usually three treatments sufficient to debride a wound. Can be used to plug holes, abscess, or tracts but should aim to open up.
Hydrogel dressings	Hydrate wound and facilitate autolytic debridement, cooling effect to wound (reduces pain)	Topical or impregnated dressings e.g. intrasite	Early in healing tend to reduce infection, later phases prevent excessive granulation tissue. Useful but difficult to maintain.
Calcium alginate	Absorb aqueous material, increase epithelialisation and wound healing	Topical dressing	Use in heavy exudates or large wounds.

The trunk is the most obvious part of the respiratory system and disorders are covered under musculoskeletal systems. Elephants are not obligate trunk breathers and can breathe through their mouths. Cartilage and muscles present as the nasal passages enter the skull can be closed completely when an elephant drinks. The larynx and trachea are similar to other species. The trachea is approximately 50-70mm wide and 300mm long in adult elephants. The elephant thorax is unusual. The Asian elephant has 19-20 ribs, and the African 20-21. There is no pleural space and the lung is directly attached to the rib cage, although functionally it is possible that the pleural space connective tissue does function as if it were a normal pleural space i.e. the lungs are not rigidly adhered to the ribs and there is some movement (Brown *et al.* 1997). Breathing is through the diaphragm and displacement of the abdominal viscera, this is an especially important consideration when anaesthetising elephants as sternal positioning can lead to severe respiratory compromise (Isaza 2006). The lung is smaller on the left then the right, with both containing one major lobe with several deep fissures partially separating the ventral aspect of the lung. Diseases of the respiratory system are not particularly common in captive elephants, however tuberculosis is one of the more important diseases currently found in elephants. The problems of the elephant respiratory system include;

Aspiration: aspiration of food items is rarely documented but has lead to one documented case of pneumonia (McGavin *et al.* 1981).

Coryza (also catarrh or cold-like syndrome): this is considered to be similar to the human cold, and results in constant trunk discharge of clear, watery serous discharge from the trunk. The eyes can become swollen with a loss of appetite. It is thought to be viral in origin but this has not been found as of yet. Supportive care indicated, care does not proceed to a secondary bacterial pneumonia (Schmitt 1986).

Infectious disease: tuberculosis is the most important infectious cause of respiratory disease and has zoonotic potential (see below). Primary pneumonia and bronchitis have been described, and can be caused by a variety of organisms that are similar to other species. Environmental Mycobacteria spp. are often found in trunk washes and are generally thought to be non pathogenic, however in certain circumstances, such as debilitated animals, then pathology has been documented e.g. M. elephantis and M. szulgai (Lacasse *et al.* 2007) (Shojaei *et al.* 2000). Pathology can be seen within the pulmonary system with several infectious agents but these are not considered primary respiratory disease, more a multi systemic disease e.g. EEHV.

Neoplasia: secondary metastases have been described in the lung (Liu *et al.* 2004), primary pulmonary neoplasia is also possible.

Obstruction of nares / nasopharynx: the nasopharynx is extremely narrow and obstruction has been reported secondary to neoplasia or dental disease (Isaza 2006).

Pharyngitis: swelling of the pharynx and surrounding tissues due to swollen parotid glands or peripharyngeal tissues have been reported, in some cases leading to partial obstruction of the larynx.

Toxicity: respiratory signs can be seen with exposure to or ingestion of several toxic agents e.g. chlorine, cardiac glycosides, etc.

Trauma: fractured ribs have been described in elephants in Burma, and tusk injuries could penetrate the thorax but are rarely documented.

SKIN

The skin is the largest organ in the body and the one that provides a barrier to external influences whilst aiding in maintaining homeostasis. The thickness varies from 1.8mm on the medial ear to as much as 30mm or more over the rear of an elephant. Hair can cover the whole animal, more so in youngsters, with the densest areas being on the tail. The temporal glands are unique to elephants and are paired modified apocrine sweat glands, located midway between the lateral canthus and the external auditory canal. It is used in chemical communication, primarily during musth. The temporal gland is highly vascular and care should be taken if probing an abscess or this area. The existence of true sweat glands has long been argued (Mikota 2006b), the first found were only in 2001 between the interdigital spaces (Lamps *et al.* 2001). Nails are discussed in MUSCULOSKELETAL section above.

The ability for elephants to take care of their skin should be made available (See Section 3.3: ENCLOSURE). Skin problems are relatively common in captive elephants and regular skin care should be given a high priority. Good skin health is promoted in wild elephants by mud wallowing, scratching against trees, submerging in water, and covering themselves with dust. In collections where the management regime allows, keepers bathe and scrub the elephants with a stiff brush or coconut husk. This may help with the skin condition, and does help increase the bond between elephant and keeper. Dusting material such as sand or dry soil should be provided, as should rock or tree stumps etc for rubbing and scratching. Oiling the skin may help in cold dry climates to prevent cracking and promote suppleness of the skin. Water and dust baths also help elephants control body temperature (Mikota 2006b).

The following conditions have been reported:

Abscesses: subcutaneous abscesses can result from bruising, penetrating injuries, wounds, poor injection techniques, etc. They tend to spread under the thick skin rather than point and burst to the outside, and often become chronic. Establishing surgical drainage is sometimes sufficient treatment, but particularly indolent abscesses may require the surgical removal of all overlying skin, allowing healing by granulation aided by appropriate wound dressings.

Decubital ulcers (pressure sores): can occur if unsuitable substrate or prolonged recumbency. Can occur over the hip, elbow, or side of the head. Not common now enclosure improvements have been made.

Dermatitis: inadequate bathing can lead to dermatitis following excessive epidermal growth . Superficial pyoderma can occur in the tail and within the roots of the hair follicles: antibiosis and depilation normal resolves this problem quickly.

Frostbite: can occur particularly of the tail and ear margins.

Infectious diseases: pox virus, papillomavirus, EEHV, fungi, and other infectious agents can manifest as skin conditions as a primary disease or as part of a multisystemic disorder.

Parasites: Lice (*Haematomyzus elephantis*) are common on wild and newly caught Asian and African elephants; fleas, ticks, flies and mosquitoes have also been described.

Neoplasia: fibromas and low-grade fibrosarcomas occur under the skin (Brown *et al.* 1973) (Liu *et al.* 2004), and papillomas are not uncommon. The latter tend to be self-limiting. In African elephants papillomas have been associated with EEHV (Jacobson *et al.* 1986).

Rashes: various allergens can be involved, but particularly insect bites.

Subcutaneous oedema: especially ventral oedema is particularly associated with general debility. Profound stress is thought to cause angioneurotic oedema in some animals and this is usually ventral. Submandibular and ventral oedema can also be associated with hypoproteinaemia, anaemia, organ dysfunction or infectious diseases such as EEHV. Ventral oedema maybe a nonspecific response to a variety of physiological stressors. It is also seen routinely following parturition (and may take some weeks to resolve).

Sunburn: in direct, hot sun the top of the head and forehead are vulnerable to sunburn, which may accompany heatstroke in extreme cases. Photosensitisation has been reported following acepromazine and xylazine sedation (Mikota 2006b). See Section 3.3: ENCLOSURE.

Wounds: many causes including other elephants, chaining, sharp enclosure features and the incorrect use of an ankus.

EYES

An excellent review of the Asian elephant eye can be found at (Baproda, 2008). The elephant eye is relatively small compared to body size and is well described. Ophthalmic examination should make up part of the general health check of an elephant but it can be difficult due to the inability for veterinarians to open the eyelids of the animal being examined. Distant techniques can be used, as well as flash photography to assess cataractous changes or retinal reflection, however the gold standard is transpalpebral ultrasonography. Disorders include;

Conjunctivitis: has been identified in captive and wild elephants. Conjunctivitis can result from many different aetiologies, including; trauma, foreign bodies, systemic disease, gamma herpes virus infections (Wellehan *et al* 2006), and other infectious diseases.

Corneal lesions: ulceration, corneal opacities, oedema, foreign bodies, hypopyon, keratitis, and panophthalmitis have all been reported.

Lens: cataracts, lens luxations, and lens dissolution have been documented in both African and Asian elephants.

Neurological: one report describes facial nerve paralysis that precipitated a dry-eye-like condition that resulted in enucleation (Mikota and Rasmussen 1994b).

EARS

The elephant ear is formed of a lattice of cartilage and is well vascularised with superficial blood vessels. They are an important part of thermoregulation for both species (Phillips & Heath 1992) and they are a useful access point for blood sampling or intravenous injection, although care must be taken to avoid peri-vascular infiltration of pharmaceuticals since subsequent ischaemia and sloughing of that portion of the pinna is common. Normal flora is described (Chinnadurai *et al.* 2009).

Trauma: tears and rips are relatively common and can result from bites, or snagging on fixed objects.

Parasites: a species of Acarinid mite has been found living in the wax of the elephant ear canal (Fain 1970).

Vascular damage: phlebitis, vasculitis, and thrombosis have all been documented resulting in the loss of part of the pinna. Agents injected intravascularly resulting in this include flunixin meglumine, trimethaprim-sulfadiazine (Suedmeyer 2006), carprofen (J. Cracknell pers comm.) and phenylbutazone (Miller 1977). Resection is often required. Frostbite has also been reported, and follows prolonged vasoconstriction in cold weather (Fowler 2006c).

THE UROGENITAL SYSTEM

The urogenital systems includes the kidneys, bladder and reproductive tract. Reproductive tract pathology and pathophysiology is one of the biggest threats to reproduction success in captive elephants. Recent advances in understanding of reproductive physiology have led to a better understanding of elephant reproduction and the improvements that need to occur with future elephant management. This is covered in more detail in section 3.6 BREEDING IN ZOOS.

Excellent reviews of obstetrics and elephant reproduction can be found in (Brown *et al.* 2004) (Hermes *et al.* 2004) (Hermes *et al.* 2008) (Hildebrandt *et al.* 2006).

Transrectal ultrasonography is an essential tool for the assessment of reproductive health and disorders in elephants. It is essential that regular reproductive assessments be undertaken on elephants in a collection. See (Hildebrandt *et al.* 2006) (Hildebrandt *et al.* 2007) (Hildebrandt *et al* 1998).

Excellent reviews of obstetrics and elephant reproduction can be found in (Brown et al., 2004; Hermes et al., 2004; Hermes et al., 2008; Hildbrandt et al., 2006b). For a full description of managing obstetrical problems in the elephant see (Hermes *et al.* 2008) (Hildebrandt *et al* 2003) (Schaftenaar and Hildebrandt 2005) (Thitaram *et al.* 2006).

Female Reproductive Pathology

Reproductive pathophysiology: A syndrome termed asynchronous or asymmetrical reproductive aging occurs in captive female elephants (Hermes *et al.* 2004). The result is an increase in reproductive pathology in older, female elephants and premature senescence. This leaves a window of approximately 10-15 years from the onset of oestrus cyclicity until a decline in reproductive fitness occurs (Hildebrandt *et al* 2000).

Reproductive problems described include;

Abortion and stillbirths: are recorded in both wild and captive elephants (Evans 1910). In captivity they can account for as many as 25% of all births (Taylor and Poole 1998). As with other species the causes are likely to be multifactorial and include; infectious causes, developmental, stressors, dam pathology or medical issues.

Cervical pathology: Cystic lesions are well described in both African and Asian elephants, but also polyps, tears during parturition, scarring post healing of tears, and subcutaneous prolapse (in association with the caudal uterus) have all been described (Hildebrandt *et al* 2000).

Dystocia: dystocia refers to a difficult birth and can be potentially life threatening for both the calf and the dam. Normal parturition is described elsewhere. Dystocia is defined by;

- Failure to push.
- Failure of the calf: presentation, viability, or size for instance.
- Obstruction of the calf: pelvis or soft tissues.

(Hermes *et al.* 2008) clinically include situations such as failure to progress, arrest of dilatation, foetopelvic or cephalopelvic disproportion, prolonged active phase, secondary arrest of dilatation, arrest of descent, and foetal malposition. They go on to list factors that may predispose to dystocia to include; early onset of puberty and pregnancy, aged elephant population combined with asymmetric-reproductive aging (compounded by related reproductive pathology), obesity, and aged primiparous cows.

For a full description of managing obstetrical problems in the elephant see (Hermes *et al.* 2008) (Hildebrandt *et al* 2003) (Schaftenaar and Hildebrandt 2005) (Thitaram *et al.* 2006). It is essential that the infrastructure and birthing plan is discussed and instigated from the minute pregnancy is confirmed. There are considerable requirements needed to manage a dystocia, and the worst possible scenario should be catered for around the periparturient period. Therapeutic support, manual manipulation, vestibulotomy and foetotomy are all possible and have been described.

Dystocia requiring veterinary intervention is defined by a failure of parturition to occur within 24-48 hours following the drop in serum progesterone, or the cessation of parturition after it has commenced but prior to the calf being born. A lack of a calf, however, does not mean dystocia is definitively present. Assessment of the calf and cow is needed at this time, and decisions should be made on a case by case basis. For example, normal births have occurred after 5-7 days (T. Bouts pers. comm.) and even 14 days later (see below). Dystocia management, both medical and surgical, is not to be undertaken lightly and it is essential that advice and support is taken from experienced veterinary clinicians.

Important considerations include;

- More common in elephants >20 years of age, as high as 50% (Hermes *et al.* 2007),
- All elephants, whether multiparous or primiparous should be monitored as dystocia can occur in any age of animal,
- All effort should be made to ensure the calf is born with the mother unchained and within the group,
- Monitoring of imminent parturition should be based on the drop in serum progesterone and relaxation of the cervix (by ultrasonographic examination),
- Parturition normally occurs within 2-5 days after the drop in progesterone to below baseline values (but can be as long as 14 days, although this maybe linked to hypocalcaemia and maybe abnormal in itself (Hermes *et al.* 2008),
- Ultrasound is essential to assess the situation,
- Confirmation of whether the cervix is open must be undertaken with the use of ultrasound,
- Medical therapy should be instigated unless a physical problem is identified, if this fails then vestibulotomy should be *considered*,
- Oxytocin should not be given without first confirming the presence of an open cervix, fatalities have been reported if this is not undertaken (Schaftenaar and Hildebrandt 2005),
- Caesarian section is not recommended and should only be considered if conservative therapy will lead to the death of the dam (Foerner 1999) (Schaftenaar and Hildebrandt 2005).

Ovarian pathology: follicular cysts have been reported.

Uterine pathology: in Asian elephants after a limited non-fertile period uterine neoplasia relatively commonly develops, with leiomyomas being the principle tumour. These are not seen in African elephants, which tend to develop cystic endometrial hyperplasia. Pyometra is also described but is uncommon. Retained foetuses do not seem to be a problem in many animals, and some carry them for many years, whilst others can be passed 2-3 weeks after the calf has died. Chronic cystic endometritis, chronic metritis, endometrial hyperplasia, and uterine cysts are also described (Mikota and Rasmussen 1994a).

Vaginal pathology: the vagina is relatively short (30cm) and that acts as a barrier during pregnancy as it becomes filled with a thick mucus plug. Two blind pouches flank the vaginal os. Cysts are relatively common within the lumen, in some cases causing obstruction but are, in general, unlikely to impact on conception rates (Hildebrandt *et al* 2000).

Vestibular cysts: the vestibule is extremely long in elephants (1-1.4m), and opens on the caudoventral abdomen. Vestibular cysts are relatively frequent findings in captive elephants of both species, vestibular polyps being found in older African cows. They are unlikely to affect conception rates but may result in pain leading to prevention of matings. Vestibular scarring and fistulae post vestibulotomy have also been reported (Hildebrandt *et al* 2000). Lymphoid follicular vulvitis is a relatively common (Munson *et al.* 1995), nondescript finding associated with different infections and possibly EEHV.

Male Reproductive Pathology

Male elephants do not seem to be affected by asymmetrical reproductive aging and reproductive pathologies are less common. There is some evidence that the problems seen in bulls, namely **lack of libido** and **poor sperm quality** may result from social factors such as suppression by dominant bulls or even keepers (Hildebrandt *et al.* 2006). In older bulls orthopaedic or even obesity problems may interfere with the act of copulation itself (Hildebrandt *et al* 1998). Vasectomy is a specialist, but well tested, technique now available in the elephant (Stetter 2006) (Stetter *et al* 2005).

Artificial Insemination

Artificial insemination is now becoming more common for captive elephants. This is a specialist technique that is still in its infancy but has resulted in live births. As a technique this will be useful in supporting breeding recommendations for captive elephants and to offset the problems of nuliparous females. However this does mean that a focus will now need to be placed on developing the technique to allow transportation of semen, as well as managing calves, improving survivorship, and ensuring that the capacity for collections is not overwhelmed with elephant calves, especially bull calves. See (Hermes *et al.* 2007) (Sa-Ardrit *et al.* 2006) (Saragusty *et al* 2009a) (Saragusty *et al.* 2009b) (Thongtip *et al.* 2004). See Section 3.6.3 for further discussion and information on research in to sexing semen.

Urinary system pathology

Kidney: Renal anatomy is well described by (Endo *et al.* 2002). **Infectious causes** can result in renal damage as either part of a multisystemic disorder (e.g. EEHV) or as a primary problem on its own (e.g. presumptive pyelonephritis caused by *Streptococcus zooepidemicus* (Sanchez *et al.* 2004). Chronic interstitial nephritis has been reported (Miller 2006). Renal cysts have also been described (Hildebrandt 2006) in an aged cow. Chronic renal failure (CRF) has been described in older animals (Mikota 1994) as a result of fibrotic conditions of the kidney, and should always be considered in the differential diagnosis of chronic weight loss. In young elephants, renal calculi may lead to CRF. Renal disease in elephants currently carries a poor prognosis.

Urolithiasis has been reported in several cases (Miller 2006) (Varma et al). Renal toxicity can occur with certain toxins or drugs such as amikacin, but this does not preclude its use as it is thought to be transient in nature (Miller 2006).

Bladder: Little is recorded about pathology of the bladder but multisystemic disorders can result in petechial haemorrhages of the bladder e.g. EEHV, septicaemia.

Urine: Typically 5-11 litres is voided in one urination, with the average in the region of 50 litres/day. Calcium oxalate crystals are often seen, the absence of which may be indicative of disease. Haematuria, polyuria, incontinence, anuria, straining or dysuria have all been documented (Mikota and Rasmussen 1994a).

NUTRITIONAL DISORDERS

Few nutritional problems have been well documented in elephant, but the following should be borne in mind (and see Section 3.4: Nutrition):

Iron deficiency anaemia is especially likely to occur in young, growing animals particularly if inadequately supplemented or without access to earth.

Hypocalcaemic tetany has been reported in elephants housed exclusively indoors with no access to sunlight (Toit 2006). Animals that have marginal calcium reserves may also develop tetany when stressed or develop reproductive disorders at parturition.

Linoleic acid deficiencies: can result in impaired sperm development and may have an impact on fertility and cryopreservation of elephant semen (Dierenfeld 2006).

Nutritional secondary hyperparathyroidism can be seen in hand-reared juvenile elephants with characteristic bowing of the long bones of the hind limbs (West 2006)(West, 2006).

Obesity: obesity is linked to the consumption of overly digestible diets and reduced physical activity. Obesity is likely to have implications for poor reproductive performance, exacerbation of arthiritis and other medical conditions.

Young African elephants fed alfalfa as the major dietary constituent can develop inward buckling of the tibio-tarsal joints, probably arising from too rapid a growth rate. This is treated by reducing dietary protein intake (Schmitt 1986).

3.15.5 Infectious diseases of elephants

BACTERIAL DISEASES

Significant bacterial infections that can affect elephants include;

Anthrax: caused by *Bacillus anthracis,* anthrax is a peracute or acute febrile infectious bacterial disease more often seen in the wild but has been reported in captive elephants (Scott 1927). Clinical signs include pneumonia, dyspnoea, colic, severe haemorrhagic diarrhoea, neurological signs, and sudden death. In cases of sudden death, and if anthrax is suspected, then the carcass should not be opened until diagnosis has been confirmed. Anthrax is generally not a problem in zoos, but in areas where it is endemic captive working elephants are routinely vaccinated. It is of concern for those who are importing elephants.

Clostridial disease: *Clostridium sp.* can cause a variety of diseases depending on the species involved but is generally not a problem in elephants. **Blackleg** (*Clostridium chauvei*) develops in the muscle and produces toxins that cause systemic signs and rapid death. Vaccination is appropriate where a particular problem occurs. **Botulism** (*C.botulinum*) has been reported in elephants and is thought to be similar to other animals. Initially incoordination, then flaccid muscle paralysis, leading to respiratory muscle paralysis. Temperature often not changed. Supportive care is needed. **Tetanus** (*C.tetani*) occurs world wide in the soil and enters via contaminated wounds where it then produces exotoxins that lead to muscle tetany. Initially this has been reported to start with being unable to open the mouth, hypersensitive to noise progressing to recumbency and tetanic spasms, in one case it took 29 days of supportive care before recovery occurred. Elephants should be vaccinated against tetanus. Other clostiridial diseases exist.

Colibacillosis: results from *Escherichia coli* infection, which can produce an invasive infection or enterotoxaemia. *E. coli* is a normal gastrointestinal flora, with certain strains that can lead to disease. It is especially a problem in the newborn and young. Septicaemia or enterotoxic diarrhoea can occur. It can be a primary agent, secondary infection, or concurrent infection with other agents. A lack of colostrum may be predisposing in juveniles. Supportive care is indicated along with antibiotics.

Leptospirosis: *Leptospira sp.* were thought not to be able to infect elephants and result in clinical disease. Antibody titres are a common finding and don't correlate with disease, only exposure. One case of clinical disease produced liver signs, including icterus. Another case had the kidney as the target organ. Antibiosis and supportive therapy indicated (Fowler 2006b) (Oni *et al.* 2007).

Mycoplasmosis: *Mycoplasma sp.* can cause an autoimmune reaction in joints, usually it is a urogenital infection but a delayed type hypersensitivity reaction resulting in a rheumatoid arthritis is suspected which responds well to antibiosis (Mikota and Clark 1994).

Pasteurellosis or haemorrhagic septicaemia results from *Pasteurella multocida* or *Mannheimia* (formerly *Pasteurella*) *haemolytica*. Typically the respiratory system is infected but septicaemia can develop from inhalation or ingestion of the organism. *Pasteurella* has been isolated form pneumonia and foot abscesses, it is thought to be a secondary contaminant in general. Systemic pasterellosis can cause an extremely acute and rapidly fatal septicaemia with clinical signs similar to anthrax. Vaccination is possible for collections experiencing problems with this pathogen (Fowler 2006b).

Salmonellosis: is a common and often fatal infection in elephants. Symptoms include profuse diarrhoea, dysentery, weakness, fever, and colic, leading to septicaemia and toxic shock. Abortion and vaginal discharges have also been noted. Other animals may present with vague clinical signs including lethargy, weakness, anorexia, ventral oedema and even constipation. Treatment is based on appropriate antibiosis and aggressive fluid therapy. Chronic asymptomatic carriers do occur, especially after recovery from a clinical case. Vaccination is possible.

Staphylococcosis: *Staphylococcus aureus* is commonly cultured from abscesses and behaves in a similar fashion to other species. Management is discussed in Section 3.15.4:SKIN above.

Tuberculosis: is caused by mycobacteria belonging to the *Mycobacterium tuberculosis*-complex (MTC), which includes a.o. *Mycobacterium tuberculosis, M. bovis, M.africanum,* and *M.microti*. Other mycobacteria exist but are classed as Environmental *Mycobacteria* (EM) (sometimes incorrectly referred to as *Mycobacteria* other than tuberculosis (MOTT) or non-tuberculosis *Mycobacteria* (NTM)), these are commonly isolated from trunk washes (e.g. *M.avium*) but are considered apathogenic. However reports of infection with EM have been recorded in atypical mycobacteriosis (Lacasse *et al.* 2007). Tuberculosis is the most important bacterial disease of captive elephants in the US and likely the EU. The last case documented in the UK, and the first in a captive elephant, was 1875 (Garrod 1875). It is thought that humans are the most likely source for infection in elephants with *M.tuberculosis* being the most common MTC isolate, with the disease then spreading from elephant to elephant within a collection before infection is discovered. Tuberculosis is **zoonotic** and the risk is considerable for keeping staff (Kaneene & Thoen 2004) (Moda *et al.* 1996) (Ryan 1997). Tuberculosis, despite being a disease that has affected elephants for over 2000 years, is classed as an emerging infectious disease since being diagnosed as affecting several elephants in the mid 1990s.

In many cases no symptoms are noticed until the disease is well established. In other cases, symptoms include weight loss, chronic nasal discharge, lethargy, and listlessness. One case had vaginal discharge (Fowler 2006b). The biggest problem of tuberculosis is that once clinical signs have developed then the rest of the herd and keeping staff will have been exposed for a considerable time, although exposure does not guarantee development of the disease (Lewerin *et al.* 2005). Culture of the organism is diagnostic.

Routine screening for tuberculosis in elephants is problematic (Lecu *et al* 2008). The most recent guidelines drawn up for the US Animal Health Association should be reviewed (USAHA 2008) as well as (Greenwald *et al.* 2009). The options for diagnosis include trunk wash, ElephantTB Stat-Pak, Multi-antigen Print Immuno assay (MAPIA), and the VetTB test. All have advantages and disadvantages that should be borne in mind when interpreting the test results. The gold standard recognised is mycobacterial culture from trunk washes, this is the only test currently recognised by Defra.

Trunk washes require training and is described by (Isaza and Ketz 1999). It requires 60ml sterile saline to be instilled into the nostril, the trunk is then elevated to wash the saline up and down the nares, and then the saline is forcibly expelled into a sample bag placed over the end of the trunk. This should be repeated three times within one week and then submitted for culture. Gloves and facemasks should be worn to reduce keepers inhaling what potentially may be aerosolised mycobacteria particles, despite the bag being placed over the trunk. This is especially true when early in the training process. Culture when positive is diagnostic, however if mycobacteria are not cultured this does not mean that an animal does not have tuberculosis, just that organisms are not being shed at the time of culture (it is suggested that animals only shed for approximately 10% of the time during infection). This is termed a *false negative*. Trunk washes have low sensitivity (i.e. proportion of true positives, the lower the sensitivity the higher the false negatives), a slow turn around time (culture takes weeks to months), and the quality of sampling is variable (Greenwald *et al.* 2009). Trunk washes may not be the best test but they are an important part of tuberculosis testing and for making decisions on whether to treat and on how to manage cases. **Serological tests** look for and culturing the organism is difficult and so tests looking at antibody responses or titres to assess the body's response to the presence of mycobacteria have been developed. These rely on the presence of a serological response and the assumption that a titre equates to disease. These tests include the ElephantTB Stat-Pak, Multi-antigen Print Immuno assay (MAPIA), and the VetTB tests. The Elephant TB Stat-Pak has multiple antigens and provides a yes or no answer, whilst the MAPIA breaks this down into the twelve separate antigens allowing a picture of serological response to be given. This allows some differentiation and interpretation of the mycobacteria involved (Lacasse *et al.* 2007). The principle antigens appear to be ESAT6 and CFP10 in MTC infection. The VetTB test is similar to that of the ElephantTB Stat-Pak but relies only on three antigens and is therefore more specific to MTC and is less likely to produce false positives, which have occurred in some species when relying solely on the Elephant TB Stat-Pak (Bouts *et al.* 2009). It should be noted that a positive serological test may indicate either: exposure and eradication (if possible, unlikely but hypothetical); tuberculosis that is in a latent phase and is presently not a risk to the individual or herd; or fulminant tuberculosis that is a serious threat to the herd health, as written in (Lewerin *et al.* 2005). The serological tests are more sensitive then the trunk wash but cannot differentiate between fulminant tuberculosis and exposure, interpretation and response needs to be based on history, known health of the herd, known exposure, in combination with trunk washes. **Other:** Intradermal testing is not recommended in elephants. Breathalysers may become available in the future. Readers are advised to review current literature as validation and new tests become available, altering how we diagnose and treat this disease.

Treatment is possible and has been achieved. Anti-tuberculosis drugs include isoniazid, pyrazinamide, rifampin, and ethambutol, several of which have pharmacokinetic data available for them in elephants (Maslow *et al.* 2005) (Peloquin *et al.* 2006) (Zhu *et al.* 2005). Treatment is for twelve months and has to be continuous; if any aspect of a treatment protocol is missed then there is a risk of developing multi-drug resistant tuberculosis (MDRT). Depending on the situation an alternative is euthanasia of the affected animal. Treatment is not without side effects and those reported in elephants include; anaemia, anorexia, behavioural changes, difficulty in moving, depression, diarrhoea, elevated renal parameters, leukopaenia, elevated liver parameters, ocular problems, sterility, ventral odema, and weight loss (Wiedner & Schmitt 2007). Even after effective treatment animals can be reinfected with tuberculosis.

The frequency of tuberculosis in captive elephants in the US is thought to be between 5-10%, it is possible that the same frequency and epidemiology occurs in Europe and the UK, posing a serious threat to the longevity of elephant populations. Initially thought not to infect elephants in range countries, it is now being found (Mikota *et al.* 2007), this is likely due to failure in testing protocols rather then a lack of tuberculosis. This is a worldwide problem, for both captive and range country elephants, reflecting similar issues in humans.

FUNGAL DISEASES

Few fungal diseases have been reported in elephants; fungal infections of the reproductive tract and of the skin have been reported. These are generally not considered to be significant group of pathogens in captive UK elephants.

PARASITIC DISEASES

Parasitic disease does not play a major role in the veterinary management of captive elephants in the UK. Intestinal infestations rarely lead to clinical diarrhoea in the long-term captive animal, although parasite-related disease may be seen in newly imported stock. Elephants are host to a wide range of parasites in the wild, and therefore vigilance is necessary especially in newly imported animals. For a comprehensive list of the helminths of elephants and their significance, see (Basson *et al* 1971) (Chowdhury and Aguirre 2001) (Fowler 2006d).

Parasitic infestations of elephants include:

- Ascarids, oxyurids, strongylids, paramphistomes, ancylostomes, sygamids and filarids.
- Biting flies.
- Coccidia.
- Elephant lice.
- Hydatid cysts.
- Liver flukes.
- Mange mites.
- Trypanosomiasis – Asian elephants.

Annual parasite screens are advised for captive elephants in the UK, although more frequent screening tests may be necessary where a particular problem exists. The management and treatment of parasites in captive elephants should follow that applied to domestic horses.

Viral infections that can affect elephants include, but are not limited to;

Bluetongue: antibodies towards bluetongue have been identified in elephants (Formenty *et al.* 1994) but clinical disease has not been reported. It is not known if elephants play a role in the epidemiology of the disease or they are a dead end host. At present it is not considered a problem in elephants. However, since the bluetongue outbreaks, moving elephants between EU Member States has proved difficult.

Encephalomyocarditis virus (EMCV): is a Cardiovirus from the family Picorniviridae. Rodents are the natural host where clinical disease is not seen. The virus replicates in myocardial cells, killing them. Clinical signs include peracture to acute death, anorexia, lethargy, and moderate dyspnoea. Clinical signs associated with cardiac disease also occur in less severe cases. Recovery may result in myocardial scars and cardiac compromise. Infection does not always result in clinical disease, however rodent males appear more susceptible and this maybe the case in elephants (Fowler 2006b). EMCV should be considered as a differential diagnosis in any cases of sudden death.

Elephant Endotheliotropic Herpes Virus (EEHV): is currently the most important, known viral infection in elephants. It has only been recently identified (Richmann *et al.* 1999) with retrospective studies identifying cases as far back as the 1970s. This is not a new disease, as viral taxonomy indicates that the virus dates back at least 30 million years (Zong *et al.* 2007). Thought to be a disease of captivity, with a hypothetical link between African and Asian elephants it is now known to have been present since the time of the mammoths and has been identified in range countries in wild and captive African and Asian elephants (McCully *et al.* 1971) (Reid *et al.* 2006) (Zachariah *et al* 2008). There does seem to be an increased incidence in captive elephants but this cannot be confirmed until more data are available from range countries. Factors for this could be small herd size, virulence factors, stress, parturition, weaning, transportation, but these are all hypothetical at present. Every single case of EEHV has been caused by a different gene subtype of virus, except in two cases documented in the USA (2009) and possibly two cases in the UK (2009). This indicates that there are multiple EEHV viruses circulating through the captive elephant population worldwide. There are currently seven known EEHV species (EEHV1a, EEHV1b, EEHV2, EEHV3, , EEHV4, EEHV5, and EEHV6), although this number is likely to increase as we learn more about the disease. Currently treatment is the same for all of them, however prognosis is generally poor even with early therapy.

The virus has a predilection for blood vessels (endothelial lining), which results in a multi-systemic haemorrhagic diathesis. Clinical signs are related to haemorrhage, the most important being petechiae and cyanosis of the tongue (one of the earliest signs seen), as well as tachycardia as the body responds to the hypovolaemic shock. Other clinical signs include; sudden death, ulceration of the hard palate, ataxia, lethargy, mild colic, oedema of the head, forelimbs and ventrum, and abortion is also suspected. EEHV cases can be simply noted as a change in behaviour, and if this occurs in any animal under the age of 10 years then EEHV should be the primary diagnosis until proven otherwise. Clinical signs vary and can occur with the stress of concurrent disease. See (Garner *et al.* 2009) (Maluy and Hawke 2007). Elephants are often under the age of ten years old, although the oldest reported case was 42 years old.

Therapy is based on early and aggressive therapy including anti-herpes drugs (famciclovir or gancyclovir), analgesia, antibiosis, fluid therapy, plasma transfusions, oxygen therapy and supportive care. Despite this many cases often die, and euthanasia should be considered in certain cases. Therapy must be instigated prior to confirmation of EEHV infection as death can occur in as little as 6 hours after first clinical signs are seen. It is recommended that a collection EEHV protocol is drawn up to allow therapy to be instigated early on once infection is suspected, for details see (Cracknell 2007). Lysine and lauric acid (found in coconuts) as nutritional additives may be beneficial in reducing viral replication, however it is unlikely that they will prevent disease in the face of large viral loads.

Diagnosis is often PCR of tissues at post-mortem, or on whole blood in the live animal. Serology is available but it is not validated. Vaccination is not possible at present although work is being undertaken with this aim in mind. A calf side snap test may soon be available for quick diagnosis. It is likely that virus is shed from oral lesions (Schaftenaar *et al.* 2007), and possibly lymphoid follicular vulvitis lesions. Virus has been isolated in trunk secretions in apparently healthy elephants, with increased numbers of viral load being found during pregnancy. It is likely that all elephant herds have EEHV, why some recrudesce and cause clinical disease is not known yet. An understanding of this disease is imperative for future captive breeding and for elephant conservation as habitat loss forces elephants into smaller more stressful situations. EEHV is the biggest medical threat to the conservation of Asian elephants.

Foot and Mouth Disease (FMD): has been reported in captive African and Asia elephants (Evans 1910) (Hedger & Brooksby 1976) (Howell *et al.* 1973), although wild African elephants are not considered to be susceptible to the condition. Clinical signs include anorexia, mild to severe lameness, vesicles on the tongue, cheek, palate, and mucous membranes of the trunk, lesions around the nails and sole, with severe cases actually sloughing the sole. Young animals can develop systemic signs with lesions in the heart and intestine with diarrhoea, or sudden death seen, although this is not common (Fowler 2006b)(Fowler, 2006b). Supportive nursing care is normally curative and there is no evidence to suggest that they become carriers afterwards. Vaccination is available.

Gamma-herpesviruses: are also another group of new herpes viruses, first described by (Wellehan *et al* 2006). These are distinct from EEHV, which are betaherpesviruses (*Probosciviridae*), and infection with gamma herpes viruses results in ocular inflammation. There is some thought that the EEHV serological tests may cross-react with these, however this is a moot point.

Papillomavirus: there are some reports of papillomas being caused by papillomaviruses, some of these are true, and others have turned out to be due to EEHV (Jacobson *et al.* 1986) (Sundberg *et al.* 1981). Not considered life threatening.

Pox virus: elephant pox is characterised by inflammation of localised skin or mucosa, leading to papule, then a vesicle to a pustule and ulceration (Fowler 2006b). Historically pox lesions in elephants came from the vaccinia virus strain used for human inoculation, likely from elephant rides in zoos (Baxby *et al.* 1979). Elephant pox virus is distinct and belongs to the genus *Orthopoxvirus*. Clinical signs include reduced appetite, difficulty in swallowing, stiffness and lameness, with pox lesions around the lips, trunk tip, tongue, eyelids, peri-anal, and peri-vulval skin. The toenail and sole can become infected and slough in severe cases. Fatal generalised disease can occur. Abortion has been reported. This is a zoonotic disease, with rodents likely to be the carrier. Vaccination can be attempted and a vaccine can be obtained from the Netherlands.

Rabies: a *Lyssavirus* that results in a fatal encephalomyelitis. There are occasional reports but is not thought to be common and is unlikely to present in the UK.

Rinderpest: caused by *Morbillivirus sp.* this is reported not to be a clinical disease in elephants (Fowler 2006b). Virus has never been isolated, but serology has been positive from elephants.

West Nile Virus: causes a viral meningomyeloencephalitis, and has not been definitively diagnosed in elephants. There were two suspected cases in elephants in the US. WNV is present in the Middle East and Africa and with global warming may become a disease here. Serology has been positive for birds in the UK but it has never been confirmed in a mammal as yet.

3.15.6 Euthanasia

The euthanasia of an elephant is a delicate procedure that is not only a highly emotive procedure but also involves a potentially serious health and safety hazard. To ensure optimal safety of all members of staff involved and to make sure that the welfare of the elephant is not compromised the euthanasia event is broken into three components;

1. Planning and discussion to ensure that all parties are in agreement that euthanasia is in the best interest of the animal and that all contingencies are made to ensure the smooth application of euthanasia.
2. Induction with an anaesthetic agent to ensure that the elephant is immobilised for the euthanasia procedure. This is in the interest of the animal's welfare primarily but also provides safety for the veterinarian and keeping staff. Etorphine is the agent of choice for the induction: see the anaesthesia section.
3. Once in lateral or sternal recumbency then euthanasia should be undertaken. Agents that have been used include pentobarbitone, secobarbital/cinchocaine (Somulose), or potassium chloride. Assessment of death should be based on a combination of loss of electrocardiogram via a preplaced ECG, lack of cranial reflexes, lack of respiratory movements, and a lack of heartbeat on auscultation.

3.15.7 Post-mortem protocol

The full post mortem examination of an elephant is a huge undertaking requiring organisation, appropriate equipment and planning. A comprehensive protocol is available (AZAA 2003). Topics included are an equipment checklist, logistics, gross examination worksheet, tissue checklist, a selected bibliography and lists of research requests. British and Irish veterinarians faced with undertaking an elephant post mortem examination are advised to follow these guidelines and seek assistance from veterinarians or pathologists that have experience in post-mortem examination of an elephant.

3.15.8 Pre-shipment Screening

All transfers to and from BIAZA collections MUST adhere to the Animal Transaction Policy (British and Irish Association of Zoos and Aquariums 2009) which states:

ALL ANIMALS SHOULD HAVE:

- Medical history sent a minimum one week prior to export
- Declaration of presence or absence of declaration diseases (for elephants: EEHV, TB and elephant pox)
- Prophylactic treatments as recommended
- A physical examination – including notification of findings to receiving collection

IT IS HIGHLY RECOMMENDED THAT ALL ANIMALS SHOULD HAVE tests for the diseases of concern indicated (for elephants: Endo-parasites and salmonella).

In addition, the following information should be sent and procedures should be undertaken;

- Medical history should include reproductive and anaesthetic history
- Body weight measurements.
- Haematology and serum biochemistry profiles.
- Serum banking.
- Determination of plasma vitamin E level.
- EEHV PCR (+/- ELISA)
- Faecal parasite and bacteria screen.
- Tuberculosis culture from trunk washings.
- Ensure vaccination status is current.
- Other tests as required/appropriate (e.g. serum tests for brucellosis, leptospirosis, equine infectious anaemia, mycoplasma etc.).

3.15.9 Quarantine

A minimum period of thirty days quarantine away from other elephants is recommended for new arrivals into a collection. However due to the social nature of elephants it maybe beneficial to consider coterminus quarantine with a member of the new herd. This may be easier to advise than implement, but there is no reason to abandon good principles of animal management simply because of practical difficulties. During the quarantine period various medical checks can be carried out if they have not already been conducted prior to transfer:

- Body weight measurement
- Determination of plasma vitamin E level.
- Faecal parasite and bacteria screen (This should be repeated even if conducted before transfer).
- Haematology and serum biochemistry profiles.
- Repeat EEHV PCR (+/- ELISA)
- Physical examination by an experienced veterinarian.
- Serum banking.
- TB culture from trunk washings.
- Vaccination status – ensure current and appropriate for local conditions

3.15.10 Vaccination

Elephants should be vaccinated against tetanus annually. Vaccines against other diseases should be given based on local disease prevalence. Little scientifically based information is available as to vaccine dose and frequency necessary to provide adequate protection in the elephant, but in general terms vaccines should be given at 2-3 times the recommended dose for adult cattle and horses (Schmitt 1986). Anaphylaxis following vaccine administration is possible, so observation for an hour after vaccination and having adrenaline available are wise precautions. See (Emaneulson 2006).

Diseases against which vaccination MAY BE appropriate include:

- Anthrax.
- Clostridial disease.
- Tetanus.
- Pasteurellosis.
- Pox.
- Salmonellosis.
- Rabies (not currently in the UK).
- EMCV (not currently in the UK).
- WNV (not currently in the UK).

3.15.11 Zoonoses and staff health

Zoonoses are by definition a disease that can be passed from an animal to man, however this can be a two way street which is termed a reverse zoonosis, an example of which is tuberculosis. There are several elephant diseases that can be passed to keeping staff, veterinarians and others in close contact with elephants and all standard precautions should be taken to minimise these risks.

Keeping staff should also be aware that elephants can carry microorganisms that cause zoonotic infections and therefore a high standard of personal hygiene is required. It is prudent for zoonosis training to occur within collections, this goes for all staff, not just elephant keepers. It is also very important that rigorous hygiene measures are employed in elephant facilities to discourage vermin, which may carry viruses (such as the encephalomyocarditis virus) and pathogenic bacteria to which elephants are susceptible. Keeping staff should pay particular attention to the regular removal of faeces and uneaten food items.

It is strongly suggested that elephant keeping staff keep up to date with tetanus and BCG vaccination and that they undergo an annual test for tuberculosis (to monitor exposure and because BCG is not 100% protective against TB and is not compulsory). It goes without saying that all animal keeping staff should adopt the highest standards of personal hygiene for their own protection and that of their charges. If there are any concerns, or doubts, then these should be communicated to line managers as soon as possible.

Significant zoonotic infections that may originate from elephants include;

- Cowpox
- Salmonellosis
- Tuberculosis (although reverse zoonosis more likely)
- Anthrax
- Rabies
- Dermatophytosis (ringworm)

3.16 Standard on Educational Activities Involving Elephants

Conservation Education is compulsory under the EU Zoos Directive; all collections MUST carry out some form of educational activity, which can be organised as follows:

- Static interpretation including signage, interactive devices and informal, unstructured, verbal explanations from keepers.
- More formal and structured /scripted narratives from keepers; often set around routine events such as foot-cleaning and feeding. This category is often described as *Meet the Elephant*.
- Demonstration and explanation of natural behaviours and a limited repertoire of trained behaviours, which illustrate management exercise and veterinary practices at a specific zoo. An example could be *Elephant Walks*.
- Demonstrations or displays of a much wider repertoire of behaviours, which may illustrate aspects of logging and methods of maintenance of physical fitness.

Clearly each of these categories could in practice merge imperceptibly into the next. However, it is important to agree categories that relate to both the breadth of 'un stimulated' and 'stimulated' behaviours expressed by the elephants and the degree of training required to reach each level.

The guiding principles for any educational activity start from the simple statement that the purpose and output of the exercise **MUST** be *truly educational* and **MUST** stress aspects of elephants' natural biology and behaviour and provide insight into their safe humane and healthy management in zoos, their conservation status and zoos' roles in securing their future.

There are two vital considerations in the establishment of more comprehensive demonstrations. The first is that any artificial or anthropomorphic behaviour may at best serve to distract people from real educational conservation messages and at worst shade into circus-type shows which do not maintain the 'dignity' of elephants. The second consideration may be less noticeable to members of the public but has a greater negative impact on the welfare of the elephants. It relates to the potential for chronic physiological and behavioural stress from a more intensive training regime and demands for less natural postures such as headstands (Kuntze 1989). Thus elephants MUST not be trained to routinely perform such activities as headstands and postures standing only on the hindlegs. There **MUST** be a demonstrable net welfare benefit from more intensive training regimes.

A further, absolute, principle is that human safety, of both visitors and staff, **MUST** never be put at risk because of an expectation that educational activities should be presented. For these, and other activities, the provision of updated Risk Assessments is essential. These **MUST** take into account variable factors such as new keepers, changes to facilities, changes in group composition etc.

Elephants should not normally be taken outside of the zoo for display purposes, see Section 3.14, Transportation.

INTERPRETATION

All collections **MUST** have a programme to educate visitors about elephants and issues relating to elephant conservation. Educational graphics and information about elephants should be on display to the public. Messages to convey might include the decline in elephant populations and habitat over the past century (Smith and Hutchins 2000). Zoos can also educate the public about the problems of buying elephant products when travelling, information on why elephants are endangered, what laws are protecting them and what each individual can do to help.

PUBLIC

Some collections allow public contact with elephants, ranging from volunteer keepers, students, film crews to 'meet the elephant' sessions. Public **MUST** only be allowed contact with elephants only when keepers are present. There **MUST** be two fully trained elephant keepers present during these encounters, for which full risk assessments **MUST** have been carried out. Some collections occasionally allow non-zoo staff to sit on and ride elephants, in this situation consideration **MUST** be given to the interpretation of this behaviour as well as health and safety issues[1]. More information is provided in Appendix 3 Section 6.3. BIAZA guidelines on animal contact (British and Irish Association of Zoos and Aquariums 2005) should be consulted Although no zoos in the UK currently give elephant rides to the general public, there are still some in North America that do.

3.17 Research

Zoos keeping elephants **MUST** make a contribution to our knowledge of elephant biology and captive management. Much of our knowledge about elephant biology (reproductive biology, analysis of vocalisations) has been gained through research on captive animals (Smith and Hutchins 2000). Research on chemical communication is presently being carried out on captive animals which may eventually be of use in manufacturing a repellent against crop-raiding elephants.

Technologies relevant to field conservation can be tested on captive animals before being used in nature. Contraceptive methods may prove to be of use in controlling populations in the wild. Work on extracting DNA from faecal samples, perfected on captive elephants, is of great use in determining relatedness between individuals in the wild.

Other research topics that require more work include: vitamin E in diets, hormones and reproduction, measurement of faecal steroids, cognition and special memory (Olson 1994), the effect of obesity and birth weights on calf survival rates, the long term effects of calf birth weights, the benefits of calves being wild born, the long term effects of stress (from maternal stress when in vitro, inter-zoo transfer and early maternal separation) (Clubb *et al.* 2009). Autopsies may provide very useful material for research.

There is a great need for survey work to aid our understanding of good captive practice, in relation to management and training regimes, enclosure design, structure and size and group composition. (see Chapter 6.7, Appendix 7).

Collections should encourage research on the use of enclosures (Mason and Veasey 2009), especially when animals are given access to and/or moved to new areas (Rees 2000b). There is a great need for monitoring of behaviour within captive groups (Garai 1992), and methods for establishing useful behaviour profiles of animals. Researchers should be encouraged to undertake this sort of project and collections holding animals should make it a priority to fill in and return research questionnaires. Further work, taking in more collections, on circumstances surrounding an elephant attack such the preliminary work recently carried out by Ray (2002) is required.

[1] Clarification regarding elephant rides added.

Each zoo should contribute in some way to field conservation of elephants and their habitats. This can be done through the Elephant Focus Group. Financial, personnel, logistic and other support can be provided for research and conservation programmes.

BIAZA has produced guidelines (Feistner and Gore 2002) on how to go about research in zoos and these should be consulted[1].

After[2] the publication of the first edition detailed suggestions for research were proposed (much of it based on the recommendations from Clubb and Mason). In 2003 surveys were carried out on the 14 collections holding elephants in Britain and Ireland. These surveys concerned management methods, training regimes, elephant enclosures and information on each elephant. The results of these surveys are presented in Section 6.7. (Appendix 7). An analysis of stillbirths in elephants has also been carried out (Stevenson 2004). An audit on BIAZA member compliance to the 2nd Edition of the guidelines was carried out at the end of 2006 and the results can be found in Section 6.8 (Appendix 8).

Itemised elephant research priorities from (Clubb and Mason 2002) and (Clubb *et al.* 2009) are listed in Chapter 6.9, Appendix 9 for interest.

Defra (with partners BIAZA, RSPCA, and IFAW) commissioned a project entitled *The Welfare Housing and Husbandry of Elephants in UK Zoos*. This was published in 2008 (Harris *et al* 2008). This project collected data from zoos holding elephants in Britain and Ireland with the goal of documenting the current state of welfare of elephants housed in zoos and the relationship to housing and husbandry. Findings have been incorporated in to this edition (3rd) of the guidelines.

3.18 Public Relations and Elephants

Zoos are often criticised for focusing on charismatic mega-vertebrates. However, although the public can, and do, appreciate and learn from smaller vertebrate and invertebrate species, there is a natural human attraction towards large life forms that can be easily related to. On the charismatic mega-mammal scale you cannot reach much higher than the elephant; not surprisingly, they are a top 'profile animal' in zoos. Nothing attracts more positive public and staff attention and an increase in visitor numbers than the successful birth of a baby.

However, injury to a keeper or death or illness of an elephant also creates much public interest as does any perception that the animals might not be in a good captive environment, exhibiting abnormal or stereotypic behaviours or being treated in a cruel fashion by staff. The elephant is a flagship zoo species and, as has been pointed out in the introduction to this document, zoos have a particular responsibility to manage them well in captivity.

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[1] See the BIAZA's *Zoo Research Guidelines* series available from the BIAZA Office and on the website.

[2] Update on research for 2nd edition.

Managed well, in a good environment, elephants provide a fantastic message to the public about conservation, trade in animals and animal parts, habitat protection, animal-human conflict and the importance of maintaining biodiversity for the future of the planet. In fact a well cared for elephant group, exhibited in an enlightened fashion, can get a wealth of important messages across to zoo visitors. This, of course, is why a good sound education policy and approach to interpretation is essential, as explained in Section 3.16.

There has been a revolution within the zoological profession within the last 20 years and this has taken place rapidly (Allen 1995). This revolution is linked to changes in environmental and animal welfare values and understanding. Along with these, our approach to elephant management has changed enormously. Zoos are changing/ have changed from menageries to conservation organisations but this rapid change is still surrounded by problems; these problems invoke criticism from those groups who are philosophically against the keeping of animals in captivity and expect the zoo world to have created instant solutions. The elephant, because of its captive history and high profile, often finds itself in the centre of this debating stage.

It is therefore essential that collections keeping elephants explain their management philosophies and protocols to the public and have literature available to public, staff and press. Members of BIAZA can explain how they conform to the recognised standards and, through cooperative management, work to continuously improve conditions, husbandry and captive breeding.

It is important that the public understand why the elephant keepers carry an ankus, what it is and how it is used as an elephant training aid. They should also be aware of methods taken by collections to ensure staff and animal safety. A good zoo should be proud of the way it manages its elephants and not try and keep methods secret. Secrets have a way of getting out (Caras 1995) and if a zoo feels it has to be clandestine about its elephant management, then it probably has something to hide.

If a collection is well prepared with its elephant information then it will be quickly able to provided essential background copy for both good and bad events. In the nature of things, both will occur, and both will attract attention.

A useful guide to managing the media is provided by the Indianapolis zoo (Gagen 1999), on the occasion of a keeper being seriously injured by an elephant. Gagan stresses that although it is not possible to plan the exact steps that will be taken when an emergency occurs, it is essential that you have planned ahead for such an event. Key issues are:

- Maintain good ongoing relations with the media.
- Do not assume an adversarial relationship: do not treat the media as adversaries, try and work with them in a partnership. The media can smell a cover up from a mile away.
- Find out what happened – fast: get a first hand initial assessment. Zoo staff need to be geared up to expect this.

- Recognise the implications of the media response: the public's reaction to anything that happens in an institution is based to a large degree on how the media interprets information.
- Just tell them what happened: don't start filtering information, put together one version of events for everyone that is accurate, concise and straightforward.
- Make information complete and short: make sure the account is clear and accurate.
- Never, never lie: everything leaks, your lies will find you out.

It is useful for a collection to have an internal communications system in operation for such media purposes.

Some of the more unfortunate events concerning elephants may require the implementation of the zoos crisis management plan. All collections should have such a plan which requires the formation of a crisis team and a crisis communication plan (AZA 2000). The crisis management plan should incorporate the following elements (Rosevear 2001):

- Management representation.
- Chain of command in the absence of the Director (scheme of delegation).
- Representatives from other sectors of the zoo including, as necessary, veterinary, PR, legal, health and safety personnel etc.
- There needs to be a periodic review of the team's composition.
- The team needs to communicate membership of the team and changes to staff.
- Good internal communication plan to quell rumours; keep staff informed and provide them with copies of any press releases.
- A spokesperson should be appointed, (e.g. the head of PR) and that should be the only person who talks to the media.
- A contingency plan needs to be prepared which should be rehearsed and reviewed as necessary.

The media should always be provided with a comfortable place to convene within the park. It is important to remember that long after the crisis is past it will still be on the media's archives.

All members of BIAZA **MUST** let the office know if they are involved in any media campaigns involving their elephants, regardless as to whether the coverage is positive or negative. Because of the potential publicity, the office should be told of any pending elephant moves.

3.19 Management Audits and Document Revision

BACKGROUND

Our knowledge of elephants, their biology in the wild and captive management, is increasing at a rapid rate and the need to conserve their habitats has never been more critical or more urgent. Zoos **MUST**[1] carry out audits on their elephant management programmes and protocols at regular intervals and that this document, its recommendations and procedures, be regularly reviewed and updated. Both processes require teamwork and cooperation. Sally Walker refers to the three C's of Conservation and the three E's of extinction with regard to elephant management. The C's are communication, cooperation and collaboration and the E's egoism, envy and elitism (Walker and Namboodiri 1996). This concept very much sums up the way forward for elephant management in the British Isles and Ireland, and indeed throughout Europe. It is only by practicing the three C's that we can eradicate the historical baggage of the three E's which have plagued moving elephant management forwards and even now still hinder its development.

METHODOLOGY

It would seem that the best method for ensuring an effective audit process is through BIAZA's Elephant Focus Group (EFG), which incorporates management and keeping staff of holding collections. An annual meeting of the EFG should have time set aside to compare objectives or key performance indicators against achievements for the year, this could be combined with a five or ten year plan for elephant management in British Isles and Irish collections. The objectives/targets would be reviewed and updated as part of this annual process. The following areas are suggested as a management audit process:

- Key areas for population management drawn up with yearly targets for each institution, both for collections currently holding elephants and those intending to hold. This, obviously, is part of the EEPs.
- Key areas regarding elephant management be listed with targets for each holding institution; incorporating the areas of elephant training, staff training, management methods, facility improvements and general elephant husbandry and management.
- Key areas for expertise sharing which would include:
    - Any new hazards identified, risk assessment techniques, and controls which have been applied[2]
    - Review of accidents involving elephants (both to public and staff).
    - General husbandry.

[1] Must added
[2] This has been added.

- Nutrition.
- Medical care.
- Problems and advances in elephant reproduction.
- Advances in our knowledge of social behaviour.
- Review of training and management techniques in use.

• EFG chair would have the responsibility of ensuring the annual auditing process took place and for collating results and supplying to BIAZA (JWGC, CAMC and Council).

Using the information gained from the above audit process, the following is suggested for document review:

- General review of document, updating of bibliography with new references, text with new information.
- Review of husbandry protocols, particularly SOPs
  - Do changes need to be made or additional information?
  - Is a further SOP required?
  - Are collections adhering to SOPs, are they realistic?
- BIAZA Office would have the responsibility of carrying out the review of the document and sending updates to collections.

It is considered imperative that this process be set in motion through the Elephant TAG. The first review was initiated in December 2003, again in 2006 and this third edition in 2009. A survey was carried out in 2002 to determine the compliance of collections to the first edition of the guidelines (see Appendix 7) with a follow up audit on areas of compliance in 2008 (see Appendix 8). A further audit is due in 2009/2010 (agreed by end of March and to report by the end of 2010) to determine compliance in areas that were not in 2008 (so tailor made for each collection) and to gather information on weight and compliance to the new enclosure size.

SECTION 4: ACKNOWLEDGEMENTS

The production of this document has been made possible by contributions and support from many people. The production of the first edition of these guidelines was overseen and supervised by Mary Talbot Rosevear, then Director of BIAZA and Chris West, then Chair of the JMSP Elephant TAG. Major contributors to the document were:

- Jake Veasey, Woburn Safari Park;
- Iain Valentine, Blackpool Zoo and currently Royal Zoological Society of Scotland;
- John Lewis, International Zoo Veterinary Group;
- Penny Cusdin, International Zoo Veterinary Group;
- Chris West, Zoological Society of London and currently Adelaide Zoo;
- Ellen Dierenfeld, Wildlife Conservation Society and currently St Lous Zoo;
- Andrea Fidgett, Zoo Nutrtionalist, Chester Zoo;
- Alan Roocroft, San Diego Wild Animal Park and currently Elephant consultant;
- Amanda Alabaster, Edinburgh Zoo and Chair Marketing and PR Committee and currently Alabaster Blue.
- Ann-Kathine Oerke , German Primate Centre , Gottingen

The EEP elephant studbook keepers and coordinators were particularly helpful: Amelia Terkel of Ramat Gan Zoo (African elephants) and Rob Belterman and Ton Dorresteyn of Rotterdam Zoo (Asian elephant).

Comments and constructive criticism was received from many in particular we would like to thank: Nick Lindsay, ZSL; Ros Clubb, Oxford University; Anthony Tropeano, Colchester Zoo; Mark Pilgrim, Chester Zoo; Gordon Reid, Chester Zoo; Mick Jones, Chester Zoo; Lee Sambrook, ZSL; Fredrik Mohlin, Woburn Safari Park; Chris Webster, Woburn Safari Park; Tony Mitchell, Colchester Zoo; Roy Smith, Interzoo Service & Logistik GmbH; Bryan Carroll, Bristol Zoo and Chair Conservation and Animal Management Committee; Robert Atkinson, RSPCA; Rebekka Deleu, Antwerp Zoo; Olivia Walter, BIAZA and Miranda Stevenson, BIAZA without whom this document would never have been put together.

Many people have assisted in this first revision, notably the members of the BIAZA and EAZA Elephant TAGs, the members of the Zoos Forum, comments from various elephant holding collections, the European Elephant Group and Ros Clubb and Georgia Mason. We are also grateful to Gareth

Broughton of HSE and Robert Landridge of Canterbury City Council for comments on areas of the document pertaining to Health and Safety.

Financial support for the printing of the first edition was provided by BIAZA (called the Federation of Zoos at the time) and the North of England Zoological Society with Woburn Safari Park and Blackpool Zoo.

Third Edition

Jonathan Cracknell must be thanked for the huge amounts of work he put in to re-writing the medical and reproduction sections of the third edition. Both of which needed a complete overhaul given the amount of published data that has been produced in the intervening years.

Andrea Fidgett, likewise, must be thanked for a complete overhaul of the nutrition section to include the latest findings and experiences from dealing with nutritional problems within the Chester Zoo herd.

Nic Masters (IZVG), Gerry Criegton (Dublin Zoo), Alan Roocroft, Kevin Buley (NEZS Chester Zoo), Lee Sambrook (ZSL Whipsnade Zoo), Andy McKenzie (NEZS Chester Zoo), David Field (ZSL), Scott Wilson (NEZS Chester Zoo), Neil D'Cruze (WSPA), Neil Dorman (Twycross Zoo) and Tim Bouts (ZSL) must all be thanked for advice, contributions and reviewing services. The Elephant Focus Group must be thanked for a final review and Georgina Groves for putting in the final corrections.

Financial support for the production of the third edition was provided by BIAZA and ZSL.

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SECTION 6: APPENDICES

6.1 Appendix 1: Training

6.1.1 TRAINING TERMINOLOGY

Teaching an elephant to come when called: The handler starts by calling the elephant's name when the elephant is very close. The handler rewards the elephant for turning to look at the handler. After some repetition and 100% correct response, the handler asks for more by rewarding the elephant only when it moves toward the handler. Again after some repetition and 100% response, the handler begins to reward the elephant only when the elephant approaches the handler when called. As the elephant progresses the handler can start to move further away from the elephant increasing the distance the elephant has to travel.

Superstitious behaviour: The elephant is asked to turn in a circle, while turning the elephant also vocalizes. The elephant is reinforced by the trainer for turning but the elephant believes that it was reinforced for the vocalization.

Accidentally reinforcing inappropriate behaviour. The trainer reacts inappropriately to the elephant throwing something. An inappropriate reaction could encourage the elephant to repeat the behaviour. Unsolicited trunk behaviours are encouraged when the trainer caresses the elephant's trunk when the elephant reaches out.

Rewarding the incorrect behaviour: The elephant comes to the handler when called but also acts aggressively toward another elephant in the process. If the handler still rewards the elephant because it came when called, in effect the elephant is also rewarded for the aggression and may repeat this undesirable behaviour.

Improperly using punishment and time-outs. The trainer punishes the elephant when the elephant is confused and does not understand what the trainer is asking it to do. The trainer gives the elephant a "time out" because the trainer is frustrated not because of the elephant's lack of compliance.

Inconsistency of the parameters of the behaviour: One trainer expects the elephant to pick up its foot two feet above the ground and another trainer expects the elephant to pick its foot up three feet. All trainers must agree upon the level of performance of a behaviour to be expected. It is unfair to the elephant to have to guess what the trainer will expect and to adjust to constant variations.

Not taking care of the elephant's basic needs: If the elephant gets overheated, it is better to cool the elephant down before a training session. If another elephant is intimidating the elephant involved in the training session, it is best for the trainer to alter the situation so the elephant being trained can focus on learning.

FREQUENTLY USED COMMANDS IN ELEPHANT MANAGEMENT

Alright	- release from previous command
Back up	- move back in straight line
Come here	- move to keeper
Come in	- laterally move toward keeper; move left
Ear	- present ear(s) forward or through ear hole
Foot	- lift the leg indicated:
	front leg/wrist to elbow parallel to ground
	rear leg/foot to knee parallel to ground
Get over	- lateral move away from keeper; move right
Give	- hand object to keeper
Go	- leave trainer and move to desired mark or target
Lay down	- lateral recumbency
Lean in	- position body parallel to, and in contact with, barrier
Leave it	- drop whatever is in trunk
Line up	- stand facing keeper; elephants stand in order of hierarchy
Move up	- move forward in straight line
No (quit)	- stop unwanted behaviour
Open	- open mouth wide for visual and tactile inspection
Pick it up	- lift object with trunk
Push	- push object with head
Salute	- raise trunk and foot simultaneously
Steady	- freeze
Stretch	- sternal recumbency
Tail	- grab and hold tail of another elephant
Target	- move toward target; respond to target by touching appropriate body part to it
Trunk (up)	- curl trunk up to touch forehead

Trunk down - drop trunk straight down to ground

Turn - pivot in circle (right and left)

Glossary

Behaviour: to act, to respond, function, react or perform in a particular way.

Bridge: any stimulus that has acquired its reinforcing properties through association with a primary reinforcement. Initially it is a meaningless signal that is paired with a reinforcer until it becomes a reinforcer itself.

Continuous Reinforcement: reinforcement is given after every correct response.

Cue/Conditioned Stimulus: stimulus where the response is reinforced.

Desensitisation: actively pairing a positive reinforcer with a negative event until the negative event loses its ability to adversely influence behaviour.

Extinction: method of eliminating a learned behaviour by not reinforcing it any longer.

Generalization: when the reinforcement of a specific behaviour increases the frequency of similar behaviours.

Habituation: accustoming the animal to a situation by prolonged or repeated exposure.

Incompatible Behaviour: a behaviour that interferes with or cannot be performed at the same time as another behaviour.

Intermittent Reinforcement

> ***Differential reinforcement:*** reinforcing selected responses of higher quality to improve performance.
>
> ***Fixed Interval Reinforcement:*** reinforcement is only available after a predetermined number of correct responses.
>
> ***Jackpot:*** a reward that is much bigger than normal reinforcement and comes as a surprise to the subject.
>
> ***Random Ratio Reinforcement:*** reinforcement is available after a different number of correct responses.

Negative Reinforcement: removing something unpleasant in conjunction with the performance of the desired action or response; something the animal wants to avoid.

Operant Conditioning: a type of learning in which the probability of a behaviour recurring is increased or decreased by the consequences that follow. This conditioning relies upon the use of positive reinforcement, negative reinforcement and punishment.

Positive Reinforcement: providing something pleasant in conjunction with the performance of a desired action or response; a reward.

Primary Reinforcer: anything that is naturally rewarding, that satisfies biological drives and does not depend on learning such as food, water, sex, and companionship.

Punishment: an unpleasant action that occurs immediately after an unwanted behaviour. This is done to decrease the likelihood of the behaviour recurring.

Regression: deterioration in the animal's learning progress or performance of a behaviour, usually temporary in nature.

Or

When a trainer retraces the steps in the shaping process or reinforce lesser levels of performance to build the animal's confidence.

Reinforcement: anything positive or negative, which occurring in conjunction with an action, tends to increase the probability that the action will occur or will not occur again. Positive reinforcement occurs during or immediately following the desired behaviour. Negative reinforcement is used to induce a desired behaviour.

Schedules of Reinforcement: rules that govern the delivery of reinforcement.

Stimulus: anything that causes some kind of behavioural response.

Successive Approximation/Shaping: building a behaviour by dividing the behaviour onto smaller increments and teaching the behaviour one step at a time until the desired behaviour is achieved.

Superstitious Behaviour: an undesired behaviour that was unintentionally reinforced and then becomes linked to the desired behaviour.

Time Out: a form of punishment in which positive reinforcement and/or the opportunity for positive reinforcement is withheld for a brief period of time immediately following an inappropriate or undesirable response. This is used in protected contact.

Training: the art of using conditioning techniques to obtain desired behaviours.

6.1.2 APPENDIX 1.1: CALF TRAINING

ELEPHANT CALF TRAINING AT THE NORTH OF ENGLAND ZOOLOGICAL SOCIETY, CHESTER ZOO

Planning the training for an elephant calf is extremely important and at Chester this begins before the calf is born. The main trainer is decided upon at this early stage as is the chaining point for the calf. The trainer teaches the calf new behaviours and builds a special bond with the calf. The other keepers are handlers for this calf reinforcing already taught behaviours in the absence of the trainer.

The calf's training starts as soon as the excitement of the birth is over. The trainer and other keepers slowly get the calf used to close human proximity. This gradual and calm process allows the mother to trust the keepers and to understand that no harm will come to her calf. This is especially important for a nervous and new mothers.

Fig. 1. Desensitisation allows the trunk to be grasped and held for some period of time. This is essential for later procedures such as the 'trunk up' command.

Naming the calf is very important and a name should be decided upon at a very early stage. The calf will gradually get used to contact with the trainer and the handlers with the trainer using the calf's name more, calling it and rewarding it as soon as a response is made to its name. The calf will start to associate with the trainer and its name calling. The calf's first command is "*NAME* COME HERE" and it is given constantly on the handlers' approach, as soon as the calf begins to approach the handler in response to its name it is rewarded. Rewards are praise and a treat item such as a few pieces of chopped apple.

Once the calf will consistently come to the handler when called, the next step in the training is taken. The handler gets the calf used to being touched, this desensitises the calf to human contact. Initially the trunk is concentrated on moving on to the head, the front and back legs and then gently holding the tail. This desensitisation of the calf to human proximity and contact is built on until the calf will allow the trunk to be held for some period of time.

The command "NO" is also introduced early in training and is clearly very important. Any undesired behaviour from the calf such as running at or pushing the trainer is responded to by with a sharp "NO". If necessary this is re-enforced by a sharp smack on the trunk from the trainers hook handle, especially if any aggression is shown by the calf. This system of reward for desired behaviour and a negative response to inappropriate behaviour is set up early in the calf life and teaches the calf what is acceptable and what is unacceptable behaviour around keepers. This can be established very compassionately as the most import thing is to build a positive and strong trusting relationship between the trainer and the calf. Once this relationship is established the calf will be eager to please the trainer making its training much easier.

At his stage the calf can be encouraged to move with the trainer. The command "TRUNK" is given and when the calf performs the task is rewarded until the response is consistently performed. The trainer can then ask the calf to lift its trunk and hold the trunk to encourage the calf to walk with the trainer by gently guiding it. A second handler can follow behind the calf to assist in this. The calf is led around in this way gradually building up the duration and distance covered. As the hook is introduced to initiate forward movement the trunk no longer needs to be held to guide the calf.

Fig. 2. The calf walking alongside the trainer.

The next step is to lead to calf to the area designated for its restraint. On arrival at the restraint point the calf is rewarded. The calf very soon associates the restraint point with a positive reward. The trainer begins to prepare the calf for restraint. This is done along side the mother, keeping stress for both animals to a minimum.

Fig. 3. The use of a looped rope to desensitise the calf to restraint.

Once the calf is calm and comfortable at its restraint point, a chain is gently placed around its leg with a large reward given for acceptance. The calf will at this time be used to the sight and sound of chains from the daily routine with the adults, including its mother. The calf quickly gets used to the chain around its leg and will accept this while the trainer is in close proximity, associating both with food. The next phase is to clip the chain in place for progressively longer periods. During this time the trainer stays with the calf and mother and rewards and reassures both. The calf should see the restraint point and its restraint time as a positive and enjoyable experience.

Once the calf will consistently performs all these behaviours, come when call, raise its trunk on command, walk with the trainer and allow the front leg restraint to be placed on either of its front legs the most difficult parts of the training are done.

Fig. 4. The calf lifting its front foot on command for washing.

We have found that attaching the rear leg restraint is far easier to achieve than the front. To do this a second handler uses a loop rope which they gently wrap around the calf's leg until it is desensitised to it. The calf is then encouraged to lift its foot and the loop is placed around the calf's ankle, but not attached to the floor. A second handler gently applies a little pressure on the rope until the calf gets desensitised to this feeling. The trainer stays at the head of the calf to reassure the youngster. Once completely comfortable with this a chain can gradually be used instead.

It is very import to reward the acceptance of restraint so that it is a positive experience for the calf. It is also important that the calf has food in front of it whilst restrained, ideally this should be leafy tree browse but hay is a sufficient substitute.

During the training for restraint, the calf was also learning to raise its foot, move over and move back to the commands "MOVE OVER" and "MOVE BACK". The command given to lift a foot is "FOOT" again with praise and reward when the calf performs the desired behaviour. To assist the calf's understanding of what is required the hook is used. The correct hook position for the command "FOOT" is placing gentle pressure on the back of the calf's foot. The essence of this is that the calf will move its foot away from the hook lifting its foot up, the behaviour is rewarded heavily. The calf will quickly associate the command with the required behaviour and reward. The command is also taught on the back legs in the same manner. These commands and the responses assist in applying the restraint to the calves legs and essential to all foot care husbandry procedures.

Once the calf is consistently responding commands, the command "STEADY" is given. This is used to maintain a behaviour such as holding the foot in the lifted position. The command "ALRIGHT" is given as a release command allowing the calf to drop the foot, as always praise is given for a correct behaviour.

The commands "STEADY" and "ALRIGHT" are important commands for the calf to learn. They are used in conjunction with all commands given to elephants in the following way.

COMMAND - BEHAVIOUR - RELEASE – REWARD

Fig. 5. The scrub routine is an essential husbandry tool.

The calf can now be introduced to other commands. The command "TAIL" allows full manipulation of the tail and "EAR" where the calf is expected to present it ear to the trainer. It is taught by the trainer tapping on the ear initially while giving the command. Similarly, the command "SALUTE" is introduced by the trainer tapping the calf on the head, as soon as the calf touches the tapped area with its trunk a reward is given. This is essential for tusk inspections and procedures involving oral inspection and veterinary care.

Fig. 6. Giving the command STRETCH.

These commands allow routine good husbandry procedures, such as close examination of the calf's skin, eyes, mouth, teeth, tusk sockets, ears and feet. Additional to examination, the routine cleaning of these areas called 'the scrub routine' which is introduced to the calf at this stage has three important functions. The obvious one is to clean the calf so that it can be examined for early warning of skin problems, as an elephant caked in mud cannot be properly examined. Secondly it desensitises the calf to being touched which makes veterinary procedures possible on any part of the body when necessary. Lastly, the scrub routine is important for gaining the calf's trust, to build a relationship between the keeper and the elephant. The scrub routine requires the calf to present each the following in a safe and controlled manner for cleaning with a hand brush; from left to right around the calf; eyes (always done first with clean water), left ear, left front elbow, left front foot, left rear leg, left rear foot, tail, right rear leg, right rear foot, right front elbow, right front foot and right ear. The scrub routine is an essential husbandry tool this gets the calf used to close human contact while receiving commands and standing still whilst keepers work around it, allowing a calm and controlled working environment.

The calf is now ready to be taught the command "STRETCH". Using the hook and continually giving the command stretch the trainer will rub the top of the calves back with the hook.

Gradually the calf will want to move away down from this while the calf moves closer to the ground the calf is heavily rewarded.

Once stretch is in place the command "LIE DOWN" can be introduced to either side of its body, pulling gently on the hook to encourage the calf to move in the required direction, again once the calf does this it is rewarded.

Fig. 7. Calf being washed in the stretch position.

The training of behaviours can vary from calf to calf, some learn quicker than others, some are not as patient or consistent or determined. As soon as a behaviour is performed consistently, the command is in place and the rewards can be reduced. The training of the elephant calves at Chester Zoo is carried out to allow us to give them a high standard of care. Behaviours are only trained that significantly improve the care and welfare of the elephant. These behaviours require an enormous amount of kindness and patience and the results are achieved through the elephant calf enjoying the training sessions.

Fig. 8. Calf being washed in the lying position.

6.2 Appendix 2: Correct Application of Chains

It is important that chains are correctly made and applied. The information in this Appendix is taken from Roocroft (1998). The following guidelines should be followed.

- The animal must have sufficient chain so that it can stand and lie down comfortably.
- The front leg chains rest loose on the foot slightly below the instep; you should be able to fit your whole hand between the chain and the foot. Too tight and the chains may cause tendon damage, too loose and the elephant can slip the restraints.
- The rear leg restraints must fit snugly around the leg just below the knee. If the chain is too slack it may slip down the leg and cause injury to the rear instep. Covering the rear chains may be appropriate in some circumstances, such as inclement weather.
- Elephants are normally chained on diagonally opposite legs; this should be alternated each day to avoid discomfort to the legs.
- During transportation the elephant might pull at the restraints and cause minor injury to the leg. This can be avoided by covering the chains with fire hose, or using webbing. Webbing is less abrasive on rear legs and distributes the pressure of restraints while travelling over a greater area of the leg. However, they are more difficult to connect and remove from less tractable animals.
- Tie connections can be either on a wall of a barn or fastened to rings in the floor. Fastening locations must be checked for corrosion.
- Swivel connections on the front chain can be used to reduce the knotting that sometimes occurs with elephants that play with their chains.
- Brummel hooks have been known to stretch and fall off. Shackles are the safest equipment for restraining all elephants.

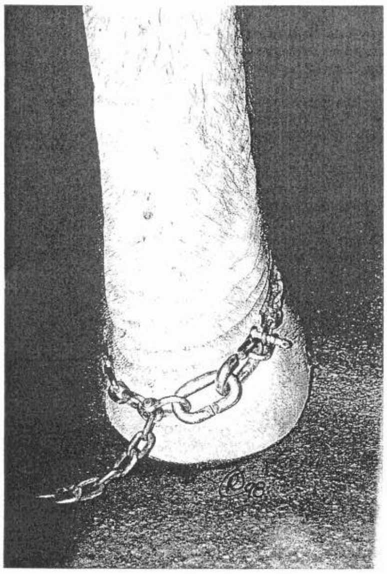


Photo one: Showing the incorrect use of Brummel hooks on the rear leg.

Also the incorrect use of shackles to attach the Brummel hooks to the chain.

Finally this photo demonstrates the use of totally incompatible equipment. 5/16" chain, 3/8" shackles and 1/2" home made Brummel hooks.

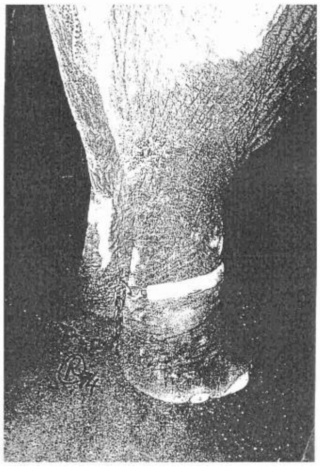


Photo two demonstrates the use of rubber hose to cover the chain.

Also notice the relaxed stand position of this elephant and the sufficient chain available.

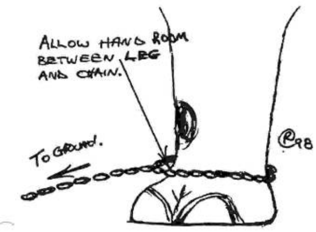


Diagram one showing front leg and position of chain around the leg.

Allow sufficient room between the chain and the leg so it won't damage tendons.

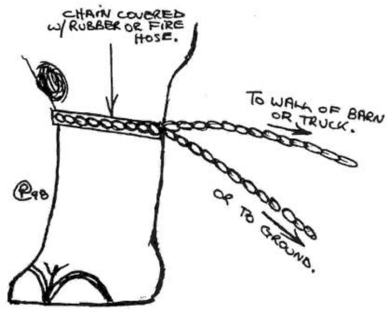


Diagram two indicating the position of chain on rear leg and also the direction of two different chain fastenings.

Diagram three demonstrating the use of webbing on the rear leg of an elephant.

6.4 Appendix 3: Risk Assessments[1]

The following should be taken in to account if risk assessments are carried out for each keeper for each elephant. A complete list of jobs (tasks) and environmental factors should be compiled which would include:

- Off chains: handling/leading/walking
- Off chains: washing
- Chaining
- On chains administering an injection
- On chains blood sampling
- Off chains walking
- Gates and gate controls
- Equipment a materials which would be used
- Cover and environmental enrichment features
- Temporary features
- Zoonotic risks

It is important that all hazards are recognised so that any risk assessment is complete. In carrying out the risk assessment the following questions must be addressed:

- Who might be affected
- How serious might the outcome of any incident be
- How likely is it that an incident may occur
- What controls do we have in place now

Whilst many organisations apply numerical risk factors to risks, what is more important is that:

- Sensible controls to eliminate or reduce risk are applied
- Controls take into account the ability and knowledge of the individuals carrying out the work
- Everyone concerned is aware of the risks and the controls

Risk assessments for any public/elephant contact also need to be carried out. Areas to be considered are:

- Separation of public from elephants
- Which elephants can participate
- Disease risks elephant/public and pubic/elephant
- List possible contact risk areas
- Staff numbers and level of staff which must be present

[1] The section on risk assessments has been review and updated after taking advice from H&S experts.

- Risk to keepers handling elephants in this situation
- The age, stature and ability of the public involved. Particular attention should be paid to physical and learning disabilities

EXAMPLE: HEALTH AND SAFETY TRAINING FOR ELEPHANT KEEPERS

Training required	Animals	Date training undertaken	Employee signature	Line manager signature
General approached to animals e.g. quiet, safe distance, accompanied				
Awareness of behavioural changes & greater risk of injury e.g. breeding, injury				
Awareness of zoonoses and appropriate hygiene protocols				
Safe handling techniques e.g. lifting (see manual)				
Handling of everyday tools				
Handling of substances hazardous to health				
Awareness of protective equip. /clothing & purpose/regulations				
Correct procedure for opening and closing gates/housing doors				
Fence checks				
Electric fencing training				
Feeding protocols				
Loading/transportation protocols				
Darting protocols				
Four wheel drive and vehicle maintenance				
Use of tractor and trailer				
Correct use of radio including emergency procedures				
Animal escape protocol				
Car overheat procedures				
Elephant handling and training				
Elephant walks				
Elephant washes				
Offsite visits				

6.4 Appendix 4: Elephant Profiles

6.4.1 Example is from Blackpool Zoo.

Information on the relationship of elephant to individual handlers, especially differences, should also be included in the profile. It is advisable to back up the profiles with some observational behaviour projects carried out by trained individuals.

Scientific name: *Elephas maximus* **Common Name**: Asian elephant

House name: Marcella **ARKS number**: M99076

Chip number: 221E3F0C38

Acq. Date: 26/10/99 **Birth date**: 1972 **Birth place:** Unknown

Sex: Female **Weight**: 3500 kg

Transaction History

Date	Type	From	To
26/10/99	Loan	Berlin circus, Union	Blackpool

Medical Problems: Foot problems: Front left and right toes

Skin Condition: Good overall but work needs to be done on head, back and legs.

Physical Condition: Good

Socialization, Temperament and Behaviour History: Socialisation: mixes well with all elephants. Temperament: good, occasionally has shown mild aggression towards Indra. Has shown no aggression towards keepers. Behaviour: Sways when chained and prior to feeding times, this behaviour has reduced. Hopefully reduction of this behaviour will continue.

Voice and Ankus Commands: Voice Commands: Responds well to all commands given 25+. Ankus use: The ankus is used when needed to reinforce verbal commands using the recognised cueing points.

Chaining: Elephants are chained daily as part of their routine. For bathing, training and footcare. Elephants will not be chained for any longer than BIAZA guidelines.

Elephant conditioned for:

	Yes	No	In training
Displays	Y		

Zoo Walks	Y		
Public Encounters	Y		
Riding		N	
Transport	Y		
TB Testing	Y		
Ultrasound	Y		
Footcare	Y		
Urine/Blood	Y		
Cycles	Y		
Stretching	Y		

6.4.2 Body Condition Scoring

METHOD 1: ASIAN ELEPHANTS: EUROPEAN ZOO NUTRITION GROUP

J. Nijboer, Rotterdam Zoo, European Zoo Nutrition Group

1 - Emaciated
Skin over ribs tight and ribs prominent; spinous process sharp and easily seen, no muscle either side of spine; skin tight over pelvis; 'Hook (hip bones) and Pins (tuber ischeii)' very prominent; deep cavity anterior to hip bones; "small" face; cheek bones are clearly visible.

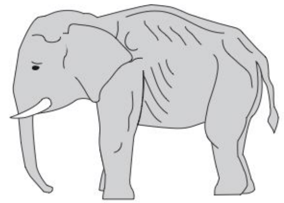
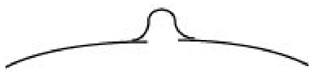
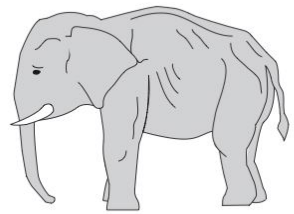
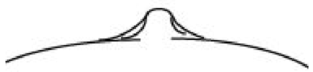
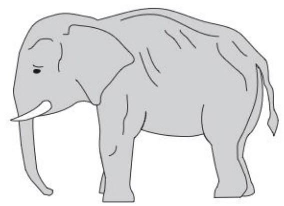
2 - Thin
Ribs visible; spinous process well defined bust some muscling; pelvis visible, with slight depression anterior to hipbones.

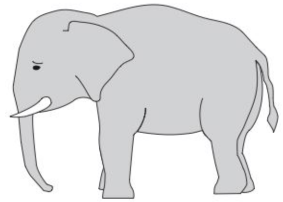
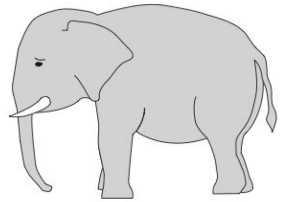
3 - Good
Ribs just visible but covered; spinous process visible with good muscling either side; pelvis rounded; 'Hook and Pins' rounded and covered - definition, but no depression anterior to hip bones; 'dry' legs; 'smooth' legs.

4 - Fat
Ribs well covered; spinous process not visible; hip bones very rounded; pelvis covered by fat; hanging belly.

5 - Obese
Ribs buried; deep 'gutter' where spinous process should be; 'gutter' extends to root of tail; pelvis buried with no definition; skin distended; eyes hardly visibly; heavy trunk; round head.

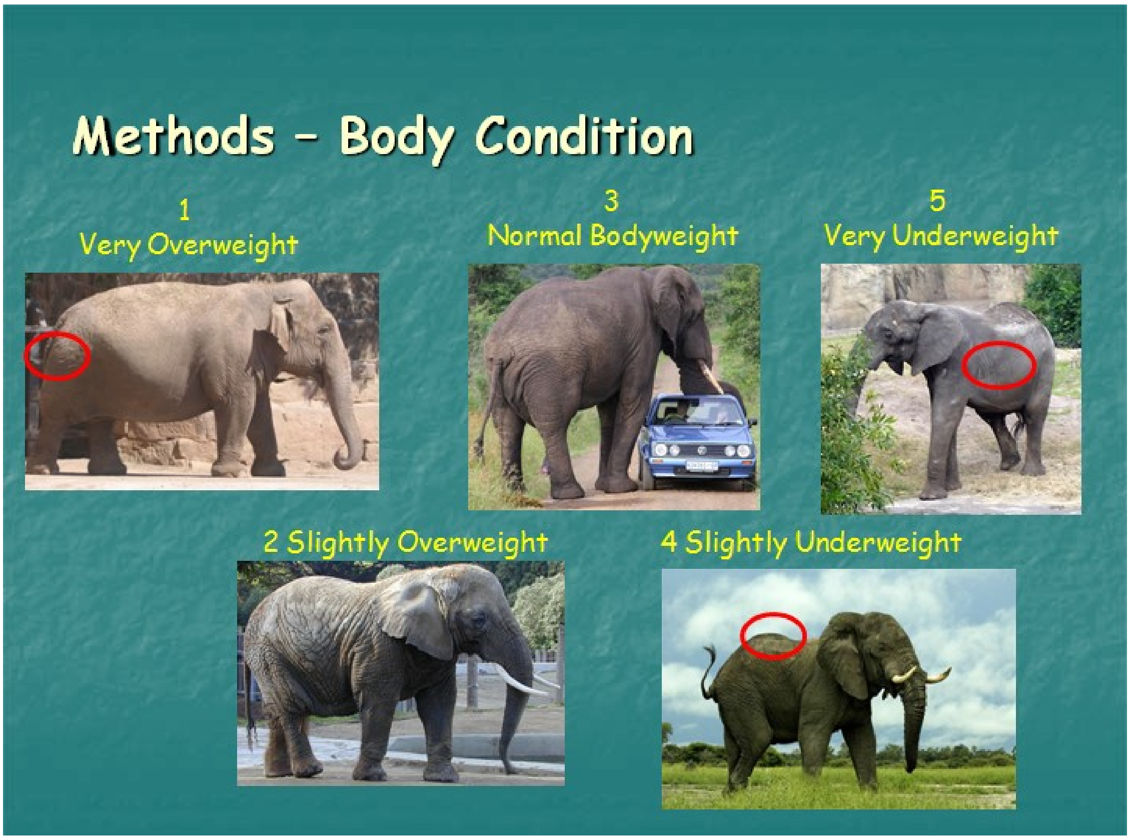
METHOD 2:

Score	Class	Description	Spine (view from behind)	Lateral view
1	Emaciated	**Head:** Deeply concave, frontal ridge forms a crater-like rim around the temporal depression **Scapula and thorax:** spinous processes prominent, scapula bladelike, acromion process obvious, majority of ribs clearly seen **Lumbar and abdomen:** depression in front of pelvis, horizontal processes of lumbar vertebrae seen, spinal ridges parallel, height equal to width, pelvis visible as jutting bone		
2	Under-weight	**Head:** Deeply concave, moderate ridge forms rim around temporal depression **Scapula and thorax:** Scapula spinous process visible as a vertical ridge, ribs seen caudal thorax, clearly demarcated but not behind scapula region **Lumbar and abdomen:** slight depression in front of pelvis, horizontal processes can be seen but not clearly demarcated, pelvis visible but not clearly demarcated		
3	Normal	**Head:** Slight or moderate concavity, frontal ridge defined **Scapula and thorax:** scapula spinous process visible as a vertical ridge with a concavity between the ridge and the posterior part of the scapula. Some ribs visible but the extent and demarcation not pronounced. **Lumbar and abdomen:** lumbar vertebrae visible as a ridge, skin slopes away from the top of the ridge, height < width, pelvis visible but not pronounced		

4	Obese	**Head:** Full and mildly convex in outline, frontal ridge vague and not clearly seen **Scapula and thorax:** Scapula spinous process only visible when leg in certain positions, ribs not visible, mild concavity over the rib spaces **Lumbar and abdomen:** lumbar vertebrae not visible, lower back smooth, pelvis not visible, region between ilium and caudal vertebrae filled with tissue		
5	Massively obese	**Head:** Full and convex in outline, frontal ridge not seen **Scapula and thorax:** Scapula spinous process not seen, een when leg in different positions, ribs not visible, skin barrel smooth and rounded. **Lumbar and abdomen:** lumbar vertebrae not visible, rounded and barrel like. Pelvis not visible, rounded between pelvis and spinois processes, flank bulges outwards in front of pelvis, spinous processes hardly protrude above dorsum as viewed from behind		

METHOD 3: UNIVERSITY OF BRISTOL BODY SCORING

(Harris *et al* 2008)



6.5 Appendix 5: Staff training

A good method of training is to have a system which categorises handlers into *trainee* and *qualified*. There would be two or more levels within the trainee category and similarly within the qualified category. There should be a Elephant Management Training programme with an evaluation system for each level. The evaluation would have both theoretical and practical elements. Keepers would not have any direct handling or training of animals until they had passed trainee level one, and must be supervised by fully qualified staff at all times. A suggested programme outline is given below.

Trainee Level 1: entry level for new staff. Duties include cleaning and other related elephant care duties, familiarization with enclosure workings, door movements etc. They must become familiar with all elephant protocols. Trainees have contact with elephants only with the permission from, and in the presence of two qualified elephant handlers. Such permission will depend on the assessed suitability and capability.

Trainee Level 2: Duties may include care contact with elephants, such as feeding watering and bathing, protected contact training and observing basic foot care etc. They trainee learns the commands and hook points used by handlers. Can begin giving commands.

Qualified Level 1: a level 3 trainee must have two qualified elephant handlers present until they demonstrate that they are proficient with the basic behaviours of individual animals. They must also demonstrate a satisfactory level of competence in assessing and making judgement relating to health and safety risks. Duties include manipulation of elephants in free and protected contact within the zoo's protocol.

Qualified Level 2: this level involves the keeper being taken through all aspects of animal management and assessed as having demonstrated a high all round performance in his duties and having acquired the necessary knowledge base. Are able to perform, all aspects of elephant management in the collection.

<u>Examples</u>

Staff training protocol from Whipsnade Wild Animal Park:

All new members of staff to the Elephant section are given a six months working timetable. This timetable sets out a list of goals that need to be achieved. At the end of each month, the keeper in charge will discuss with the trainee his or her progress. Any comments will be noted and signed by both parties.

New keepers will also be shown the safety guidelines pertaining to working on the Elephant section. If the keeper is new to the Park they will also be shown the WWAP health and safety manual.

Introduction to the Elephants will only be done by the keeper in charge or the next senior keeper (R. Chaplin). This will help to avoid confusion over minor differences in techniques.

Introduction to the Elephants is done in set stages; see working timetable for new keepers.

Trainees will begin working with Lucha and Kaylee. They are both steady animals with no history of aggression towards staff. All Elephants will be placed on chains for introduction of new keepers. Tow chains are the normal practice, but four chains may be used if the animal has a history of aggression towards new staff.

If at the end of six months the trainee has failed to reach each goal, then he or she's suitability for working on the Elephant section should be reconsidered.

Working Timetable For The Introduction Of New Staff To The Elephant Section

This timetable is based over a six month period.

Month One:
Keeper needs to understand all safety aspects of working on the section.
Keeper needs to fully understand the daily working routine of the Elephant section.
Keeper needs to consistently show a high level of cleaning skills and general hygiene.
Keeper needs to show initiative and flexibility throughout the working day.

Month Two:
Begin working Lucha and Kaylee through their morning bath routine.
Demonstrate proper use of the ankus.
Move Lucha and Kaylee throughout the Elephant facility.

Month Three:
Work Lucha and Kaylee through their morning bath routine without assistance.
Begin working Lucha and Kaylee through their behaviours.
Move Lucha and Kaylee throughout the Elephant facility.

Month Four:
Move Lucha and Kaylee throughout the Elephant facility without assistance.
Work Lucha and Kaylee through their behaviours without assistance.
Begin working Emmett in protected contact.

Month Five:
Begin walking Lucha and Kaylee through the Park.
Work Emmett through his daily routine without assistance.

Month Six:
Handle both Lucha and Kaylee through a working day without assistance.

Whipsnade Wild Animal Park
March 2003

Example from Woburn Safari Park on keeper training levels and H&S forms

KEEPER NAME	
DATE OF ASSESSMENT	
SIGNED BY KEEPER	
SIGNED BY ASSESSOR	

ACTIVITY	Female Elephant LEVEL OF COMPETENCE			Male Elephant LEVEL OF COMPETENCE		
	L 1	L 2	L 3	L 1	L 2	L 3
Ankus use and Hooking Points						
Elephant Handling on Chains						
Elephant Wash Routine						
Elephant Chaining and Shackling						
Handling Elephant in Yard						
Handling Elephant in Paddock						
Walking Elephants				N/A	N/A	N/A
Walking Elephants with Public				N/A	N/A	N/A
Walking off site				N/A	N/A	N/A
Handling Elephant (demonstrations/PR)				N/A	N/A	N/A
Elephant Riding				N/A	N/A	N/A
Special Visits				N/A	N/A	N/A
Elephant Loading on Transporter						
Blood Taking						
Urine Collection						
Foot Care						

It is agreed that the person with the highest level of competence will take charge of each activity according to availability. Staff are identified in levels of seniority.

Skill levels are identified as follows:

L1 = Basic Skill Level, L2 = Intermediate Skill Level, L3 = Fully Competent Skill Level

6.6 Appendix 6: Elephant Nutrition

6.6.1 List of plant species used as browse for elephants in UK zoos (Plowman and Turner 2000).

(The column 'Occurrences' represents the number of different zoos who reported using each plant species)

Common Name	Scientific Name	Occurrences
Alder	Alnus	1
Apple	*Malus domestica*	2
Ash	*Fraxinus*	3
Bamboo		4
Banana	*Musa*	2
Bay Laurel	*Laurus nobilis*	2
Beech	*Fagus*	5
Birch	*Betula*	2
Bramble	*Rubus fruticosus*	1
Cherry, sloe etc	*Prunus*	3
Clover	*Trifolium*	2
Daisy Bush	*Olearia*	1
Dandelion	*Taraxacum*	1
Elm	*Ulmus*	2
Evergreen Oak	*Quercus ilex*	4
Hawthorn	*Crataegus monogyna*	2
Hazel	*Corylus*	3
Hornbeam	*Carpinus betula*	1
Horse Chestnut	*Aesculus hippocastanum*	2
Ivy	*Hedera helix*	1
Knotweed	*Fallopia*	3
Lime	*Tilia*	3
London Plane	*Platanus Xhispanica*	2
Maize	*Zea mays*	1
Maple	*Acer*	2

Common Name	Scientific Name	Occurrences
Mimosa	*Acacia*	1
Mulberry	*Morus*	1
Nettle	*Urtica dioica*	4
Oak	*Quercus*	5
Oleaster	*Elaeagnus*	1
Pear	*Pyrus communis*	1
Pines	*Pinus*	1
Plane	*Platanus*	1
Plum	*Prunus domestica*	1
Poplar	*Populus*	1
Pride of Bolivia	*Tipuana tipu*	1
Rose	*Rosa*	1
Rubber Plant	*Ficus elastica*	1
Rushes		1
Sedge	*Carex*	1
Sweet Chestnut	*Castanaea sativa*	1
Sycamore	*Acer pseudoplatanus*	4
Thistle	*Cirsium*	4
Tree of Heaven	*Ailanthus*	1
Willow	*Salix*	3

6.6.2 Vitamin E for Elephants and Hoofed Stock

Notes prepared by Dr Andrea Fidgett, Chester Zoo, NEZS

VITAMIN E: DEFINITION AND DESCRIPTION

Vitamins are organic components of food, generally present in minute amounts and essential for normal physiological functions such as growth, maintenance and reproduction. Vitamin E is a fat-soluble compound that functions in the animal mainly as a biological antioxidant. The term 'vitamin E' refers to two groups of compounds, the tocopherols and the tocotrienols, whose natural synthesis only occurs in chlorophyll-containing plants, phytoplankton and micro organisms. The predominant form of vitamin E is alpha (α-) tocopherol, deemed the most biologically active and typically used as the measure of overall vitamin E activity.

Vitamin E conversion factors

Vitamin E supplements may be labelled **d** for natural and **dl** for synthetic. Commercially there is no truly 'natural' tocopherol product available since even the d α-tocopherol commercial products are obtained from the original raw material only after several chemical processing steps. Hence it should really be referred to as 'naturally-derived'. The international unit (IU) is the standard of vitamin E activity and is the same regardless of source, although conversion factors for d & dl tocopherol are different:

1 IU = 1.00 mg dl α-tocopherol acetate (synthetic)

= 0.67 mg d α-tocopherol (natural/naturally derived)

Unless stated otherwise, dl α-tocopherol acetate has been taken as the active ingredient of supplements named in this document since it is the most commonly used form commercially.

REQUIREMENTS & RECOMMENDATIONS

While the production goals may be very different, comparative data from domestic livestock are used since requirements for most zoo species have not been established. Perissodactyls all possess a digestive anatomy with an enlarged hindgut for plant fermentation, hence horses are likely physiological models for exotic equids and other perissodactyl groups (tapirs and rhinos). Elephants have similar gut morphology and are included within this group for comparative purposes. Exotic ruminants (artiodactyls) include all antelope, deer, giraffe, mouse deer and camelid families. Though considerable gastrointestinal variation exists across the taxa, all rely on foregut fermentation thus cattle and sheep are the best physiological models available.

Vitamin E requirements for domestic species range from 5-50 IU/kg dry diet and most commercially available compound feeds are fortified accordingly (~50IU/kg dry matter). In response to an increasing observation of vitamin E deficiencies in many captive wild animals, recent recommendations for these species are considerably higher, around 100-200 IU per kg dry diet. Green forage and other leafy material are good natural sources of α-tocopherol; young grass being a better source than mature herbage and lucerne being especially rich. Leaves may contain 20 times as much vitamin E as the stems. Yet losses during haymaking can be as high as 90%, thus captive herbivores with limited access to fresh herbage may require supplementation.

VITAMIN E SUPPLEMENTS

In the UK a number of products are used to supplement vitamin E for captive herbivores. Vitamin E form and potency of selected products (including one in 2 strengths) are compared in Table 1.

TABLE 1 SELECTED VITAMIN E SUPPLEMENTS REGULARLY USED IN THE UK

Product (*Supplier*)	Vitamin E compound	IU/kg or l	Form/Std. Quantity
Equivite Original (*Spillers*)	dl α-tocopherol acetate	10 000	Powder, 3kg or 15kg
Equivite VitE & Se (*Spillers*)	dl α-tocopherol acetate	40 000	Powder, 3kg
Zoo-E-Sel (*IZVG*)	dl α-tocopherol acetate	22 000	Powder, 2kg
Emcelle Tocopherol *(IZVG)*	d α-tocopherol	500000	Liquid, 1l
El-E-Vite (*Mazuri*)	d α-tocopherol polyethylene glycol succinate (TPGS)	3000	Pellet, 25kg

A pelleted supplement offers the benefit of vitamin being evenly incorporated within a palatable feed item, thus less wastage. However the compound used in the only pellet listed (TPGS in El-E-Vite) is a water-soluble form of the fat-soluble vitamin, with limited evidence to support its effectiveness. Powdered supplements are usually sprinkled onto or mixed with other food items; likewise the liquid form which can also be mixed with water (although this may not be a reliable method of delivery unless it is to dilute the product so it can be used as a spray onto food). Price increases with vitamin potency, but the cost is offset by being able to feed far less to achieve the same dose – an important consideration for animals larger than 1000kg (see Table 2). All the products (except Emcelle Tocopherol) also contain selenium due to positive interactions between the two nutrients although one does not substitute for the other. Equivite Original provides other vitamins and minerals which the concentrated forms (VitE & Se, Emcelle Tocopherol) do not, so maybe more suitable for smaller species.

PRACTICAL GUIDELINES FOR SUPPLEMENTATION

Recommendations are generally made on a per kg dry matter diet basis, but few collections are able to quantify this effectively and find it hard to know how much to feed. Most will have body weight ranges and can use these instead to determine supplementation regimes. Species should be further divided according to their digestive strategy - perissodactyl or artiodactyl as already described. On this basis, the following guide for supplementation can be used:

Perissodactyls, hippos, elephants 1 IU vitamin E / kg body weight / day

Artiodactyls 0.5 IU vitamin E / kg body weight / day

Table 2 shows dose rates across a range of body weights for various supplements, using the rate for Perissodactyl species. The guidelines can be used all year round, providing a vitamin 'top-up' for animals receiving only compound feed and dried forage during winter months. Access to fresh browse and paddock grazing during spring/summer will of course add 'natural' vitamin E to the diet, but over-supplementation is extremely unlikely (see Toxicity below).

TABLE 2. DOSES FOR INDIVIDUAL SUPPLEMENTS BASED ON RELATIVE VITAMIN E POTENCY, USING RATE FOR PERISSODACTYLS (1 IU / KG BODY WEIGHT / DAY). DIVIDE BY HALF FOR ARTIODACTYL SPECIES AT ANY EQUIVALENT BODY WEIGHT. RELATIVE COSTING IS INTENDED FOR GUIDANCE ONLY.

	body weight (kg)						
	100	250	500	1000	1750	4000	6000
	Supplement dose (g) and approximate cost*						
Equivite Original	10	25	50	100	175	400	600
	£0.03			*£0.27*		*£1.07*	*£1.60*
Equivite VitE & Se	3	6	15	25	44	100	150
	£0.04			*£0.38*		*£1.53*	*£2.30*
Zoo-E-Sel	5	11	25	45	80	180	275
	£0.04			*£0.39*		*£1.55*	*£2.32*
Emcelle Tocopherol	0.02	0.05	1	2	3.5	8	10
(ml)	*£0.03*			*£0.27*		*£1.08*	*£1.62*
El-E-Vite	35	80	170	325	600	1125	2000
	£0.06			*£0.56*		*£2.24*	*£3.36*

**Based on current retail prices, March '04*

TOXICITY

Toxicity has not been demonstrated in ruminant or equine species. Both acute and chronic studies of rats, chicks and humans have shown that excessively high levels can result in undesirable effects; abnormal bone mineralization and clotting abnormalities, suggestive of metabolic interactions with other fat-soluble vitamins (D and K). A dietary level of about 75 IU/kg of body weight is presumed to be the safe upper limit for vitamin E intake.

FURTHER READING

Dierenfeld, E.S. 1999. Vitamin E: Metabolism, Sources, Unique Problems in Zoo Animals, and Supplementation. Pp 79-82 in: Zoo and Wild Animal Medicine: Current Therapy 4, M.E. Fowler and R.E. Miller, eds, Saunders, New York.

Dierenfeld, E.S. and M.G. Traber. 1992. Vitamin E Status of Exotic Animals Compared with Livestock and Domestics. Pp. 345-360 in: Vitamin E in Health and Disease, L. Packer and J. Fuchs, eds. Marcel Dekker, Inc., New York

6.7 Appendix 7: Elephant TAG Survey Results 2003

Federation of Zoological Gardens of Great Britain and Ireland

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N.B. The Federation of Zoos was renamed the British and Irish Association of Zoos and Aquariums (BIAZA) in 2005

BRITISH AND IRISH ELEPHANT TAG QUESTIONNAIRE REPORT

Miranda Stevenson and Olivia Walter, Zoo Federation
Mark Pilgrim and Karen King-Sharpe, NEZS - Chester Zoo

EXECUTIVE SUMMARY

In March and April 2003 surveys were sent out to all holders of elephants (14 collections) in Great Britain and Ireland. This represents all elephants in these geographical areas with the exception of one female Asian that is held in a monastery in Wales and three Asian females belonging to a circus.

Following are the results of the survey and comparisons with the Federation of Zoos' Management Guidelines for the Welfare of Zoo Animals as published in September 2002. Most collections are within 100% compliance with the guidelines. Collections keeping bulls are currently managing with the aim of breeding and have the highest standards and degree of compliance.

Of the nine collections (64%) that house bulls, five collections were successfully breeding at the time data was collected. In two of the non-breeding collections with bulls, the elephants are too young to reproduce. In a 'non-breeding' collection, breeding appears to have ceased for some unknown reason (possibly due to having two fully grown bulls on site). One collection with no bull has bred cows by A.I. Four collections (40%) do not have the minimum group size of four cows and three collections that have potentially reproductive females have no bull.

Eight collections (57%) separated their female elephants in some form overnight. All stalled females were in contact. All adult bulls (i.e. those who were not with the matriarchal herd full time) were separated from the cows over night (with one exception) and had varying degrees of contact with females. When in the outdoor enclosure, most bulls were mixed with the females when ever possible (one exception with a bull that was incompatible – being moved).

In summer all the elephants were out all day from early in the morning to until the zoo closed. Two collections allowed their elephants access to outside for 24 hours. The time allowed out was the same in the winter (with the exception of being left out overnight). It was noted that elephants chose to spend more time inside if given access to both.

Three collections had indoor enclosures for both their males and females that were below the recommended 50 m²/animal (two non-Fed). One of these is

building a new enclosure that will be ready by the end of 2004. A further collection does not comply for its females.

One collection did not comply with the guidelines for an outside enclosure of a minimum of 500 m^2 for males, but it has been noted that the area they have given is for a bullpen that is only used on its own in emergencies. Otherwise all collections complied with the minimum guidelines for outdoor enclosure size for females and bulls (where relevant). The smaller enclosures were those that did not have a bull. Please note that the results of measurements for the outdoor bull enclosure are not clear, as some collections gave only results for a 'bull pen' whilst others only gave the size of the paddock that included the females.

All collections comply with the guidelines that there must be at least two members of staff present when working with the elephants. Three collections (21%) did not have written training protocols for staff. All collections bar one have specific risk assessments for working with elephants. Of those that did, eight had a risk assessment for each elephant but only five had one for each elephant/elephant keeper. It is very clear that elephant profiles need further investigating.

Four collections do not use free contact management with their females at all, using either zero or protected contact, or a mixture of the two. The others are on a scale between free and protected contact and it varies from animal to animal. All males over the age of 8-10 are in protected or restricted contact except for one. Males under this age are with the matriarchal herd or undergoing training for protected contact.

There are currently five collections that posses an electric goad for use in emergency or life threatening situations, and a further one is thinking about it.

Sixty percent of collections put their animals on chains regularly for no longer than three hours a day, most for less than an hour. This was mainly in the morning while routine husbandry and management was carried out.

The Asian elephant population began breeding in 1975 and the current population ranges from 3 to 47. The median age of females is 21, and for males is 10. It is an older population than the Africans and has more problems. Older nulliparous females tend to show reproductive problems, as do non-nulliparous females which have not bred for some years. There is a relatively high (in comparison to the African population) incidence of stillbirths and the rate of infanticide with first calves. Both are currently being investigated. It has been shown (though with a very small sample size) that reproductive success increases with parity. Social bonding in Asians is more complex than in Africans which makes the movement of animals between herds more difficult.

The African elephant population started breeding in 1971 but most significantly since 1984. It is a younger population than the Asians, with the eldest female aged 37 and male aged 19. The median age for females is 20, and for males is 8. Given it is smaller, the African population is showing a trend to be self-sustaining and does not seem to have the problems associated with breeding that have been seen in the Asian population. Africans appear to be more acceptable to changes within a herd, so movement of animals between institutions is much easier than with Asians.

The data indicate that there may be a difference in the age of first oestrus and musth between Asians and Africans. The Africans appearing to be later developers than the Asians which coincides with research currently being carried out by Ann-Katherin Oerke (pers. com.).

Less than half the population have a health record of any kind. Health problems are predominantly foot or leg related (73% of females that had health problems) and three males have had problems with their tusks after a trauma. Uterine polyps and ovarian cysts have occurred in a few Asiatic females.

Stereotypic behaviour was noted in a third of the elephants in collections surveyed. These behaviours took the form of head bobbing, pacing and weaving/swaying/rocking. It was seen in all bar three collections and was not seen in animals under the age of 19. The duration varied from 20 minutes to four hours, did not occur every day and was more likely around feeding time or when the animals were due to come in.

Other 'behavioural problems' were mainly an animal's inability to mix with some other elephants (three collections) and attitudes to some keepers.

No bulls are currently trained in a routine or are removed from their enclosure. One collection does a public feed with their African elephants and 13 Asian females in four collections perform a trained routine. Three collections take Asian females out of their enclosure and around the grounds. No collections take their elephants out of the collection grounds.

In conclusion, the overall compliance to the Federation's current guidelines is not 100%. It must be pointed out that almost all of the collections comply with the majority of the recommendations and are willing to improve in areas that they are non-compliant. These guidelines are based on current knowledge, which has been shown to be inadequate in areas. As more knowledge is gained, the guidelines will be updated.

BACKGROUND

The questionnaires comprised of:

A general one asking for statistics on animals and enclosures

More detailed questions about each individual male and female elephant

An elephant conservation projects survey

An education survey is currently taking place but the results are not complete at time of writing.

The surveys (questionnaires - see appendix) were sent to the 14 collections keeping elephants in Great Britain and Ireland. Four of these are not Federation collections. This represents all elephants in these geographical areas with the exception of one female Asian that is held in a monastery in Wales and three Asian females belonging to a circus.

Collections and their Elephants

At the time the survey was taken (March/April 2003) there are 44 (10.34) Asian and 41 (10.31) African elephants in the region (total 85). Twenty five elephants were captive bred in a western zoo - 11 (6.5) Asian and 14 (4.10) African (total 25 or 29%).

Collection	Asian	African
Belfast #	1.4 [1.1]	0
Blackpool	0.4	0
Blair Drummond*	0	0.3
Chester # ++	4.5 [4.1]	0
Colchester # ++	0	2.4 [1.0]
Dublin	0.2	0
Howletts* #	0	4.11 [3.8]
Knowsley # ++	0	2.10 [0.2]
Paignton	0.1	0.1
Port Lympne* # ++	3.6 [1.1]	0
Twycross #	0.5 [0.2]	0
West Midland*	0	2.2
Woburn	1.2	0
WWAP # ++	1.5	0

* Non Federation collections

Collections where females have bred

++ Collections currently breeding

[x.x] Captive bred in western zoos

As can be seen, of the 14 collections five do not have bulls and therefore the elephants are not in a natural breeding situation. Twycross females were inseminated by natural mating at Chester and two WWAP females have bred, but produced stillborn calves. Paignton is the only collection keeping two cow elephants of different genera, both are old and non-reproductive, similarly the cows at Dublin are non-reproductive. Blackpool intend to carry out AI on some of their cows, Blair Drummond is presently reviewing its elephant management in light of the Federation Guidelines. Five collections are currently breeding (three Asian, two African). The Woburn and West Midland animals are just reaching breeding age. Thus the only collections keeping animals in a breeding situation that should be reproducing but are not are Belfast and Howletts. The Howletts situation is unclear and the studbook keeper has planned moves, it may be that keeping two bulls is inhibiting breeding. The present bull at Belfast (captive born in Chester) appears to be a non-breeder and moves are planned by the studbook keeper (has since deceased and left a non-cohesive group of females at Belfast). In the past 12 months calves have been born and survived at Colchester, Knowsley and Port Lympne (total of 4). All elephant moves are under the auspices of the EAZA EEPs.

The results of the surveys are summarised. It should be noted that at present the Federation's guidelines are only mandatory for member collections.

Staff

Minimum staff working with elephants was 2 or 3 in all collections. Three of the 14 collections did not have written training protocols (one of these was a Federation collection). More detailed research needs to be done before a summary of elephant keeping expertise is summarised.
Summary: all complying with condition of minimum staff numbers, one Fed and two non-Fed collections not complying with mandatory written training protocol.

Risk Assessments

One collection (a Federation member) did not have risk assessment specific to working with elephants. Of the 13 that did five did not have a risk assessment for each elephant (four of these were Federation members). Only five collections had risk assessment for each staff member against each elephant (four of these were Federation members).

Summary: one Federation member not complying with guidelines, and nine zoos need to prepare assessments for each member of staff against each elephant.

Elephant personality profiles

Five Fed members had prepared these.

Summary: seven collections (five Fed Members) need to prepare elephant profiles. It is apparent that the methodology for doing this needs to be reviewed and advice given to collections.

Ankus and electric goad

One collection (not a Fed member) was not aware of the SOP re use of the ankus. Four collections (two non-Fed members) do not use an ankus as they do not use free contact management at all at present (Blair Drummond, Howletts, Belfast and Paignton). Five collections had an electric goad (four Fed members) but only for use in emergency or life threatening situations. One member collection was looking in to the possibility of getting one

Summary: all Fed members complying with SOPs re ankus and electric goad use.

Bathing and foot care

Two collections (both non-Fed) did not specifically wash their elephants but the animals did have access to water for bathing. Only three collections (two non-Fed members) that do not operate free contact management did not perform foot care on their elephants.

Housing and enclosures

Size inside male: recommended minimum is 50 m². The range is 30-450 m², (per male) with an average of 162.6 m². Three collections were below the minimum. One of these is a Fed member who is building new housing which will be ready next year.

Size inside female: recommended minimum is 200 m² for four cows with an additional 50 m² for each additional cow over two years (minimum heard size is four cows). As well as checking for the 200 m² minimum inside space per female was calculated. Range per female was 30 – 500 m² per animal with a mean of 120.22 m². Four collections did not comply with minimum standards (two Fed members, of the Fed members one is building new housing which should be ready next year).

Size outside bullpen: recommended minimum is 500 m². Range is 70-6000 with an average of 2211.25 m². One collection (non Federation) did not comply with the guidelines for an outside minimum area, but it has been noted that the area they have given is for a bullpen that is only used on its own in emergencies. Please note that the results of measurements for the outdoor bull enclosure are not clear, as some collections gave only results for a 'bull pen' whilst others only gave the size of the paddock that included the females.

Size outside female: recommended minimum for 8 animals is 2,000 m² and for cows and bull 3,000 m². Range is 2000 – 6744.77 m² with an average of 7998.5 m². All collections complied with the minimum; the two smallest outside areas were for collections that only kept cows.

Indoor substrate: ranged from concrete to tiles to rubber and tarmac, 13 collections used concrete in part or all areas.

Heating: Twelve collections had indoor heating, of the two who did not (and are therefore not complying with guidelines) one was a Fed member, but is building a new house with heating. Temperature range was 15 – 22 °C. (minimum recommended is 15). Four had underfloor heating.

Pools: Thirteen collections have outdoor pools with one having an additional indoor pool. One collection has neither an indoor nor an outdoor pool (Fed member) and is therefore not complying with guidelines.

Restraint chute: only one collection had this therefore complying with the guidelines for collections holding bulls.

Enrichment: all collections carried out enrichment and had scratching posts.

Browse: 13 of the 14 collections fed browse – the one that did not is a Federation member and not complying with guidelines.

Group Composition

Summary for indoor: three collections kept females separate when indoors (2 non-Fed) and were therefore not complying with guidelines.

Summary for outdoor: All collections keeping mature bulls had separate outdoor enclosures for them and all but one mixed the bull whenever possible but Howletts have one incompatible young bull which is being moved to another collection. Thus all but one collection (which is now changing its management regime) are complying with guidelines.

Summary for separated at night: Eight collections carried out some form of separation and stalling at night. All stalled females were in contact in the same space. Most separation was bulls from cows.

Number of hours spent outdoors – summary: summer – range 6.5-24 hours with an average of 13.75 (two collections left their elephants out all the time in summer). *Winter*: range 4-18 hours with an average of 7.14. However most collections gave their animals choice in the winter – but animals often preferred to stay indoors. It was noted that another question is required re choice of access to outside area.

Hours spent alone by bulls

For bulls over 12 this ranged from all the time to overnight depending on variables such as musth, new calves present etc. All had contact through bars.

Group size

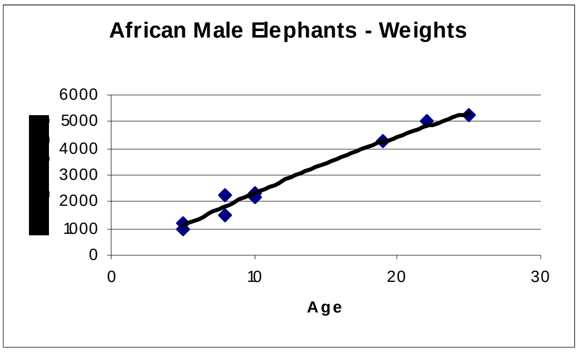
In the guidelines it states that the minimum group size is four cows over two years and that reproductively active females should be kept with a bull. Four collections (three Fed and 1 on non-Fed) keep fewer than four cows and three (2 Fed and 1 non-Fed) with reproductively active females had no access to a bull.

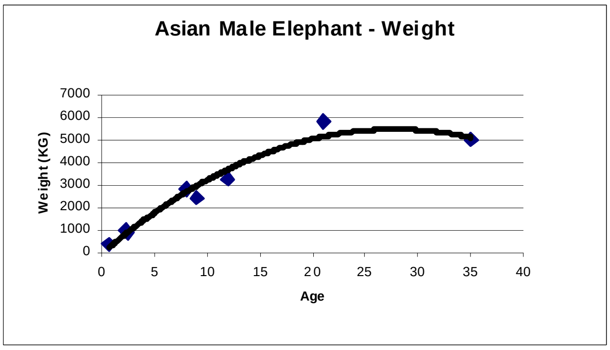
Summary: four collections did not keep the minimum herd size of cows and those with females with reproductive potential had no access to bulls.

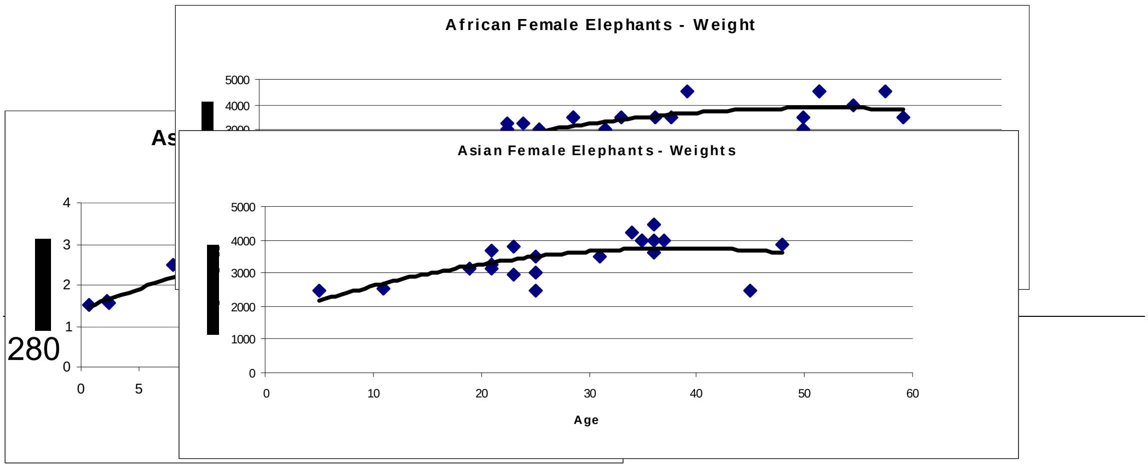
THE ELEPHANTS

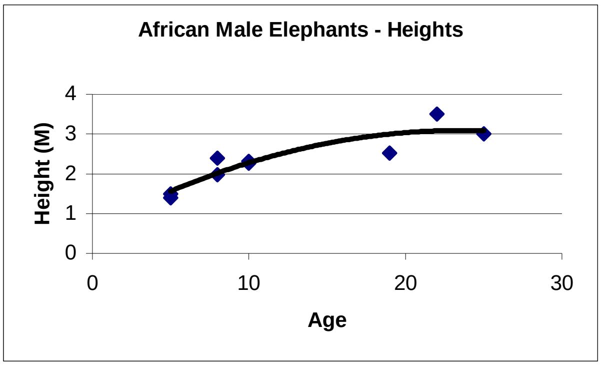
Weights and heights

N.B. Weights above 1000 kg are estimated to the nearest 500kg









Musth period and duration

Eight males (three African, five Asian) have been through some kind of musth (one has not had a full musth and another is irregular). The African males had their first musth from between 18 and 22. The Asians appear to start earlier, with ages seven, 11 and early teens stated for those whose history is known. Duration lasts from one month to 3-4 months. In most animals, the intensity of the musth comes and goes.

Access to females by bulls
All mounted females with the exception of one (*who has since deceased*). Of the 8 bulls that have mated females 6 have produced offspring. All collections reported daily access to females with exceptions being due to staffing levels, bull in musth and weather conditions.

Mating observations

Males; Musth - Of the bulls over 8 years old, only one has not mounted females though he has had access (Fed collection - *he has since deceased*).

Males; Mating - Of the Africans, only the adults that have been in musth have mated (the others are all aged 8-11), of the Asians, only the elephant that has not mounted has not mated. Of the eight animals that have mated, six have sired offspring. The two that have mated, but not sired, are both only eight and nine. ***Summary*** – only one bull that is in musth has not mated (*since deceased*). There appears to be a big age difference between Asian and African as to when males come in to musth and will mate successfully with females – need a much larger sample size to investigate fully.

Females; cycling – 34 out of 64 females are cycling regularly (one has uterine polyps and another has tumours on her vaginal wall that prevent her from conceiving). For Asians, the youngest is four and the eldest is 48, for Africans the youngest is eight and the eldest is 34. The top end of this range is due to these being the eldest elephants in the respective population.

Of the non-cycling females, one is acyclic, six are probably too young, three have reproductive disorders (ovarian cysts x 2 and the other had mucus build up in the uterine horn – disappeared now), two were cycling and appear to have stopped (possibly something to do with having two adult bulls on site) and for the remaining 13 the reason is unknown.

Age for first observable oestrus (N = 12) ranges from four to 34 but mainly between eight and 14 in Asians and 12, 13, and 14 for Africans.

Females; pregnancies – African – 14 pregnancies in 11 females, 100% survival of offspring, two still pregnant at time of writing. Two females have been pregnant more than once.

Asian – 25 pregnancies in 14 animals (of 33), three currently pregnant, 17 produced live calves (68%), four stillborns. Ten females have given birth to live calves, two have given birth to stillborns as a result of their only pregnancy and two females are pregnant for the first time. Six females have given birth to one live calf, two have had two calves, one has had three and one has had four and is currently pregnant with her fifth calf.

Three calves out of 17 live births were killed by their mother/member of the herd before they are 1 year old. Three females have rejected their calves. Of these, one has rejected two out of three, another rejected two out of four, and the third has rejected both of her calves.

Females – unsuccessful pregnancies; five females have had unsuccessful pregnancies at three collections. There is not enough information on any of the unsuccessful pregnancies to give any reason.

Health

Male – out of the 20 animals surveyed, ten have some kind of medical history; four Africans, six Asians - tusk repair (x3 all had to be anaesthised to repair, x 1 in calf), birth defect (x1), weight loss and diarrhoea (now dead), temporal gland infection (cleared up), loose faeces caused by ingesting toxic material, abscess, temporary joint problems. Four elephants have had general anaesthetics, one four times due to tusk problems.

Female – out of the 64 females surveyed, 25 females had a medical history (30% Africans and 48% of Asians). These ranged from mainly foot problems (abscesses, cracked toes) and limb stiffness (arthritis, stiff joints, most in front legs, N = 1 African, 7 Asian), to one case of tusk infection (African) and tumours on the vagina (as stated above).

Summary – No major medical problems were reported. The main problem with females appears to be stiffness in joints. All these animals are over 20 so possibly indicating a management practice that induced this stiffness in their past. This is very subjective and very difficult to pinpoint how, why, when and if these animals have arthritis (if indeed they do) due to management practices.

Stereotypic behaviour

Males - There was no stereotypic behaviour seen in 80% of the bulls (N = 9 Africans, 7 Asians). Behaviour reported included head bobbing, pacing and weaving. Instances occurred at four of the 11 collections that hold males. The duration varies from a total of 2 to 4 hours a day. The majority of circumstances occurred towards the end of the day, prior to coming inside.

Females – 47% of Asians were reported as displaying stereotypic behaviour. Time ranged between 20 mins to 10 hours per day. This behaviour took the form of weaving or swaying (9 animals), head bobs (2 animals), rocking (3 animals) and pacing (2 animals).

23% (7 animals) of Africans reported stereotypic behaviours. This behaviour took the form of pacing, lack of response to commands, walking in circles, weaving or swaying and head bobbing.

Summary – A third of the elephants in collections surveyed have been seen to perform some kind of stereotypic behaviour. This is occurring in all bar three collections and in animals above the age of 19. The duration varies from between 20 mins to four hours a day, and does not occur every day. Anecdotally, collections say that this behaviour tends to occur just before being fed or when waiting to come in (something they have to wait to come in to be fed).

Other behaviour

A further nine females were described as having 'behavioural problems' other than stereotypy. These were mostly in their inability to mix with some of the other elephants (three collections in particular reported on this). Possibly that most of this is 'elephant politics' as only two collections actually separate their elephants as a management tool.

Comments were made as to behaviour of certain elephants towards certain other elephants and particular keepers.

Frequency of handling

Males – no Asian bull over eight years old is handled in free contact, the others being in restricted (x 2) or protected contact. The eight, nine and twelve year olds have been recently moved in to restricted or protected contact. These are handled every day. The older bulls are handled occasionally.

Africans – all bulls under the age of 10 are handled daily in free contact, although the two eldest are in training for protected contact. Of the three bulls over 20, one is in zero contact, another in protected (but handled daily) and the third is still in free contact.

Females – Nine collections handle their females every day in a free contact management system. Two collections do not handle their animals at all and practise a zero contact management system. One collection handles their animals daily in a protected management system. One collection handles two out of five females in protected contact and three in free contact. All animals are handled daily. The remaining collection (total = 14) handles two animals daily in protected contact and one is not handled at all in zero contact.

Tools used during handling

Eight collections used the ankus, two used targets, and one used both. Three collections did not answer the question.

Time spent on chains

Bulls - No bulls over the age of 12 are put on chains. Of those put on chains, none were put on for more than three hours.

Female - Five collections put their female elephants on chains for less than an hour a day and two for between one and three hours per day. Five collections do not chain their animals at all.

Trained routines and removal from enclosure

Males – no bull elephants are trained in a routine nor removed from their enclosure

Females – Only one collection that has Africans does any public demonstrations and this is in the form of a public feed. Thirteen Asian females in four collections perform a trained routine. Eight females at three collections are taken out of their enclosure (only two of these do displays as mentioned previously). No collections take their elephants out of the collection grounds. All the above collections are Federation members.

6.8 Appendix 8: BIAZA Elephant Focus Group Audit 2007

Elephant Audit November 2007

Summary of results

BIAZA
BRITISH & IRISH ASSOCIATION
OF ZOOS & AQUARIUMS

Overall the collections reviewed in this audit are 88% compliant with the BIAZA Elephant Husbandry Guidelines. Targets and plans submitted with the audit indicate that by the end of 2008 the compliance could reach 94%.

Significant areas of non- compliance

- Group size (54%) – this is dependant on EEP recommendations. Also some institutions have agreed with the EEP to hold non- breeding cows and therefore four cows may not be achieved.
- Unrestricted social groupings (46%) – where this is facility dependant those institutions have plans to increase and improve those facilities. In other cases this is due a consistent incompatibility between one or more herd members and is therefore a specific management decision.
- 24 hour access (54%) – it is clear that institutions are striving to do this when possible but some are completely restricted due to safety and security considerations. Over the next year this compliance should rise to 70% with more institutions providing access during summer months.
- Indoor space for cows (62% rising to 78% over the next 12 months). Where less than four cows are being held the space is currently sufficient.

General comments

The audit is encouraging in the level of compliance and indeed the targets which are being set by zoos to achieve compliance.

However this audit has only considered whether an institution is compliant or not. The quality of compliance (and therefore facilities) has not been fully considered. This should be a target for future audits.

The provision of risk assessments and training and management protocols has been incomplete. This has required the auditors to interview and clarify a great deal of detail in follow ups. The quality of risk assessments varies considerably as does the definition of a trained keeper. This is something that should be reviewed in 2008 in order to provide a greater degree of integrity to the audit results.

Since the previous audit in 2003, there is one less elephant collection within the UK & Ireland. Port Lympne no longer keep a group of Asian elephants, leaving a total of 13 collections with elephants. Only one is now not a BIAZA member (Blair Drummond and West Midland Safari Park have since joined BIAZA). The BIAZA management guidelines are only mandatory for member collections.

At the time of the audit (November 2007), there were 37 (6.31) Asian and 33 (8.25) African elephants in the region (total 70). This is a reduction from numbers in 2003, with a 16% reduction in the number of Asian elephants, a 19% reduction in African elephants, and an 18% reduction overall.

Elephants in UK and Irish Collections, November 2007

Collection	Asian	African
Belfast #	0.3	
Blackpool	0.4	
Blair Drummond		0.3
Chester ++	3.7	
Colchester ++		3.4
Dublin ++	0.4	
Howletts* ++		3.9
Knowsley ++		1.6
Paignton	0.1	0.1
Twycross #	0.4	
West Midland Safari Park		1.2
Whipsnade ++	2.6	
Woburn	1.2	

* Non BIAZA members

Collections where females have bred, but not currently

++ Collections currently breeding

All collections are members of the EEP and are therefore compliant with BIAZA guidelines.

HERD STRUCTURE

Seven collections keep Asian elephants, five keep African elephants. One collection keeps both African and Asian elephants in the same exhibit. ***The guidelines state that African and Asian animals MUST not be mixed in the same social grouping. Overall, collections were 92% compliant on this issue.***

Five collections keep fewer than four cows, and one collection does not have four cows over two years of age (though will be by end of 2008), totalling six collections (46%) that are non compliant. One collection with fewer than four cows will be making changes in 2008, following a recommendation from the EEP to maintain a group of non-breeding cows. ***The guidelines state that zoos MUST strive to keep a minimum group size of four compatible cows older than two years. Overall, collections were 54% compliant on this issue.***

Six collections (46%) do not currently have bulls and therefore are not in a breeding situation. One has plans to obtain a bull via the EEP in 2009.

COWS

The guidelines recommend keeping a group of related females. Seven (54%) of the collections have related cows. Of these, one has three generations within the herd, four have two generations and two have only one generation. Five collections have unrelated cows. One is unknown.

Three collections report incompatibility issues, and hence separate the herd. Two of these have plans to resolve the issue by removing individuals from the group, the other collection continues to manages the situation by mixing the incompatible female with other individuals she tolerates. The other ten collections (77%) keep the main herd as a single group. ***The guidelines state that routine and prolonged separation (>16 hours in 24 hour period) of compatible cows MUST not be practised. Facilities which have incompatibility issues, such that individual cows are kept separated for prolonged periods of time, MUST ensure that these situations are resolved expediently. Collections are 100% compatible on both of these issues.***

Eight collections (62%) separate their cows at night. Three plan to resolve this with planned changes to accommodation. One will resolve once incompatibility issues has been fixed. One collection separates females in house during the winter months only (left with access outside in the summer). The remaining three collections separate due to aggression in the group. ***The guidelines state that zoos MUST strive to keep animals in unrestricted social groupings at night. Overall, collections are currently only 46% compliant on this issue. Two collections will mix the main herd once a larger facility has been completed in 2008 so compliance will rise to 62%.***

Reproductive history

- 5 collections have had no breeding in the herd
- 8 collections report females that have been pregnant
- 4 collections report still born calves
- 4 collections report retained calves

- 3 collections report unsuccessful pregnancies for other reasons
- 7 collections have produced live calves
- 2 collections have had rejected calves

BULLS

Seven collections (54%) have a bull. Six of these run the bull with the herd, one does not and does not plan to manage the bull within the social group. The number of hours of the day that the bull is separated from the main herd ranges from 0 to 14-22 hours depending on the season. In all collections the bull has visual and auditory contact with the rest of the herd when separated during summer months. In winter, the bull at one collection has only 5 hours with visual and auditory contact and at another the bull does not have any contact during winter.

The guidelines state that all bulls MUST be maintained in such as way that at the very least they can be separated from females and other males. Overall, collections are 100% compliant on this issue.

The guidelines state that from the age of four, regular updates of a bull's profile notes and a six monthly review MUST take place in combination with risk assessment. Of those that hold bulls, collections are 50% compliant.

MANAGEMENT

Eight collections use free contact with their cows, six use protected contact and two use zero contact. Three use a mixture of free contact and protected contact with different cows in their collection. Four collections use protected contact with their bulls, two use zero contact. Apart from the two adopting zero contact, all collections handle their elephants on a daily basis.

Six collections use ankus, three use targets and five use a combination of both ankus and targets. Two collections use different tools for different elephants. Nine collections in total use ankus (on its own or with targets).

Use of ankus

The majority of collections that use the ankus (56%) use it on the trunk, top of head, ear and feet. One uses on the trunk only, one uses on the trunk, top of head and feet, and one uses on the trunk, top of head, ear, front ankle joints and feet. One collection failed to answer the question.

Eight of the collections reported having Standard Operating Procedures for the use of ankus. Three use the BIAZA SOP, three use their own and two use both. One collection failed to answer the question on SOP. SOP is communicated through staff training and in staff manuals/working protocols that are made available to staff.

Goad/hot shot

Six collections (46%) own a hot shot. Mostly the voltage was unknown; only two reported voltages of 10,000 and 4,000. Five of these have never had to use it. One has only used it once in 5 years. None of these give authority in writing before use. In only one of these collections is the hot shot carried routinely by staff. Five have a written code of use, one does not. Five has Standard Operating Procedures for the use of the hot shot – three use their own, two use BIAZA SOP, 2 use both. One does not have SOP (as it is never used).

All have written safety procedures for use of the hot shot and / or staff training. The SOP is communicated to staff in all collections that use hot shot through staff training and staff safety manuals.

Time spent on chains

Four collections do not chain their elephants at all. One collection has one elephant they never chain, and one collection only chains one.

All chain less than three hours within a 24 hour period; 5 of less than one hour, four for 1-3 hours (two report less than 1 hour 30 mins). Three collections use a mixture for different elephants.

The guidelines state that elephants MUST not be routinely chained for periods in excess of three out of 24 hours. Overall, collections are 100% compliant on this issue.

The most common reason for using chains is bathing (7), followed by foot care (5), health checks/veterinary procedures (5), practice/training (2), giving birth (1) and introductions to new individuals (1) (*number of responses shown in brackets*).

All collections report that their elephants respond to commands. Elephants respond to over 20 commands in six collections (46%), 11-20 in two collections, and 1-10 in five collections.

Six collections (46%) put on public performances with a trained routine. In half of these, all elephants are used. The other half used selected individuals.

Two other collections give a presentation that does not include a trained routine.

Four collections use a written script (one not as part of trained routine). All eight collections that put on a public performance include a conservation message. Seven describe how and why elephants are trained (the other does not use a trained routine).

Seven have a risk assessment for the public performance (six of which have a trained routine, one is a public feed).

Four collections take elephants out of their enclosure. The reasons given are for exercise (3), enrichment (2), grazing (1). None of the collections take elephants out of the zoo.

HEALTH AND WELFARE

Nine collections report chronic health problems: cataracts (1), colic (1), osteomyelitis (1), broken tusks (2), foot problems (5), tooth problem (1), reproductive problem (1).

Eight report behavioural problems: head-swaying/bobbing (3), undefined stereotypy (3), aggression (2).

Eleven (85%) collections carry out active footcare. Those that have zero contact management do not. Reasons for active footcare were maintenance/routine care (9) and treatment (5). Most (63%) carry out footcare 'as necessary'; this ranged from every 6 weeks to every 2-3 months. Three collections carry out footcare on a daily basis, two on a weekly basis and one every month.

Ten collections (77%) bathe their elephants as part of a routine. Reasons given were: maintenance/routine care (7), to check for injuries/wounds (3), to clean the elephants (2), and to create a bond (1). All but one of the collections bathe elephants daily (one during summer months only), one collection carried it out on a weekly basis.

Three collections do not bathe their elephants. Reasons given were negative behaviour by the elephants (1) and provision of pools and rubbing posts deemed sufficient (2).

FEEDING AND NUTRITION

Details of diet were provided by all but one collection. Eleven collections monitor diet consumption, two do not.

The guidelines state that nutritionally sound food, comprising of good quality forage (hay and browse), concentrates and produce (optional), MUST be provided in sufficient quantities to maintain animal health and appropriate weight. All collections appear to feed an adequate diet but detailed analysis of each diet would need to be carried out to ensure that each diet is nutritionally sound.

All collections provide browse, one in summer months only.

The guidelines state that elephants MUST be provided with appropriate browse. Overall collections were 92% compliant in the summer, and 85% compliant in the winter on this issue.

ENCLOSURE

The guidelines state that all elephants MUST have indoor and outdoor facilities. Overall collections are 100% compliant on this issue.

The guidelines also state that zoos MUST strive to provide conditions that allow elephants the choice of outdoor access 24 hours a day with welfare and safety consideration. Overall, collections are only 54% compliant on this issue.

Total area indoor for main herd

The guidelines state that the indoor space for the cow herd MUST allow 200m² for four animals and should increase by 50m² for each additional animal over two years of age. Overall collections are 62% compliant on this issue.

Five collections have an indoor area for the main herd that is less than $200m^2$. Two of these have less than 4 cows and therefore the space is sufficient for what they currently hold, but should aim to increase area to at least $200m^2$ to enable them to hold the minimum recommended herd size of four cows over the age of two. Inside space per female ranges from $32.7m^2$ to $183.3m^2$, average $83.5m^2$. Two collections provide less than $50m^2$ space per female.

In all but one collection, elephants can move as a group indoors. One collection has to split the group indoors,

The guidelines state that the inside area MUST be designed for a herd, ensuring the elephants can move freely as a group and be able to move, turn and lie down. Overall, collections are 92% compliant on this issue.

Two collections are making changes to current enclosures which will bring them in line with the guidelines. Therefore there are is only one collection that currently will not comply with minimum space requirements per female in the indoor enclosure.

Total area indoor for the bull(s)

Indoor area provided for the bull ranges from $23m^2$ to $283m^2$ with an average of $96.5m^2$. Two collections are below minimum standard. One is building a new enclosure that will provide an indoor space of $209m^2$ for the bull, brining them in line with the guidelines.

The guidelines state that the minimum indoor stall size for a bull MUST be at least $50m^2$. Of those with bulls, collections are 85% compliant. One collection is currently addressing this issue, which will increase the level of compliance to 100%.

The guidelines state that separation and isolation facilities MUST be available to allow veterinary and behavioural management. Overall, collections are 92% compliant on this issue.

Enclosure features

Two collections maintain the indoor temperature at levels below the recommended minimum.

The guidelines state that the inside temperature MUST be no less than 15c. Overall, collections are 92% compliant on this issue.

Lighting system

Sodium bulbs (5), natural light/sky lights (7), fluorescent tubes (5), floodlights (3), other (2), combinations (8)

Flooring

Concrete (10), tiles (2), rubber (1), rubber & sand (1), sand (1), underfloor heating (1) (1 insulated concrete)

Woburn new enclosure changing from concrete and tiles to rubber and sand

Only one collection has a pool indoors

Presentation of food and water

Drinking water is constantly available in all collections. Hay is fed *ad lib* and feeds of concentrates and produce are given as scatter feeds, or fed on the ground.

The guidelines state that animals MUST have access to drinking water from the indoor area as well as the outdoor area. Overall collections are 100% compliant on this issue.

Outdoor

Area of the main paddock ranges from 1450m² to 38,500m² with an average of 16122m². Only one falls below recommended minimum of 2000m². All collection with cows and bull exceed the recommended minimum of 3000m².

All provide a substance that is primarily natural. Where there is concrete, natural substrate is in greater proportion.

Grass and sand (4)

Sand and concrete (4)

Grass, sand and concrete (5) (one + bark chippings)

The guidelines state that outside substances MUST be primarily natural. Overall collections are 100% compliant on this issue.

Outdoor area for the bull pen ranges from 171.5m² to 6000m², with an average of 1561.4m². Only one collection has a bull pen <500m². This is being rectified with the building of a new elephant facility in 2008. One collection with bulls does not have a separate bull pen.

The guidelines state that the outside bull pen MUST be no smaller than 500m². Of those with bulls, collections are 86% compliant. This will soon rise to 100% with the construction of new elephant accommodation in one collection.

Substrate in bull pens is either concrete and sand (3), or grass, sand and concrete (3) (one + bark chippings). One new enclosure will change to grass and sand.

Two collections do not provide a pool in outdoor enclosure. One has showers for elephants in hot weather, the other has mud wallow available to elephants in the grazing paddock.

The guidelines state that elephants MUST have water for bathing, especially during hot weather. Overall, collections are 100% compliant on this issue.

Outdoor enclosure features

All provide features such as scratching posts, wallows and boulders. Environmental enrichment was also carried out in all collections.

The guidelines state that the environment MUST be positively challenging to the animals and should contain devices and structures which enrich the environment and encourage natural behaviour. Enrichment MUST be incorporated into enclosure design with objects to rub against, interact and play with. Overall, collections are 100% compliant on these issues.

Five collections do not provide shelters outdoors. One give access to elephants indoors for shelter. Two collections report that the enclosure boundary wall offers sufficient shelter.

The guidelines state that the outdoor area MUST be protected from extremes of sunlight, wind and rain, i.e. sufficient sheltered areas should be provided. Overall collections are 62% compliant on this issue, or possibly 85% if some of the provisions for shade are deemed to be sufficient.

The types of boundary vary greatly. The majority (38%) have a combination of metal posts and cables with hot wires. Other boundary types include stone ha-ha's, rock walls, water and electric fences at ground level.

The guidelines state that dry moats MUST be replaced and interim plans made for getting out any animals that fall or are pushed in. No collections have dry moats; therefore there is 100% compliance on this issue.

The guidelines state that gates MUST be designed to operate remotely by staff. Overall, collections are 70% compliant on this issue.

STAFF

The number of dedicated elephant staff ranges from 3 to 8. This equates to a working ratio of keeper per elephant of between 0.5 and 2.67. Those with zero contact have the lowest ratios. Those with free or protected contact have ratios of 0.71 – 2.67.

Training and experience

Ten collections say staff are given clear job descriptions (two say that staff are not given clear job descriptions, one collection failed to answer the question). Eleven (85%) have written working protocols. The level to which an institution considers a keeper trained varies considerably

PUBLIC

Six collections (46%) allow some contact between elephants and the public.

The guidelines state that the public MUST only be allowed contact with elephants when keepers are present and that there MUST be two fully trained keepers present during these encounters. Of those that allow public contact, 92% are compliant on these issues. However, non compliance is only due to a collections not providing sufficient evidence to prove compliance.

RISK ASSESSMENTS

Twelve collections (92%) have risk assessments for the elephant area. One does not, but will complete by mid 2008.

The detail and level of risk assessments and management protocols varies considerably between institutions. The auditors had to clarify a significant level detail to complete the assessments.

The guidelines state that an objective assessment of risk of injury MUST be undertaken before giving unrestricted access to the house and each other for the first time. Over all collections are 69% compliant.

All collections review their risk assessments at least annually. Five review more frequently. (Two collections failed to answer this question – both do not currently have full risk assessments, but are reviewing them and will complete in 2008).

David Field, Elephant Focus Group Chair

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November 2007

6.9 Appendix 9: Appendix Research Priorities

These research priorities were drawn up by (Clubb and Mason 2002), (Clubb *et al.* 2009), (Harris *et al* 2008) and (Mason and Veasey 2009).

Adult mortality: main causes and risk factors related to the captive environment

Zoo elephants have relatively short lives compared to elephants in good timber camps, and this is particularly so for zoo-born elephants. The most common cause of death is illness, primarily circulatory problems, but more work is required to gather additional data on causes of death (generally lacking from the Asian elephant studbook) and corroborate interpretation of pathology data. Risk factors for circulatory problems, associated with the captive environment include excessive body weight; a lack of exercise and psychological stress. The effect of these factors on adult mortality needs to be investigated, and in particular, factors causing zoo-born elephants to die much younger than imported elephants need to be identified.

Excessive body weight: incidence and effects on health, reproduction and calf mortality

Studies of Asian female elephants have revealed that a large proportion are significantly overweight. It is important to establish the extent of this problem, including whether or not it affects Asian males, or either sex of African elephant (anecdotal evidence suggests it does not, or at least is less of a problem). Possible causal factors that need to be investigated include a high fat content of diets and a lack of exercise (related to enclosure size, training regime and the use of enrichments). The role of excessive body weight in various health and reproduction problems also needs to be assessed, including foot and joint problems, circulatory problems, high stillbirth rates, high calf birth weights (and subsequent implications of this) and low male and female fertility.

Infant birth weight: effect on later health and lifespan

(Clubb *et al.* 2009) found that one consequence of being zoo-born was being heavy at birth, possibly with a higher Ponderal Index (are less lean). Weights and heights at birth need to be analysed to determine if this is true and to test if there is a relationship between Ponderal Index at birth and the ability to cope with stress in later life (e.g. inter-zoo transfers).

Welfare measures: identification and measurement

Limited data are available to measure the welfare of zoo elephants on a wide scale. More work is needed to gather data on a wider spectrum of indices related to welfare, from a large number of animals. These could include corticosteroid and catecholamine output (e.g. from faeces, urine or even saliva); health problems (e.g. foot and joint problems; recurrent veterinary conditions; skin condition); stereotypic behaviour; activity levels and detailed of cause of death data. Such measures all need refining, but could then be used together to investigate the effect of various aspects of husbandry on welfare.

Stillbirths: risk factors

Stillbirth rates are very high for Asian elephants in zoos: far higher than that reported in timber camps in Asia. Possible causal factors include excessive body weight of dams (at conception and at the birth), the birth weight of the calf, the age at which females give birth, parity and psychological stress (e.g. caused by environmental disruption or the social environment). The effect of these factors needs to be investigated, as well as the reason why relatively low rates of stillbirths are seen in African elephants.

Poor maternal care: risk factors

Zoo elephants frequently attack and sometimes kill their newborn calves; a problem that appears to be minimal in timber camps, and possibly the wild. Possible risk factors include: inexperience of the dam; a lack of experienced females around the dam at the time of birth and stress (e.g. caused by separation and/or chaining the dam prior to birth). The influence of each of these risk factors needs to be elucidated and quantified.

Fertility problems: risk factors

Male and female elephants in zoos suffer from various fertility problems. These include acyclicity and reproductive tract pathologies in females, and low sperm quality, reproductive tract pathologies and low libido in males. Possible risk factors for low fertility include nutrition; excessive bodyweight; social suppression; psychological stress (e.g. due to mixing unfamiliar animals, or changes in keeping staff), and for females alone, a lack of breeding early in life and early puberty. More work is needed to quantify the most common problems affecting male and female elephants, whether these are more or less common in wild elephants, and to identify the extent to which these, and other, risk factors affect their incidence.

Early puberty: causes, and effects on elephant breeding life and lifespan

Female zoo elephants often reach puberty at far younger ages compared to those in the wild and in timber camps, and this is particularly marked for zoo-born elephants. It is of concern because of the association between early puberty and the early cessation of reproduction, and reduced life expectancy. It also represents a management problem, as it can lead to females being impregnated by their fathers. The causes for this remain unknown, but may relate to early nutrition (e.g. increasing body fat) and rearing environment (being born in captivity).

Management regime: effects on health, reproduction and behaviour

There are three main types of elephant management: free contact, protected contact and no contact, although in reality the systems used vary along a continuum. There are various purported advantages and disadvantages to the different types. For instance, traditional 'hands-on' management is said to provide essential physical and mental stimulation; allow the performance of preventative health care measures (e.g. foot trimming) and the treatment of minor veterinary problems without the need for anaesthesia. Possible disadvantages include the negative effects of physical punishment and negative reinforcement (acute and chronic); consequences of being 'dominated' by the keeper, such as reduced fertility; transient relationships between elephant and keeper (due to high staff turnover and limited working hours); and health problems induced by training 'power behaviours' (e.g.

head stands; hind-leg stands). Protected contact is said, at least by some, to encompass most of the pros of traditional training, but with the added advantages of allowing elephants to choose whether or not to participate in training sessions (cf. traditional training where 100% compliance is required); not using physical punishment and improving the behaviour of problem animals. It has been argued, however, that not all veterinary procedures can be undertaken and elephants do not gain sufficient physical exercise. No contact systems are rare, but could potentially provide the most naturalistic form of care. Such systems negate the use of punishment as no training is undertaken, however, veterinary procedures cannot be undertaken without the use of anaesthesia and some say that elephants do not get sufficient levels of physical exercise or mental stimulation, said to occur during training. These purported pros and cons of different management regimes need to be investigated to quantify the effects of each system on elephant health, behaviour and reproduction. In addition, the response of elephants to their keepers in these different regimes should be determined, particularly in traditional systems, to try and determine whether elephants really do respond to their keepers as another group member (or indeed group leader).

Foot and joint problems: incidence, severity and risk factors

Foot and joint problems appear to be very common in zoo elephants, although their incidence does not yet appear to have been quantified. Aspects suggested to be associated with these problems include: hard, unyielding substrates; long periods of chaining; nutrient deficiency; excessive body weight; the performance of 'power behaviours' (e.g. head stands; hind-leg stands); stereotypic behaviour and general stress. Factors thought to alleviate them include regular foot care (which may differ in different management systems); regular exercise and access to mud wallows and natural substrates. The influence of these various factors on foot and joint health needs to be investigated, in addition to quantifying the incidence and severity of these problems in zoo elephants.

Stereotypic behaviour: incidence, frequency, source behaviours and risk factors

The stereotypic behaviour of zoo elephants has not received much attention, but from the data that are available, 40% of elephants studied showed these behaviours to some degree, albeit at a generally low frequency. Research on orphaned elephants suggests the behaviour stems from restricted movement and possibly impaired social interaction. Due to the possible link to welfare, the incidence and severity of stereotypies needs to be scientifically quantified, possible causal factors identified and investigated.

Intra-specific aggression: incidence, severity and risk factors

Although not quantified, aggression between zoo elephants is said to be relatively common. The risk of aggressive interactions has shaped management regimes to some extent, for instance the use of indoor stalls; a reluctance to allow elephants to move freely between indoor and outdoor enclosures at night when keepers are not present, and the use of training (to allow some degree of intervention). Possible risk factors that have been highlighted include: a lack of relatedness between group members; mixing unfamiliar animals and enclosures that do not allow sufficient flight distances, or places to avoid aggressive conspecifics. Due to the obvious link with welfare, through injury and social stress, the level of this problem needs to be quantified, including the severity of aggressive interactions, and the relationship with the risk factors identified.

Environmental enrichments: use and effectiveness

Environmental enrichment has become a common component of many elephant husbandry regimes. These encompass both structural (e.g. pools, mud wallows) and more typical enrichments, which are mainly food-related (e.g. browse, food-hiding, scatter-feeding). There is, however, very little data on the effectiveness of such enrichments, nor of elephants' relative strengths of preference for different forms, despite purported benefits to elephant health, behaviour and stress levels. It is thus important that the use of enrichments are not only quantified, in terms of the different types used and the frequency of use, but also that scientific assessments are conducted to determine their effect on elephants.

Chronic and acute stress

Both are known to reduce adult lifespan in humans and other species, reduces fertility and elevates still birth rates, impairs maternal care and infant survivorship, and even induces reproductive senescense. Chaining, translocation and early separation from mothers are all likely stressors. Exposure to elevated stress hormones *in utero* and/or inadequate parental care in infancy may disrupt stress responses through life, elevate stress-related disease and shorten lifespan. If zoo-born calves experience more early stress than wild born calves, it provides and alternative explanation for the birth origin effect found by (Clubb *et al.* 2009). To test this hypothesis, the following measures could be correlated with birth and life history: measures of corticosteroid, ACTH and catecholamine outputs; assessments of immune and inflammatory responses; wound healing rates; adrenal and thymus weights, post mortem.