



Core Fundamental Standard of Practice for Captive Wild Animals

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Preamble

Wild Welfare has established a need to develop and implement an international Core Fundamental Standard of Practice for Captive Wild Animals to provide an evidence-based procedure for the systematic and forensic animal welfare auditing of captive wild animal collections.

The Wild Welfare Core Fundamental Standard of Practice for Captive Wild Animals is derived from current and prevailing trends and published literature pertaining to Zoo and Aquarium animal welfare.

This Standard may be used for auditing accompanied by the Wild Welfare Live Collection Audit Checklist.

Introduction

Cognition is the mental process of perception, processing information and learning [1] [2] and is linked, but not inseparably, to sentience capacity which is the ability to feel and experience emotions, both positive and negative [2] [3]. Therefore, it has been suggested that cognitive ability should not be the sole determinant of the degree of welfare protection an animal is afforded [2]. Yet, understanding an individual's cognitive capacities, along with knowledge of the animal's different emotional states, can help assess its welfare and increasing our knowledge of sentience in the different species is critical for improving general attitudes towards animal welfare and how animals are treated and looked after [2]. Improved awareness to and appreciation of the range of emotions the different species of animals may experience and their sentience is important to drive advances in husbandry and animal management techniques in order to ensure good animal welfare.

Vertebrate species are generally accepted as sentient beings [2] [3] and this is reflected in the level of welfare protection afforded to them through current legislation, although specific invertebrate species have also been given legal protection in some countries. For example, cephalopods have been afforded legal welfare protection in certain countries, largely as a result of their advanced cognitive abilities [4]. Recent research that examined similarities in the behaviours between invertebrates and vertebrates suggests that some invertebrates have the capacity for nociception, and also may be able to experience the emotion of pain, as well as stress, and if an animal can experience pain and stress, which are negative experiences, then it may too have the ability to suffer [4]. Some invertebrates, such as bees and octopuses, may also display a level of cognitive ability [4]. Therefore, increasing the knowledge and understanding of pain perception, sentience and cognition in the many different species of invertebrates, as well as vertebrates, is important to further reinforce the need to ensure that husbandry provisions are made for all captive animals that provide for appropriate biological and physical function and also sufficiently promote positive experiences and minimise negative states, which will ultimately improve and support their good welfare.

The Five Freedoms [5] are internationally well-known. They act as a foundation, defining and underpinning fundamental animal welfare standards and considerations and were originally produced by the UK Farm Animal Welfare Council following the 1965 UK Report of the Technical Committee to enquire into the welfare of animals kept under intensive livestock husbandry systems, to assess welfare in farming situations. However, they can be applied to animals in other circumstances and are a useful method of evaluating animal welfare.

The Five Freedoms are:

- Freedom from hunger and thirst
- Freedom from discomfort
- Freedom from pain, injury or disease
- Freedom to express normal behaviour
- Freedom from fear and distress

Yet, whilst past focuses may have been on negative experiences and minimising distress, the advancement of recent scientific concepts has led to the consideration of positive factors and the development of various positive welfare measures, encouraging the management of animals to promote positive experiences and mental states, whilst also ensuring the provision of their basic husbandry needs, in order to provide for good welfare [6] [7]. The model of the Five Domains of Potential Welfare Compromise (the 'Five Domains'), which has evolved since its original development [9], illustrates how compromises in an animal's *nutrition, environment, health* and *behaviour* can all impact upon its *mental state* and hence how each of these *five domains* may overlap and have combined effects on the overall welfare status of an individual animal [8]. The 'Five Domains' concept thus serves to offer a fresh, useful framework for the broad assessment of animal welfare, addressing the need to consider physiological and behavioural indicators of animal well-being, in association with the type of mental experiences an animal may have [8] [10].

In the Five Domains model, the four physical or functional domains (nutrition, environment, health and behaviour) are concerned with biological function, or physical well-being, whereas the fifth domain, the mental state, considers the 'affective state' or psychological well-being, and represents the animal's overall subjective feelings and experiences and hence this fifth domain is a key element of animal welfare. An animal may experience positive or negative emotional states and it is the balance between these subjective experiences that can influence an individual animal's 'quality of life' [6], with the phrase 'quality of life' generally being considered synonymously with 'animal welfare status' [11]. A positive affective state arising from the presence of positive experiences and sensations, with the avoidance of, or minimal, negative experiences, is therefore important to ensure good animal welfare and this can be achieved when the physical (nutritional, environmental, health and behavioural) as well as psychological needs are addressed [6] [12] [8] [10]. However, an individual's mental state and hence its welfare can vary from one point in time to the next, aligned with the different sensations it may experience during its lifetime, which may be positive or negative, can change [8] [10]. Thus, it is the complex interactions between each of the five domains that, in combination, may determine an animal's overall welfare status, as illustrated by the 'Five Domains' model [Figure 1].

With this in mind, implementing management techniques and standards that promote positive physical and mental health for every species accommodated within zoological institutions, whilst also minimising unpleasant experiences for the animal, is fundamental to the care of wild animals in captivity. This can be accomplished by, for example, providing appropriate nutrition to meet the animal's biological needs which is presented in a manner to satisfy its feeding behavioural requirements, the provision of environmental choices, access to conspecifics (as appropriate) and access to a complex, variable and stimulating environment, in addition to the continued provision of high standards of both husbandry and veterinary care. In some countries animal welfare legislation is developing and evolving to address the concept of a 'duty of care' to animals, ensuring people who are responsible for animals take appropriate steps to meet the animals' needs and requirements and promote good welfare through positive animal management.

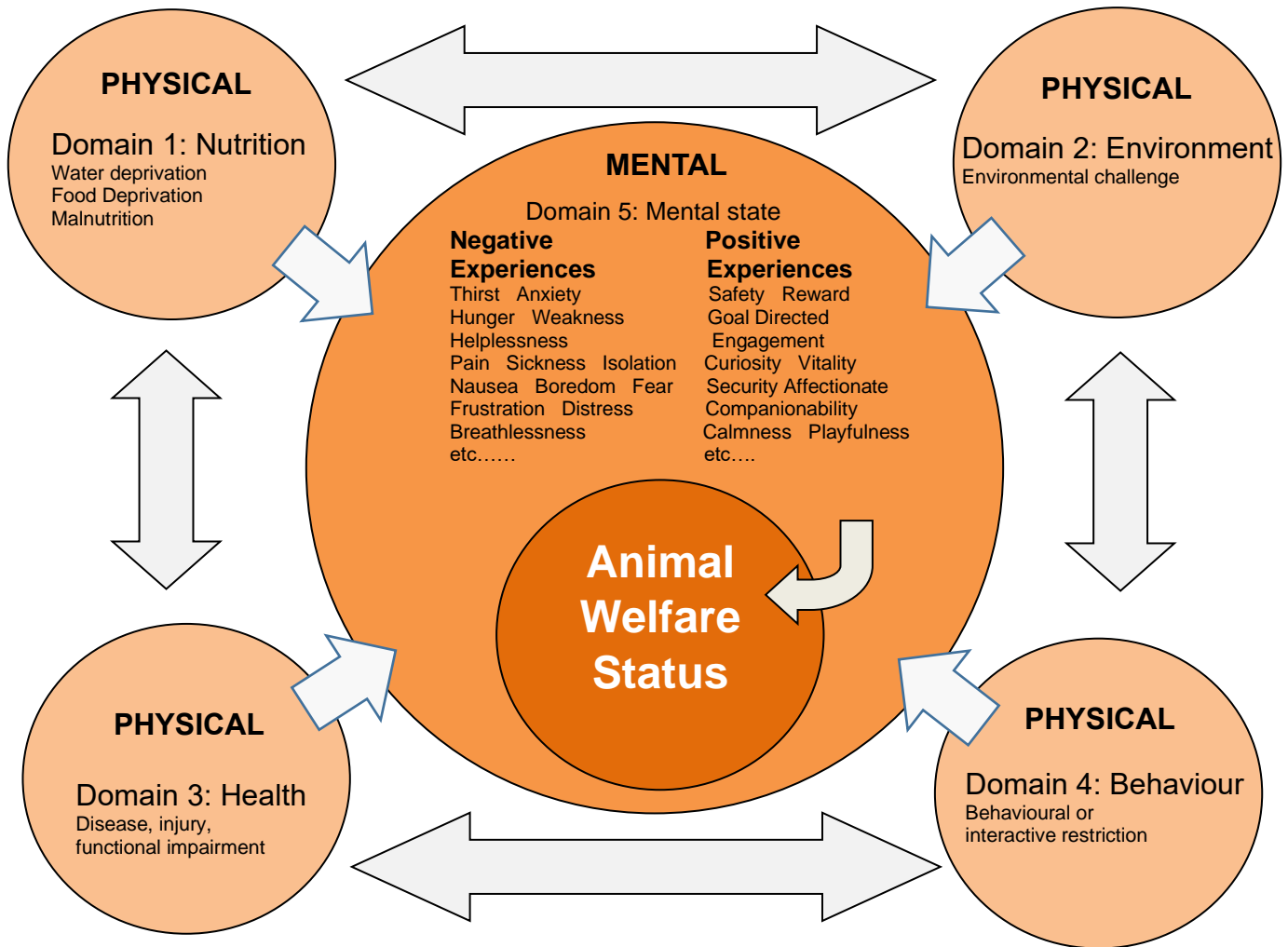


Figure 1: The Five Domains of potential welfare compromise which illustrate that the overall welfare status of an animal arises as a result of combined interactions between the animal's environment, its nutrition, its health status and its behavioural and mental status. (Interpreted and adapted from Mellor et al 2009 and Mellor, 2013).

Scope

This Standard is applicable to captive collections of wild animals held internationally, both public and private, in and ex-situ, where “**captivity**” is defined as a “*state wherein animals are kept in confinement by human beings, whereby the animals’ day-to-day needs, welfare and wellbeing are subject to the provision of human intervention and care.*”

In this regard, this Standard specifies the requirements where wild animal facilities seek to:

- a. demonstrate their ability to consistently provide compliance to the Wild Welfare Core Fundamental Standard of Practice for Captive Wild Animals and;
- b. to enhance animal welfare through effective application of the systems, including processes for continual improvement of the systems and the assurance of conformity to international norms and standards of captive wild animal welfare.

Use of the standard

This document specifies the primary welfare requirements for the maintenance of wild animals’ dependent upon the provision of daily care by humans and the format adopted relates to the concept of the ‘Five Domains’.

The statements listed under Section One; Prescriptive Core Standard of this document are the provisions of the Wild Welfare Standard and regarded as being mandatory in their requirements. They are fundamental to animal wellbeing and clarify how something should be undertaken or provided. When being audited against this Standard, a facility must be able to demonstrate its operational compliance with these statements.

Further supporting information describing the necessity for the listed requirements is provided under Section Two, Derivational Information. A glossary of terms used in the Standard is given in Appendix One.

SECTION ONE:
PRESCRIPTIVE CORE STANDARD

Management practices Wild Welfare considers unacceptable and which Wild Welfare recommends should cease in order to provide for good animal welfare include:

1. The feeding of live vertebrate animals to any animal;
2. Training techniques involving physical punishment, or training practices that compromise the animal's physical or behavioural health, development or psychological well-being;
3. Animal demonstrations that are detrimental to the physical or psychological well-being of the animals;
4. Confinement in barren enclosures that severely restrict physical movement and compromise psychological wellbeing;
5. Unregulated feeding of the animals by visitors; and
6. Mutilation procedures for cosmetic purposes or to make an animal safe for handling.

1. Domain 1: Nutrition

1. Fresh, clean drinking water of sufficient quantity shall be available to all animals at all times and in an appropriate manner, which also minimises the risk of contamination or freezing.
2. An appropriate good quality, nutritionally balanced diet, must be fed in sufficient quantities to keep the animal in good physiological health. The diet should be suitable for the animal's species, age, size, body condition, activity level, and reproductive and health status.
3. Food items must be sourced appropriately, be of adequate quality and must not be contaminated by herbicides, pesticides, lead shot, infectious disease agents or other chemicals or impurities that may adversely affect the animal.
4. Veterinary or other specialist advice in all aspects of animal nutrition shall be obtained and followed.
5. All diets must be documented and where appropriate monitored. Feeding records must be daily maintained and shall provide information on the diet, feeding frequency and food intake of individual animals.
6. Regular documented and dated reviews of all diets should take place.
7. Storage programmes, thawing procedures and food preparation processes must be designed to prevent loss of nutrients and bacterial contamination
8. Appropriate dietary supplements shall be used where the food or the environment does not provide the required essential nutritional elements.
9. Suitable feeding protocols should be in place in case hand-rearing becomes necessary.
10. Feeding methods shall be safe for animals and personnel.
11. Unregulated feeding of the animals by visitors shall not occur. Where the feeding of animals by visitors is considered appropriate by the Management Authority, only suitable and approved food should be used and the practice demonstrably managed to prevent over-feeding/inappropriate feeding by the public.

12. Food and drinking water must be provided in a manner that meets the animals' specific natural feeding behaviours, timings and motivations, prevents contamination, dominance or competition from other animals in social groups, and allows sufficient access to both for all individuals at all times.
13. Feeding methods must be balanced in relation to a routine feeding programme and as a method of environmental enrichment.
14. Care shall be taken that feeding does not reinforce unwanted behaviours.
15. The feeding of live vertebrate prey should not occur and can only be considered in terms of prevailing legislation, following documented veterinary input and/or due consideration by an in-house ethics committee.

1. 1 Food Hygiene

16. The preparation and storage of food must be carried out hygienically in a specific, separate area that is only used for this purpose.
17. Routine and appropriate procedures for the cleaning, disinfection and sanitation of food preparation equipment and facilities must be established. Standing water, rusty surfaces and organic debris must be avoided.
18. In the dedicated storage areas food must be protected from damp and contamination by pests (e.g. insects, birds, rodents).
19. Perishable foods shall be kept refrigerated, unless they are brought fresh and given to the animals on the same day, and the manufacturer's recommendations for shelf-life and storage conditions of commercial diets must be followed.
20. Cross contamination between foodstuffs must be avoided and care must be taken to ensure that different types of frozen foods are isolated.
21. Food and drink containers must not be used for any other purpose.
22. Toxic substances shall not be kept in food storage or food preparation areas.
23. Personnel shall keep strict standards of personal hygiene and must follow good food hygiene practice.
24. Food and drink, and feeding and drinking receptacles, whether inside an enclosure or not, will be placed in positions that minimize the risks of contamination from soiling by the animals themselves, or by wild birds, rodents or other pests.
25. Food, water and drinking receptacles, where used, shall be regularly cleaned and appropriately disinfected and shall not contain any chemicals or impurities that may adversely affect the animal.
26. Self-feeders, and automated watering systems where used, shall be inspected at least once daily to ensure that they are working effectively and are not contaminated. Any faults or defects must be rectified immediately and an effective backup system must be in place.
27. Uneaten food shall be regularly removed, as appropriate, to maintain hygiene and shall be disposed of appropriately.

2. Domain 2: Environment

2.1 Enclosure and Environmental Design

1. The requirements of the species must dictate the design and management of the enclosures and the enclosures must provide resources consistent with the needs of the species.
2. Only animals that can be comfortably and suitably housed throughout their lifetime at the institution should be brought into the collection and the number of animals kept must not be greater than the capacity of the institution.
3. Animal enclosures shall be designed to meet the fundamental requirements of the animal throughout its lifetime, and such provisions shall be made to:
 - a) Provide sufficient space (vertical as well as horizontal) to give opportunity for the animal to perform normal ranges and patterns of behaviours and exercise;
 - b) Offer protection from weather extremes;
 - c) Provide a comfortable area and suitable resting place;
 - d) Promote natural locomotion patterns
 - e) Offer appropriate environmental choices, stimulation and variability;
 - f) Offer security and adequately protect against fear;
 - g) Be safe and not cause the animal any harm;
 - h) Enable effective cleaning, maintenance and animal management;
4. Enclosure size, shape, layout and management must:
 - a) Protect individuals from persistent and unresolved disputes with other animals within the group, or between different species in mixed exhibits, which may result in harm;
 - b) Prevent individuals being overly dominated by other individuals within the group and provide enough opportunities for animals to avoid conflict or aggression from group mates;
 - c) Prevent the accumulation and spread of infectious agents and parasites;
 - d) Enable effective removal of waste and there must be good, safe drainage of waste water;
 - e) Provide opportunity for safe appropriate enclosure maintenance by personnel and husbandry practice, such as appropriate hygiene practices, provisioning of environmental enrichment and veterinary interventions.
5. Sufficient appropriate shelter and refuge areas must be provided for all animals within an enclosure, which are freely accessible at all times.
6. Refuges that allow animals to comfortably rest away from public view or group mates must be provided.
7. Sufficient pathways, including at varying heights where appropriate, must be provided to allow animals to comfortably move about the entire enclosure and/or escape more dominant animals,
8. Different species or incompatible individuals must not be housed within such a distance that it will cause distress.
9. Overcrowding within enclosures must be avoided and a review process documented, demonstrating appropriate species management for population control.
10. Social species shall be normally kept in compatible social groups. The group must consist of species appropriate number, age and sex ratio of animals.
11. Individuals of such social groups must not be housed in isolation, except where it is necessary for veterinary purposes, or it is justified for other reasons (e.g. imminent birthing) and where such isolation will not jeopardise the individual's welfare. In situations where social animals are housed temporarily away from the group, it shall be in suitable accommodation and only for such a time that will allow their uncomplicated reintroduction back to their social group.

12. The temperature, ventilation, lighting (both lighting levels and spectral distribution), humidity and noise levels of enclosures shall always be suitable for the comfort and wellbeing of the species.
13. As appropriate, suitable equipment for measuring environmental variables such as humidity and temperature shall be available and must be used correctly.
14. Where life support systems and environmental quality are dependent on external utilities (for example, water or electricity), adequate provisions must exist for their constant function, with adequate backup facilities in case of failure.
15. All external services and the backup system must be inspected daily and they must be suitably serviced and maintained.
16. Proper standards of hygiene in enclosures, facilities and treatment rooms shall be maintained. In particular,
 - a) Consideration must be given to the management, monitoring and appropriate cleaning of enclosures and the equipment within them, to reduce the risk of potential harm and/or disease;
 - b) Suitable cleaning agents must be readily available, and the appropriate and safe means to apply them;
 - c) Personnel must be appropriately trained in the correct usage of suitable cleaning agents and disinfection protocols;
 - d) Personnel must use protective clothing and equipment as appropriate and in accordance with the institution's hygiene procedures;
 - e) Advice from a veterinarian or other competent person must be obtained and followed regarding the routine cleaning requirements of enclosures or other areas;
 - f) If an infectious disease is identified in any animal, appropriate biosecurity protocols must be immediately implemented;
 - g) Consideration should be given to cleaning practises for species that scent mark.
17. Enclosure and barrier design, construction and maintenance must be such to fully ensure the safety of the animals, personnel and visitors. In particular:
 - a) Barriers must be positioned to allow a reasonable flight/safety distance between visitors and contact with the enclosure;
 - b) If a fault occurs in any part of a barrier or an enclosure that may result in harm, it must be promptly suitably repaired or replaced, or the animal must be relocated to other suitable accommodation;
 - c) Enclosure accommodation and fittings should be well maintained and inspected regularly to avoid potential injury to the animals;
 - d) Water-filled and dry moats used for the containment of animals must provide a means of escape back into the enclosure should animals fall into them;
 - e) All natural materials (for example, plants and their products, such as seeds or fruit) and non-natural materials (for example, paint, chemicals, rubber, plastics, treated substrates and treated water) used within the enclosures must be non-toxic to the species held;
 - f) The enclosure construction and design must be safe for the animal, predator proof and must consider the animals' natural behaviours so that animals cannot escape and so that animals are deterred from trying to escape. Trees overhanging a perimeter fence should also be regularly inspected and trimmed to prevent any damage occurring to the fence through which an animal may escape;
 - g) The perimeter boundary, including all access points, must be designed, constructed and maintained to discourage unauthorised entry and act to assist with the effective confinement of all animals within the institution.
18. Where appropriate, enclosure design shall provide adequate protection from the effects of natural disasters, such as flooding or fire.
19. Attention shall be given to acoustics and possible sources of loud noises in order to avoid stress and anxiety in animals caused by excessive, repetitive or high decibel-level noise.

20. Disaster plans for implementation in the event of a natural disaster should be produced by the Management Authority.
21. Animals destined for rehabilitation must not be used for public exhibition.
22. Animals in aquatic environments must be provided with appropriate and documented environmental parameters.
 - a) Environmental quality control records must include:
 - b) Test parameters and standards for water quality (including water cultures for relevant pathogens and organisms);
 - c) Test parameters and standards for water chemistry, (including water quality log)
 - d) Facility maintenance log,
 - e) Filtration operation log.
23. Pool water must be monitored daily for basic chemical parameters as appropriate for closed or open circulation systems. In particular,
 - a. Water must be tested often enough to ensure maintenance of a pH value of not less than 7.6 or more than 8.3;
 - b. Water must be tested often enough to ensure maintenance of appropriate oxidation levels that do not exceed the specification requirements of the particular animal;
 - c. Water must be free of residual dissolved ozone;
 - d. Salinity of water must be maintained to suit the requirements of the species where cetaceans are held. If other marine species are held, appropriate measures must be taken if the animals are not held in salt water.
 - e. Measures must be taken to ensure that toxic levels of ammonia, nitrates/ nitrites are not reached.
24. Pathogenic growth in pool water must be limited through a programme of water turnover rate, skimming, disinfection, pathogen monitoring and general exhibit maintenance.
25. Indoor aquatic facilities must be ventilated by natural or artificial means to provide a flow of fresh air that minimizes the accumulation noxious fumes and odours. An appropriate vertical air space of at least two metres must be maintained in all primary enclosures, including pools of water.
26. Holding enclosures or pools that allow separation of groups of animals for treatments, feeding or the introduction of new animals should be provided and these should be designed to be of sufficient size to enable the animals to exercise appropriately without hindrance
27. Specific water quality requirements for Aquaria:
 - a) Species specific water quality and environmental requirements must be documented, available and on file, as well as realistically achievable before such species are considered for display/housing.
 - b) Water quality monitoring must be carried out as routine. For new exhibits or ones that have undergone major servicing, regular monitoring must include temperature, salinity, (as mg/kg or as specific gravity (SG) in salt water tanks), pH, total ammonia and nitrite/nitrate, and dissolved oxygen. This must be measured daily at first and then at least twice weekly after stabilization. After a one-month period, if a tank is stable, tests can be carried weekly;
 - c) At all times, there must be provision of sufficient water treatment equipment to ensure maintenance of water; and quality within set parameters to meet species-specific requirements.
 - d) Waste water generated must in no way negatively impact on receiving natural water bodies. Where negative impact is foreseen, waste water needs to be pre-treated to obtain environmentally acceptable standards before discharge, or alternatively discharged into the sewer system with prior arrangement/permission from the local authorities.

2.2 Transportation and Movement of Animals

28. The transportation and movement of animals should conform to all applicable regional, national and international legislation, norms, standards and guidelines.
29. The conditions and facilities as required by IATA for the transportation of animals internationally shall be used as minimum guidelines.
30. All necessary travel documentation, health certificates and permits must be complete and readily available for inspection, as appropriate, to avoid any delays in the transportation.
31. A transport plan must be in place. The transport plan must include documented contingency plans to counter the effects of unplanned delays in transport, especially where such delays might subject the animals to excessive heat, cold, thirst or hunger. Emergency protocols to safeguard animal welfare during transportation should also be produced
32. The transport of any animal has the potential to cause that animal stress. If the stress is severe, appropriate steps should be taken (such as the use of tranquillizers) to reduce the level of stress as much as possible.
33. All animals must be appropriately inspected by a veterinarian prior to transportation to ensure that all animals are fit to travel.
34. The restraint and handling techniques used must be appropriate for the species, and safe for both the animal and the handler.
35. A sufficient number of competent and experienced personnel shall be involved at every stage of animal transportation to ensure the security, health and welfare of the animals during transport.
36. Transport accommodation and facilities shall:
 - a. Be free of projections, fittings or structures that might injure the animal
 - b. Be secure and appropriate in design and structure for the species of animal, age and number of animals being transported
 - c. Have suitable ventilation of appropriate airflow
 - d. Provide species appropriate environmental conditions
 - e. Provide flooring that, where appropriate, gives secure footing for the animals
 - f. As appropriate to the species and the circumstances, and in compliance with national and international legislation regarding imports, suitable bedding or absorbent material should be provided on transport cage floors.
37. Where groups of naturally social animals are transported, the group must be of compatible individuals and the transport accommodation must be of sufficient size. Animals of very different ages, weights or sizes shall not be mixed together for transport.
38. Animals shall only be kept confined in their transport containers whilst they are in transit or during the preparation period immediately prior to transit.
39. Animal records shall accompany all animal transfers. As a minimum requirement, the records shall provide the recipient with sufficient information to adequately accommodate, feed and treat (if applicable) any animal being transferred.
40. The outside of each individual container accommodating animals should have appropriate information about the animals being transported, including the species, the number of individuals, any special handling requirements, whether the animal is categorised as dangerous, and appropriate feeding and watering information. Contact details for both the sending and the receiving institution should be available.

2.3 Animal Transactions

41. Management must consider the necessity of all animal transactions. Where possible, alternative options should be studied if there is any possibility that animal welfare may be compromised
42. A disease risk analysis must be undertaken by the veterinarian of the institution acquiring an animal.
43. The institution must ensure that the animals leaving the collection are only passed to institutions with the appropriate facilities, resources and expertise to achieve comparable welfare standards. The institution specifically should not dispose of animals to any laboratory conducting invasive research or testing of any kind, or to any hunting concern.
44. Animal acquisition from the wild should only be considered following appropriate ethical assessments in terms of conservation benefit, positive individual animal welfare outcomes and the undertaking of a thorough individual animal welfare benefit/cost analysis.
45. A regular review of all animal acquisitions to and transactions from the institution should be undertaken to assess and ensure appropriate welfare requirements compliance in all transactions.

3. Domain 3: Health

3.1 Animal Health and Veterinary Care

1. The Institution shall have a documented working arrangement with a veterinarian with appropriate expertise in the veterinary care of all of the species held at the Institution
2. The level of veterinary facilities and care must be consistent with the overall welfare needs of the animals in the collection.
3. Proactive veterinary care must be clearly evident, including:
 - a) Documented routine clinical examinations of all the animals in the Institution;
 - b) Documented treatment and preventative medication protocols of the Institution;
 - c) Health monitoring of animals (e.g. disease screening, regular blood, urine or faecal examinations, endoparasite monitoring, etc.), as indicated;
 - d) Safe and proper collection, preparation, handling and appropriate forwarding of diagnostic and other samples;
 - e) Ensuring that post-mortem examinations and any necessary laboratory investigations are carried out, including the submission of suitable samples for pathological analysis, whenever possible;
 - f) Supervision of quarantine premises and other tasks required by law, or as part of good zoo veterinary practice;
 - g) Nutrition and the development of diets;
 - h) The establishment of written procedures to be followed in the event of the accidental use of dangerous drugs; and
 - i) Secure management of all medications, including appropriate documentation, control, storage, issuing, and destruction and disposal of such veterinary drugs in accordance with manufacturer's guidance and recommendations, and relevant local legislation.
4. All animals must be inspected by personnel at least once daily, except in situations such as when:
 - a) Daily inspection may negatively affect the animal's welfare; or
 - b) Disturbance during the particular stage of the breeding cycle may be detrimental to animal welfare, (e.g. presence of new-born young or egg incubation); or

- c) There has been a change in the environment, the introduction of new individuals or where there has been a change in social group structure, which may necessitate more frequent inspections.
5. Animal care staff must be appropriately trained and competent in observing signs of good animal health and welfare. A regular review of animal care staff's ability to observe abnormalities in health or behaviour should be undertaken and suitable opportunities provided for staff for training to further develop their abilities and skills.
 6. Immediate appropriate action must be taken if an animal is injured or unwell, or if the animals are showing behaviours that may suggest poor welfare. Any signs of injury, poor health or abnormal behaviour shall be immediately reported and a veterinarian promptly consulted as necessary.
 7. A suitably experienced senior member of personnel must be available at all times to take decisions regarding the euthanasia of animals. There must be provision for an effective method of euthanasia and standard protocols must be documented (see **Euthanasia 3.3**).
 8. Mutilation procedures on any animal for cosmetic or behavioural purposes or to change the appearance of the animal should not be undertaken.
 9. Curative and preventive veterinary medicine must be provided and appropriately documented.
 10. Veterinary records must document clinical observations, laboratory procedures undertaken, the results of post-mortem examinations, details and dates of any treatment given (dosages, route and frequency of all medications used) and whether an individual or the whole group was medicated.
 11. There must be a regular review by the relevant veterinary and curatorial personnel, of clinical, behavioural and pathological records and mortality. Husbandry and preventive veterinary practices must be reviewed as necessary.
 12. Clinical waste and refuse must be regularly removed and disposed of in a manner approved by the local public authority.
 13. All animal carcasses must be handled appropriately to minimise the risk of exposure of other animals at the institution to potentially infectious diseases.
 14. A safe and effective pest control programme must be established and, where necessary, the deterrence of predators must be carried out.
 15. Where casualty wild animals are rehabilitated, the risk of introducing novel infectious diseases to free-living wild animals and animals of other species following the recovered casualty's release must be minimised by appropriate veterinary checks prior to release.

3.2 Veterinary Facilities

16. Facilities must be adequately equipped for the practical veterinary needs of the animal collection. To this end a dedicated treatment room shall be provided on site be available at all times for the use for the routine examination and treatment of animals. The room should be of sufficient size, have washable floor and wall surfaces, and be hygienically maintained with adequate drainage. The minimum facilities shall include:
 - a) Examination table;
 - b) Hot and cold running water;
 - c) Safe and secure storage of all pharmaceuticals;
 - d) Appropriate ambient temperature;
 - e) Suitable ventilation;
 - f) Good lighting; and

g) Electrical power

17. All pharmaceuticals and other veterinary products shall be kept appropriately secure with only authorised personnel having access. The veterinarian must regularly remove and appropriately dispose of expired drugs.
18. Complete, accurate records of drug stock, usage and disposal must be kept.
19. All used, unwanted or contaminated veterinary material or equipment must be safely and appropriately disposed of in accordance with accepted international practice and in compliance with existing legislation.
20. Facilities for the safe and appropriate handling and disposal of clinical waste must be available.
21. Specific accommodation must be available for the isolation and examination of new animal arrivals, and for the care of sick or injured animals.
22. Suitable facilities and equipment for capture, restraining, treating, and, if necessary, for the administration of general anaesthesia, for euthanasia and for the aftercare of all of the species kept at the institution shall be available.
23. There must be strict hygiene practices and biosecurity where sick, injured, isolated or quarantined animals are kept. Protective clothing, equipment and utensils used by personnel only in the isolation area must be appropriately cleaned and stored in that area only.
24. Specific cold storage or freezer facilities should be available for the appropriate storage of animal carcasses that cannot undergo prompt post mortem examination

3.3 Euthanasia

25. The Institution must have a documented ethical review process particularly in situations where the use of animals may be in conflict with the best welfare interests of the animal(s). The process must be effective in relation to allowing independent critical review and assessment of ethical issues and it shall not be perceived as merely an agent of management and work in an open and transparent manner whilst recognizing possible requirements for confidentiality.
26. There must be a written institution policy and standard procedure for the euthanasia of animals, which is regularly reviewed. These must show that:
 - a) Veterinary advice and guidance regarding euthanasia and acceptable emergency methods of euthanasia has been obtained;
 - b) For all of the species kept at the institution, there are suitable facilities and equipment available for euthanasia, including for the emergency euthanasia of casualties. Such facilities and equipment must be securely kept and well maintained;
 - c) A competent, suitably trained senior staff member, who has access to the necessary facilities and equipment, is contactable and available at all times.
27. Euthanasia must be carried out in compliance with regional and national legislation and in an acceptable way.
28. Euthanasia must be undertaken in a distress free manner that involves a rapid and painless death.
29. Other animals should not be present when an individual animal is to be euthanized.
30. All staff involved with the euthanasia of animals must be fully aware of acceptable euthanasia methods and must be appropriately trained and experienced in those methods.

31. Where the humane killing of animals (e.g. mice, rats, rabbits and birds) is carried out to feed zoo animals, it must be carried out ethically and according to acceptable and recognised welfare standards.

4. Domain 4: Behaviour

4.1 Environmental Enrichment and Stimulation

1. Enclosure design must provide:
 - a) **Security:** Areas for seclusion and refuge (e.g., a den, an elevated resting place, sufficient suitable enclosure space, a burrow, or nests with appropriate nesting materials) are important for animals to escape from public viewing, or from the attention of conspecifics. Naturally social animals can also feel secure in the presence of compatible conspecifics. Refuges must be of sufficient number and size to accommodate all individuals at one time.
 - b) **Complexity:** a suitably complex environment to encourage normal behaviours and increase exercise, behavioural diversity and stimulation must be provided. For example, some birds need access to sufficient suitable perches and enough space for flight. The animals must be able to display their natural response to the photoperiod.
 - c) **Challenge:** Environmental choices must be provided. Enrichment programmes shall be used to encourage decision-making and allow animals to choose their preferred environmental conditions, exercise problem solving abilities, and giving them more control over their environment and daily lives.
 - d) **Novelty:** a safe, variable environment shall be offered (e.g. rotation of enclosure furniture, enrichment tools, husbandry management regimes, etc.), but the balance between environmental change and the husbandry routine must be appropriate to avoid stress.
2. An appropriate species-specific environmental enrichment programme must be developed and put in place for all species kept at the institution. It must be demonstrably researched and planned.
3. For every animal, specific requirements shall be considered in relation to any possible:
 - a) Species-specific physiological needs;
 - b) Particular social requirements; and
 - c) Behavioural developments over an animal's life span and the impact and demand these would have on the animal's environment.
4. Once in place, the Enrichment Programme shall be suitably documented, and assessed on a regular basis. Improvements or changes in the programmes shall be made where necessary.

4.2 Animal Training

1. Training objectives and goals must never compromise an animal's physical well-being (e.g. performing behaviours that may cause undue stress on particular body parts or joints).
2. An animal's behaviour should not be modified by techniques that rely on causing the animal any pain, injury, fear, or distress.
3. Training methods must primarily rely upon positive reinforcement techniques.

4. Negative reinforcement and positive punishment techniques should never form the basis of routine training and must be avoided. The deliberate infliction of injury or pain or the use of fear-provoking stimuli is unacceptable and should not be practised.
5. Training areas, equipment and facilities should be appropriate and well maintained and where necessary, appropriate barriers used.
6. Training techniques and objectives must be appropriate for the species and the individual animal, taking into account the differences in physical and mental capabilities that may occur between individual animals.
7. The duration of training sessions must be tailored to the individual animal's responses and condition and appropriately recorded.
8. Animals should appear to be relaxed and move naturally during training sessions.
9. Personnel involved in animal training must be experienced and competent in carrying out acceptable animal training techniques and should be regularly assessed in terms of their competence by the institution's Management Authority.
10. Training techniques must be demonstrably researched and all training methods and their aims shall be appropriately documented and subject to regular documented review.

4.3 Animal Contact

11. Only contact which is neutral or of positive benefit to the animal is acceptable. The wellbeing of the animals must be regularly assessed.
12. All situations where the public and animals are in direct physical contact should be subject to regular, documented risk assessment.
13. A documented policy statement on the use of animals for contact with the public should be produced.
14. Animals involved in contact situations must have received appropriate training, be habituated to such interactions and must always be supervised and under the direct control of an experienced, competent animal keeper. Contact situations must consider and be appropriate for the individual animal's physical and mental capability.
15. Abnormal demands must not be made on animals (e.g. continuous petting) and animals must not be made to carry out displays that compromise their wellbeing.
16. Contact experiences and associated noise must not be distressing for the animals and suitable measures must be in place to prevent animals from being provoked or worried by visitors.
17. Animal contact situations must always be strictly controlled and supervised by authorised personnel. Suitably experienced and competent personnel with appropriate training and knowledge must be present at all times in situations where there is animal contact.
18. If injury, ill health or abnormal behaviours are observed, they must be immediately reported and the animal must not be involved in animal contact, or the contact session immediately stopped.

5. Domain 5: Mental State

1. Management and husbandry practices must demonstrably minimise unpleasant, negative affective states and experiences (e.g. pain, fear, etc.), whilst promoting and encouraging positive emotions and experiences (e.g., happiness, calmness, etc.) for the animals.
2. Natural behaviours shall be encouraged. Important natural behavioural considerations for each species include:
 - a) Foraging and feeding behaviour;
 - b) Excretory and elimination behaviour;
 - c) Agonistic and aggression behaviour;
 - d) Sexual and reproductive behaviour;
 - e) Relaxation behaviour;
 - f) Comfort-seeking behaviour;
 - g) Investigatory or exploratory behaviour;
 - h) Mimicry and group behaviour;
 - i) Care-seeking behaviour;
 - j) Care-giving behaviour; and
 - k) Play behaviour;
 - l) Locomotion patterns
3. Enclosures must provide suitable sensory stimulation that is appropriate for the species within a suitably complex, variable and mentally challenging environment that allows for normal exercise and behaviour expression.
4. Animal handling and restraint, when required, must be carried out with the necessary and appropriate care and consideration.
5. Differing food options must be regularly provided in a manner that allows for individual preferences and provides the opportunity for appropriate foraging behaviours.
6. Temperature gradients across the enclosure environment must be provided, offering animals choice and control over where they reside.
7. The enclosure environment must encourage a range of behaviours that the animals can choose to carry out at any given time.
8. Indoor/outdoor access where appropriate to species/enclosure should be provided at all times where possible.

6. Miscellaneous

6.1 Governance

1. Each institution/facility shall have a documented policy commitment to manage animal welfare appropriately.
2. All animal care staff members should understand the organisation's commitment to animal welfare and be demonstrably knowledgeable with the procedures to implement this commitment.

6.2 Record Keeping

3. Records must be kept and maintained of all individually recognisable animals and groups of animals in the institution.
4. Where possible, animals must be suitably individually identified by a marking means that causes the animal no long-term harm and does not adversely affect natural behaviour.

5. Records must be kept by a method that enables quick and easy access to the information and which is secure. There shall be a secure, long-term archive system in place.
6. At a minimum, animal records must provide the following information:
 - a) Identification to specific level and scientific name;
 - b) Whether captive-born or wild born. Identification of parents, where known, and previous locations the animal has been kept at, if any, must also be recorded;
 - c) Dates and details of entry into the collection and source, and disposal from the collection and if applicable, to whom;
 - d) Date, or estimated date of birth or hatching;
 - e) Sex (where known);
 - f) Any distinctive markings, including tattoos, freeze-brands, tags, rings or microchips;
 - g) Health records and clinical data, including details and dates of any treatment given and whether an individual or the whole group was medicated;
 - h) Behavioural and life history data;
 - i) Breeding records of each animal and of the group;
 - j) Date of death and results of any post-mortem examination and laboratory investigations;
 - k) Food, daily food intake and diets;
 - l) Details of any escapes, including damage or injury caused to the animal, or to persons or property, reason for escape and action taken to prevent reoccurrence of such an event; and
 - m) Additional species-specific information may need to be kept in accordance with applicable local legislation.
7. Accurate records of specific environmental parameters, as appropriate for the species, must be kept.

6.3 Escapes

1. There must be a written emergency protocol for managing animal escapes, or if unauthorised persons enter an enclosure, or have deliberate or accidental interaction with an animal through an unauthorised practice, detailing the procedures that should be immediately carried out in such an event.
2. These procedures must be understood by all staff and periodically practised, assessed and documented in an appropriate manner.
3. This protocol must comply with all relevant local and national legislation, be available to all members of personnel and be regularly reviewed and up-dated, as appropriate.
4. Every attempt must be made to recover all escaped animals, live or dead.
5. There shall be a written protocol for the possible destruction of the escapee, which shall ensure that a capable and experienced, senior member of staff is always available to make decisions regarding escaped animals.
6. Documented emergency protocols covering fire, extreme weather, natural disasters, and other such catastrophes must be developed in relation to managing an animal escape and implemented as appropriate, and suitable, effective contingency plans must be produced.
7. A record of all escapes shall be kept.

6.4 Personnel

1. The institution shall appoint one full-time Chief Executive Officer in charge of the facility. The said officer shall be delegated adequate administrative and financial powers.
2. The number of personnel and their levels of expertise shall be sufficient to attend to all the needs of the animals under their care at all time.

3. The Institution shall ensure that all personnel who handle animals and who make professional judgements in this regard are competent and suitably experienced. Where necessary, they should be academically qualified and up-to-date with current knowledge in their field.
4. Animal-care personnel should regularly meet to discuss husbandry and welfare issues and/or concerns.
5. The Institution shall make provision for appropriate staff training and further development.

SECTION TWO:

DERIVATIONAL INFORMATION

Husbandry and Welfare

A positive mental state can occur when the animal's physical needs including nutritional, behavioural, health and environmental needs (i.e. the four physical domains) are met, resulting in a positive state of animal welfare. Therefore, safeguarding the welfare of animals is dependent upon adequately providing for an animal's essential needs, including the appropriate provision of food and water, the provision of an appropriate environment with suitable shelter and accommodation, the prevention or rapid diagnosis and treatment of injury or ill health, the ability to display normal patterns of behaviour and movement, and the minimisation of negative experiences, as depicted by the Five Domains of Potential Welfare Compromise [8], throughout the animal's lifetime. Furthermore, good animal husbandry depends upon reliable information and knowledge about animal needs, physiological, behavioural and psychological, which will vary between different species, in order to maintain good animal health and welfare; there is a critical need to know and understand the natural biology of each animal species and their fundamental physiological requirements during all stages of their life, growth and development, as well as their natural behaviours, so as to prevent the occurrence of conditions that may be detrimental to animal welfare.

Prior to the acquisition of new species, a management review must be undertaken to thoroughly assess the suitability of the institution's accommodation for each species and to consider the institution's ability to provide the fundamental and appropriate environments necessary to meet all of the specific species' physiological, behavioural and psychological needs.

Physical Components

The four physical domains emphasize how compromises in an animal's nutrition, environment, health and behaviour may impact upon an animal's biological function and hence physical wellbeing. However, it is important to highlight that a single domain should not be viewed independently of the other four domains, since each domain may impact upon one another and it is the combined effects of the four physical domains that influence the psychological wellbeing or mental state of the animal (fifth domain) which determine the overall welfare status.

When regarding the welfare of captive wild animals, it is important to address an animal's fundamental nutritional, environmental, health, behavioural and psychological requirements, thereby working to promote positive experiences, together with avoiding or minimising negative experiences [6] [12] [8]; good welfare can be achieved by meeting the physical and psychological needs of an animal throughout its entire lifetime.

1. Domain 1: Nutrition

A critical basic requirement of all animals to protect their health and welfare is the need for appropriate food and water. An appropriate, nutritionally balanced diet necessary to maintain good health and vitality and which meets their biological requirements must be provided daily, along with appropriate access to suitable water [13]. Insufficient or inappropriate food may lead to hunger and predispose to disease and ill health, compromising welfare. Thirst is a motivation that can occur for a variety of different reasons, including ill health (pathological thirst) or lack of access to water, and it can be a form of suffering [14]. Welfare compromise can result following water deprivation, food deprivation, or malnutrition. Food deprivation, or dehydration from fluid deprivation, can result in emotional states such as hunger, thirst, or exhaustion, thereby causing negative experiences and an adverse welfare state.

Yet, challenges in meeting the needs of specific captive wild animals can arise due to lack of detailed knowledge of their species-specific biology including information about their essential nutritional requirements [10]. The nutritional requirements of animals may not only vary between different species, but also between individuals within a species, taking into account age, physical activity, sex, size and body condition, as well as physiological, reproductive and overall health status. All of these factors should be considered, but particularly the body condition of the animals, when determining the level of feeding; obesity can adversely affect an animal's health, hence overfeeding should be avoided. The social structures of individual groups of animals must also be considered in relation to the manner of food and drinking water presentation, ensuring that all individuals can sufficiently access food and water; various feeding sites may be necessary to avoid potential problems associated with competition from other individuals within the group [15] [16]. To maintain good health and welfare, dietary supplementation must be carried out in circumstances where the environment or diet does not provide the required essential nutritional elements. Supplements must be stored and handled appropriately.

Encouraging the management of animals to promote positive psychological states, as well as good physical health, is fundamental since these components have interrelated effects on the overall welfare status of an individual animal. Therefore, providing appropriate food to meet the biological needs of the animal, as well as presenting it in a way that satisfies the animal's species-specific natural feeding behavioural requirements and motivations, is also an important component of zoo animal nutrition management. Where possible, food and water shall be offered to each species in a way that stimulates their natural behaviour patterns, for instance arboreal (tree-living) species should be presented food off the ground.

Furthermore, food related enrichment strategies form an important part of enrichment programs. In the wild, animals may spend a large proportion of their activity period foraging for and processing food, with comparatively little time actually consuming the food. Species have evolved specific skills for this purpose which may be expressed behaviours that are necessary for the health and well-being of the animal. Also, young animals may learn foraging behaviour from the adults [16]. Therefore, appropriate food must be presented in a manner to encourage natural feeding behaviours, as well as increased activity. For example, scatter feeds can encourage natural foraging activities in a number of different species, although the use of scatter feeding as a positive activity is dependent upon the species and the individuals concerned as this practice can encourage dominance behaviours. Notwithstanding encouraging increased activity, may also help to reduce the risk of obesity amongst captive wild animal species.

The feeding of live vertebrate prey is considered inappropriate [17] [16]. Facilities must strictly adhere to any existing local legislation regarding this matter. On the contrary, the appropriate provision of live insects, such as crickets, as a protein source is important both nutritionally and to encourage natural feeding behaviours in some species (e.g. lizards).

To protect animal health, visitors must not be permitted to provide food unless closely regulated and monitored by qualified staff. Animal food should not be sold to visitors to discourage public feeding of the animals. Where visitor feeding is allowed, appropriate species must be selected (e.g. domestic

farm animals housed in contact paddocks within zoological institutions) and approved by the Management Authority. Only suitable food provided by the institution should be used, and the feeding controlled to prevent over-feeding [17] [15]. Such permitted animal feeding must be strictly monitored and regulated, with the food supplied by the zoo as a part of the animal's regular, daily allowance. Visitor feeding must be regularly reviewed by the institution's ethics and welfare committee and Management Authority.

1.1 Food Hygiene

Strict hygiene standards and practices must be observed when preparing and storing food items, and rigorous personnel hygiene standards must be practiced when preparing and distributing food to avoid disease transmission both from humans to animals and *vice versa*. Food must also be stored appropriately and adequately protected from damp, deterioration and contamination by pests to help protect the physical health and hence welfare of the animals. Where commercial diets are used, the manufacturer's recommendations for shelf-life and storage conditions must be followed in order to ensure the quality and nutritional value of the diet

2. Domain 2: Environment

Confinement in a captive environment imposes a number of restrictions on the animals, and if the captive environment is inappropriate for the species, it cannot provide for the individual animal's basic biological, behavioural and psychological needs and requirements, and poor welfare will result.

2.1 Enclosure and Environmental Design

Husbandry systems must be designed to provide species-specific appropriate enclosures and environments with a sufficient amount and complexity of space, proper facilities, furnishings appropriate social interactions, and they must give the animals the opportunity to carry out their full range of normal behaviours and movements, especially those behaviours with a strong internal motivation and hence 'need' for expression [13]. For example, some birds require perches and sufficient suitable space to fly, whilst arboreal animals need accommodation to allow their fundamental desire to climb and move about high above the ground to be fulfilled. Therefore, a good knowledge and understanding of different species' biology, environmental requirements, natural habitats and normal behaviours is essential to adequately meet all of the physical, psychological and social needs and requirements of animals' throughout their lifetime, whilst they are in captivity, in order to promote good animal welfare. A barren, restricted environment imposes an unrewarding lifestyle and may cause abnormalities in an animal's physical health and development, and have detrimental behavioural and psychological effects [18]). Hence, the provision of appropriate environmental enrichment in captive animal husbandry and management to increase behavioural diversity and promote positive psychological experiences throughout the animal's life, also plays a very important role in ensuring high welfare standards and in protecting animal well-being.

2.2 General design

The design of animal accommodation must primarily address the needs and requirements of the specific species to be accommodated, which, along with high standards of husbandry and management, is critical to adequately safeguard animal welfare; a positive psychological state can occur when the animal's physical needs (i.e. the four physical domains) are met, resulting in a positive state of welfare. Enclosures must be designed for comfort and security and must be well maintained to protect animals from injury. Veterinary and Behavioural Management [72] consultation on enclosure design may be helpful to ensure that materials safe for the animals are used and that the enclosure structure and facilities will not only provide an appropriate environment for the species to be accommodated, but that they will also be conducive for carrying out any necessary veterinary and other management procedures safely and securely. The shape and design of all aspects of an enclosure should also prevent subordinates from becoming trapped by more dominant individuals in corners, shelter areas or dead ends and should provide for a suitable refuge area where the animals can rest appropriately, away from public view and, if necessary, away from their group mates [16]. Circular enclosures can prevent vulnerable individuals from becoming trapped in corners [16]. Pathways, both terrestrial and arboreal, should be in sufficient quantity and design to accommodate safe movement of animals within the group, and situated such that subordinate animals have escape opportunities. Where appropriate, enclosure

design should also enable reasonable precautions and protection from the effects of natural disasters; areas of accessible high ground should be included in regions prone to flooding and, in regions where it is appropriate, adequate fire breaks should be maintained [19].

2.3 Safety

In addition to the safety of the animals, the safety of the staff and visitors is important in the overall design of animal enclosures. All barriers must be appropriate for the species accommodated within the enclosure, taking into consideration the natural physical capabilities and behaviours of the animal species, providing safety and security for the animals. For example, for enclosures containing animals that dig, fences should be buried an appropriate depth into the ground. Enclosure perimeters should be designed and built to be strong and secure, they should be free from damage or defects, and be maintained in good condition. Trees within or near animal enclosures must be regularly inspected and appropriate action taken, as necessary, to prevent and deter animals from escaping. Moats, both wet and dry, must be wide enough to prevent animals crossing them, but must also be designed to offer a quick and easy exit should any animal fall into them. Dry moats should contain a suitable soft substrate to prevent injury and harm to any animal that falls into them. For some species, dry moats are considered too dangerous and should be avoided or replaced with a gentler slope down to a wall. Glass and transparent barriers enable the visitors to view the animals, but can also have a negative effect on animal welfare by reducing the air flow and ventilation to the enclosure, resulting in poor thermal and humidity environmental control. Enclosure doors and gates should be locked, have a double-door entry system and must open inwards to prevent an animal escape. Enclosures housing potentially dangerous captive wild animals must have an appropriate and secure containment or shift area, with a sliding door operable from outside of the enclosure. Animals can be safely kept here during routine husbandry, maintenance veterinary procedures, or emergency situations. A perimeter fence surrounding the institution's enclosures and grounds will improve site security; a perimeter fence may not only help to prevent unauthorised personnel entry, it may help to discourage feral animals to enter thereby improving bio-security, and in the event of an animal escape, a perimeter fence may help confine escaped animals within the institution's grounds.

2.4 Flooring

The type of flooring and substrate provided in animal enclosures has an important impact upon animal welfare. Flooring surfaces inappropriate for the species can result in discomfort and physical harm. Hard surfaces such as concrete can be cold in cool weather and hot in warm weather and can cause difficulties in thermal regulation for those species housed on them. Hard concrete surfaces also do not allow for the expression of natural behaviours such as foraging or digging, and may cause undue stress and pressure on joints, exacerbating existing conditions, causing pain and discomfort and contribute to some degenerative joint and bone disease. Wire floors can cause pain and discomfort to the feet of animals and make the provision of appropriate bedding and suitable regulation of the thermal environment difficult. The characteristics of the substrate used should be such that it helps improve the welfare state of an animal. For example, deep sand floors in elephant houses provide the elephants with opportunities to dust bathe indoors and forage, whilst also offering a comfortable surface for resting [16].

2.5 Size

Adequate space (vertical as well as horizontal space) should be provided for all animals to allow for the performance of normal behaviours and movement, whilst providing the animals with a sense of security, thus promoting positive behavioural and psychological health. Enclosures should be the appropriate size and shape for the number and type of animals. This is particularly important when housing social groups; enclosures allow for the escape of individuals from any conflict or aggression shown to them by conspecifics [20]. The size and design of the enclosures must take into account the individual species' needs and behavioural biology, including feeding strategies, home range/territory size, movement patterns, seasonal needs, etc. For example, carnivore enclosures must be tailor-designed for the species to avoid detrimental effects on animal welfare - carnivores having large home ranges in the wild, and are kept in inappropriate or small enclosures, frequently develop stereotypies and have high infant mortality rates [21]. The territoriality of different species, in association with social behaviour, should be acknowledged in enclosure design, with suitable space and a suitable social structure provided for highly territorial species to reduce competition [16]. Enclosure size should be large and its area maximised through efficient and appropriate use of both horizontal and vertical space; climbing

structures, raised platforms or perches, and pathways, can be used to maximise available vertical space [17]. It is the quality of the enclosure space, in conjunction with the availability of the species appropriate quantity of space that is essential to assure a positive state of animal welfare.

2.6 Shelters and refuges

The provision of appropriate shelter for different species is another fundamental aspect of captive wild animal husbandry. Consideration of the animal's biology and natural behaviours should be undertaken when determining the type of shelter that should be offered. For example, shelters should provide a comfortable resting place and may feature nest boxes, hollow trees, natural or artificial vegetation planting, underground dens, rockwork or piles, or off-exhibit areas of enclosure accommodation, as appropriate for the species. Similar consideration should be given to Aquatic and Marine species. Sufficient shelter areas that are appropriate for the species and the number of animals accommodated within the enclosure must be available at all times and must provide suitable protection from weather extremes. The provision of multiple shelters may be required. Nesting or denning areas should not only be protected from the weather and accessible at all times to the animals, but facilitate escape from public view and other animals, and contain bedding or nesting material that is appropriate for the species. Privacy is important for many species, and some may be particularly disturbed by the presence of or exposure to visitors, resulting in increased levels of stress. Hence the appropriate provision of sufficient suitable areas for rest and seclusion from visitors, that can include partial visual barriers and sound dampening barriers, can help reduce negative effects caused by visitor presence. Big enclosures that provide large distances between animals and the public may help reduce visitor-induced disturbance in some animals, such as rhinoceros, and therefore can minimize negative effects visitors may have on animal well-being.

Enclosures must allow animals to move away from each other when socially housed. Dominant and subordinate positions are natural within a social hierarchy, and group dynamics and positions may fluctuate. Subordinate animals must have the opportunity to escape, both physical and visually, from potentially negative physical interactions with dominant individuals. Multiple shelters, partial visual barriers, and pathways distributed throughout the 3-dimensional space can help reduce the chance of serious injury, and provide added security for all animals within the enclosure. The availability of suitable, sufficient vertical space can help arboreal primates escape aggressive encounters with conspecifics, and satisfy their vertical flight response and need to climb when alarmed [23].

2.7 Environmental parameters

Different animal species have evolved and adapted to live in particular climates, environments and species-specific thermal ranges and altitudes, water flow/movements. Therefore, in addition to levels of humidity, light spectrums, levels of lighting and ventilation, salinity as appropriate for their specific biological requirements, it is important that captive wild animals are provided with appropriate thermal environments according to their species-specific needs, at all stages of their lives, from newly born/hatched to elderly, to adequately safeguard their welfare. This reinforces the need to understand the natural biology and fundamental physiological requirements during all stages of life, growth and development, as well as natural behaviours, such that situations potentially detrimental to animal welfare may be avoided.

Species housed outside and in a climate inconsistent with natural ranges of environmental conditions will require some form of protection from the weather to minimise the risk of either cold stress or heat stress. Captive, wild mammals may be physiologically challenged to cope with high temperatures and humidity. Therefore, they must be given the opportunity to access shaded areas (e.g. shelters, burrows or areas shaded by vegetation, and/or access to wallows and pools when the environmental heat load is very high. The provision of a gradient of temperature across enclosures can assist captive animals with thermoregulation.

Species whose natural habitats are humid tropical regions, or dry deserts, will require high and low humidity levels, respectively. Inappropriate humidity provision for species can lead to health issues, for example providing unsuitable environments of low humidity for reptiles originating from tropical climates can cause abnormal skin shedding [16]. Therefore, the regular monitoring of both enclosure temperature and humidity is critical to assure that species-specific environmental requirements are met and hence animal health and welfare is further protected.

Seasonal changes must be taken into account, including the photoperiod cycles. Equatorial regions have relatively constant hours of dark and light, compared to the opposite extremes nearer to the poles. Light cycles should mimic the animal's natural environment where possible. If animals from equatorial regions are moved to an institution with outdoor environments located nearer the poles, there may be welfare concerns (e.g. acclimation time, behavioural changes prompted by the change in photo-period, and special concern for young born in cold or wet seasons). To mitigate adverse consequences of such a move, animals who naturally occur in tropical climates yet are kept in temperate climate institutions, the provision of appropriate climate-controlled, indoor housing is required for pregnant females nearing parturition, or for neonates [16]. Consideration should be given to species whose behaviours are dependent on a photoperiod cycle; if such species are to be housed indoors, appropriate provisions must be made. Photoperiod cycles can influence breeding behaviours and hibernation in certain species [16] resulting in behavioural restriction, and hence poor welfare if appropriate photoperiods are not replicated.

The quality and type of light is important for many species, including reptiles, birds and fishes. To ensure good health, reptiles need access to UV light and have a fundamental requirement for wavelengths of both UVA and UVB light, which are necessary for activity and vitamin D3 synthesis. Therefore, an appropriate gradient of UV light must be provided for captive reptiles, in addition to an appropriate temperature gradient and humidity.

Alongside the necessity to provide appropriate types of lighting, adequate and suitable levels of lighting are required to enable regular and satisfactory observation and inspection of the animals, needed for the prompt detection of problems related to animals' physical or mental health and well-being. Circumstances may require more frequent inspections, for example if an animal is unwell, if there has been a change in the social group structure (such as the addition of a new individual), or if there has been a change in the animal's environment [17].

Appropriate ventilation is critically important in the husbandry of captive wild animals. Poor ventilation and hence poor air quality can result in thermal stress and ill health, seriously compromising animal welfare. Enclosure design, construction and maintenance must provide for sufficient, appropriate ventilation at all times.

2.8 Hygiene

A high standard of hygiene is an important part of good animal husbandry, therefore the design and management of the accommodation and other husbandry practices such as food preparation should incorporate appropriate hygiene measures, whilst also ensuring that the environmental, physiological, behavioural and psychological needs of the animals are not compromised, taking into account different individual animal circumstances, such as health or reproductive status, as well as the fundamental enrichment of the environment. Contaminated bedding or stale food or water must not be allowed to build up and a safe, effective pest control programme must be implemented. However, as many diverse species are dependent upon scent marking, consideration must be given to allow opportunities for the expression of these behaviours without compromising basic hygiene.

2.9 Social interactions

Social animals should be kept in appropriate social groups, with group size, the social structure or composition of the group and stocking density being taken into account to safeguard welfare. Enclosures must provide opportunities for animals to escape conflict situations in order to protect individuals from physical harm and safeguard their psychological well-being. Inappropriate overcrowding of an enclosure can lead to increased and intensified aggressive encounters, and result in heightened competition for important resources, such as food and water. Chronic social isolation in species that normally live in family groups, herds or flocks can lead to the development of pathological behaviours such as stereotypes. Temporary separation from group members may be required in specific circumstances, such as medical intervention and treatments, or impending births where the new-born may be at risk from the group.

Enclosure design and environmental provisions, must not only take into consideration the species' behavioural biology and natural history, but also must account for an individual's needs. Within a species, individuals may present considerable differences in personalities and behaviours, which can

result in individual animals responding uniquely to varying aspects of their captive environments [4]. Therefore, providing a species-specific, suitably safe, stimulating and variable environment in which the expression of inherent natural behaviours is encouraged, whilst also understanding that within a species, individuals will vary in their behaviours and responses is an essential aspect of good welfare.

2.10 Water environments

The environment in an aquarium requires careful management to safeguard the welfare of the animals within the aquarium. Water quality needs and requirements will vary in accordance with the different species being accommodated. Features that need consideration include water temperature, water depth, the movement of water, light spectrum, volume of water in relation to the size and number of animals kept, and water chemistry [16]. Water chemistry addresses aspects of the water such as pH, salinity, concentrations of oxygen, carbon dioxide and ammonia, nitrite and nitrate levels. It is important that all of these features are maintained within the parameters appropriate for the species. Water quality should be frequently and regularly monitored so that if changes occur, then they can be promptly rectified before having a negative effect on the health and welfare of the animals [17]. Aquarium water must be free of harmful contaminants and must be filtered. Water can be filtered using a variety of different techniques, for example biological filtration, mechanical filtration, chemical filtration or ultraviolet light filtration. The design of aquarium enclosures must be appropriately strong and water-tight, be made of safe materials and accessible for easy cleaning to maintain high standards of hygiene [16] [17]. In situations where water environments are provided outside, the water quality in pools must be protected from contamination from drainage water or excessive overflow from surrounding land or buildings [17]. Aquaria must provide enclosures of suitable size, design, depth and volume, and furnished to properly accommodate the species and number of individuals.

Appropriate social group composition is fundamental for certain aquatic and marine species, such as dolphins and whales [24] and schooling fishes. The aquatic environment amplifies sounds which can disturb animals, disrupt their communications, and result in adverse behavioural changes; cetaceans can be particularly disturbed by noise stimuli. Therefore, careful consideration must be given to the noise level and frequencies, and other potentially harmful sensory stimulation within the captive environment [25].

2.11 Transportation and Movement of Animals

To safeguard animal welfare and minimise the risks of injury, ill health and negative psychological states during transportation, a good methodology for the same is essential. Factors that may impact an animal's physical and psychological well-being include handling techniques, the method and duration of transport, the availability of food and water during transportation and social grouping. In addition, differences may exist between different countries regarding animal transport legislation, for example with the recommended space requirements for the transport of different animal species. Therefore, it is necessary to ensure that the movement and transportation of animals conforms to and preferably exceeds, the requirements of all relevant regional, national and international legislation.

The methods used for handling captive wild animals for transportation purposes, as well as handling for some specific husbandry management practices, should minimise, as much as possible, the stress experienced by the animals and the potential for trauma. Hence, an understanding of natural animal behaviours is important when handling or moving animals. The health and safety of the animals and of the attending personnel must also be taken into account. Appropriate risk assessments should be carried out prior to handling captive wild animals and appropriate equipment and facilities should be available. Positive reinforcement training, as appropriate for the animal species and individual animal concerned, can help improve the safety of handling animals, whilst also minimising the requirement for physical and chemical restraint.

The transportation of captive wild animals may occur for a variety of reasons, for example, animal transfers between institutions both regional and international, or transportation within an institution for veterinary or management reasons. However, the whole process of transportation, including capture, handling, loading and unloading, can be a stressful experience, and can negatively affect an animal's physical and mental well-being, causing fear, distress and in some instances high mortality [26] [27]. For some specific species, such as cetaceans, the stress experienced by the animal during the handling and confinement associated with transportation can result in an increased risk of death during and

following transportation [25]. Therefore, it is essential that the transportation of captive wild animals involves high standards of animal management and care.

Wild caught animals in particular may experience extreme stress and compromised welfare during capture, handling and transportation with resultant high mortality rates [28].

Removing an animal from its enclosure by the trap capture method may cause high levels of stress for the animal. When trap capture is required, this procedure can be made less stressful habituating the animal to the trap prior to capture. This is done by placing the trap in the animal's enclosure, preferably in an area routinely visited by the animal, leaving the trap open and placing food inside to entice the animal to enter the trap. Animals can be fully trained to voluntarily enter transport crates through the application of positive reinforcement and desensitization training, resulting in a far less stressful procedure. Crate training can reduce the risk of animal injury and the level of stress experienced by the animal during transportation [29]. Covers placed over crates and traps may help decrease animal stress and reduce temperature fluctuation within the crate resulting from outside influences. Care must be given to provide adequate ventilation at all times to prevent heat stress, which can pose considerable risks during transportation [28]. Excessive noise and vibration are sensations that an animal may experience during transportation and can contribute to the stress of the experience. Both habituation and positive reinforcement training, through the application of desensitization, can be used to help the animal learn to tolerate some of the stimuli that will be experienced during transport. Entering a transport crate/box via a ramp can pose challenges and frighten the animals. Steps to minimize the animal's adverse reaction may include covering the ramp with a soft substrate (,e.g. for camels, sand is used to cover ramps thereby minimizing the noise produced and hence helping reduce the negative disturbance experienced during transport [16]. Entering a transport crate/box via a ramp can pose challenges and frighten the animals. Steps to minimize the animal's adverse reaction may include covering the ramp with a soft substrate (,e.g. for camels, sand is used to cover ramps thereby minimizing the noise produced and hence helping reduce the negative disturbance experienced during loading [30], ensuring the ramps are an appropriate design, size, incline, and made from safe material suitable for the species and individual, so as not to cause injury [27].

All accommodations used for the transportation of animals must be secure so as to prevent an animal escape. Containers and crates must be designed to prevent excessive movement during transport to reduce the risk of physical or psychological harm. Accommodation, facilities and equipment must be suitable for the species and must be well maintained to reduce the risk of injury, stress, and ensure the safety of the animal [27]. Animal transport accommodation must allow the animal, to travel in a species appropriate, natural body posture when lying down, sitting or standing and enable the animal to maintain body temperature within a normal range for that species [28] [27]. Consideration must also be given to the internal design of the transport container, including perches for some birds [28]. and hand holds for some primates. Nonslip accommodation flooring should be correct for the species and, as appropriate, suitable absorbent bedding should be provided on container floors. Appropriate bedding can absorb urine and faeces, whilst also providing comfort on hard floors and a means of protection from adverse weather [27]. However, the provision of suitable bedding material must be in compliance with national legislation; some countries do not allow some specific materials, such as straw, to be imported [31].

If appropriate for the species, animals may be transported in suitable compatible groups (for example animals reared together or female and young offspring) in accommodation of appropriate size, taking into account the number of individuals involved. It is important to ensure that the individuals are familiar with one another before transport to help avoid potential problems with aggression during transport [28]. Behaviours may be heightened as a result of the stress of transportation and where there is close confinement with conspecifics. Animals of very different ages, weights or sizes should not be mixed together for transport [27]and, as appropriate, mature males and females should be separated from one another [32]. The specific needs and requirements of young animals of certain species must also be taken into account for their transportation [33].

To further minimize the risks associated with transportation, animals should be transported in good health, and deemed fit to travel by a qualified veterinarian, and when possible, suitably competent and experienced personnel should accompany the transport to monitor and observe the animal's status. Extreme stress such as that associated with transportation can compromise an animal's immune system, thereby increasing susceptibility to illness during and after transportation. Therefore, monitoring

the animal's health and behaviour during and in the weeks following transport is essential. The use of a checklist can aid in the process, and a contingency plan in case of emergency should be included in the transport plan. Inadequate levels of dissolved oxygen in the water can pose considerable danger for fish during transport [28]. Therefore, water quality must be carefully monitored by experienced staff with attention to dissolved oxygen, carbon dioxide, ammonia, pH, temperature and salinity; these must be maintained within the parameters appropriate for the species [27]. Extra water is advised to allow for clean water changes if needed for longer transports or in the case of a delayed transport.

All personnel involved in the transport of captive wild animals must be competent in the care and handling of species being transported. There must be a sufficient number of suitably experienced personnel involved to safeguard the welfare and security of the animals at every stage of the transport [28] [27].

Long distance transports pose more risks compared to shorter ones, and as such may negatively impact an animal's physical and psychological well-being. Long journey times will add to the likelihood of fatigue and may increase the risks to an animal's health. Therefore, to protect animals during long distance travel, special accommodations must be made to make the animal as comfortable as possible during transport, and experienced staff must accompany the animal on transport. Animals should be kept confined in appropriate transport containers during transit and, during period immediately prior to and following transit [34]. In situations where animals are moved within the institution, they should be confined in transport containers for the least time possible to minimize stress of [34].

Additional factors influencing the stress level associated with transport include the duration, and method or mode of transport. For example, the transport vehicle should be equipped to comfortably and safely transport the animals over the anticipated terrain, [27] whether it be road, air or sea. The vehicle should, be designed to reduce excessive motion or vibrations, and afford comfort by offering protection from weather extremes throughout the duration of the journey. A transport or journey plan is required and should detail water, feed, space, ventilation, and rest requirements. Contingency plans to safeguard animal welfare and avoid suffering in the occurrence of unexpected circumstances including unplanned delays and adverse weather conditions must be made, with appropriate action being taken in the event of such an occurrence [27]. Emergency plans in the case of animal illness or injury must be detailed and appropriate veterinary supplies on hand during the transport; this is particularly important for longer duration journeys.

IATA (International Air Transport Association) publishes minimum requirements for the safe transportation of animals internationally and these guidelines and regulations should be followed, whilst also giving consideration to individual animal needs and species-specific space requirements with regards transportation.

2.12 Animal Transactions

The monitoring and regulation of capture, transport and trade of wild animals is necessary to safeguard their health and welfare during these processes, and to reduce potential adverse effects on the viability of the wild populations. Appropriate documentation detailing transactions helps to ensure auditable welfare standards are upheld, in addition to confirming adherence to all necessary legislation; all animal transactions must comply with all applicable regional, national and international legislation to adequately protect animal welfare, and the sustainability of wild animal populations.

If wild animals are transported between institutions in different climates, it is essential to ensure that the environment and climate to which animals are moved can meet the animals' specific requirements (physiological and behavioural) and can satisfy the individual's psychological needs to promote positive welfare. Welfare will be poor if the animal is not acclimatised to the new environment or if the environment is unsuitable and cannot meet species-specific needs. Animals should not be routinely transferred between institutions if they are not in good health or not fit to travel. Equally important is that the receiving institution can appropriately manage and accommodate the species being receiving, including that the recipient institution has personnel suitably experienced in the husbandry and care of that species, and that the recipient institution has an appropriate philosophy regarding the management and care of animals and animal welfare [35] [36].

Attention must be paid to minimise the risk of disease transmission between institutions during animal transactions. Animals should receive a comprehensive veterinary examination prior to transfer which includes required and recommended pre-shipment testing. Examinations should take place within a suitable time frame before transportation and again immediately prior to transportation to ensure animals are in good health. New arrivals to an institution should undergo a quarantine period consistent with recommendations for the species and remain in quarantine until cleared by a qualified veterinarian. Quarantine duration will vary depending on the species, place of origin, and overall health of the animal, and is essential to maintain a high standard of biosecurity, and to safeguard the health and welfare resident animals. Appropriate medical records for animal translocations and acquisitions should be given to the receiving institution, and include any relevant history of disease, injury or illness, including behavioural pathologies

2.13 Source of animals

Animal acquisition from the wild is discouraged. Although an increasing number of wild animal species are being bred in captivity enabling wild animal acquisitions from captive sources, some animals including marine fish, birds and reptiles are still captured and brought into captivity from the wild. Animal acquisitions must comply with all relevant legislation and it is important that an ethical review process is in place any time animals are obtained from the wild. Animals should only be sourced from the wild if there are data to show that there would be no negative effects on the wild species population or its habitat and principally, the welfare of the individual animal must be considered and be of primary concern. A thorough evaluation of the potential benefits and potential welfare costs to the individual animal should occur before any animal is taken from the wild, especially if its husbandry requirements are not fully understood. Additionally, the potential for harm to the individual during capture, and the subsequent transportation must be evaluated and measures taken to minimize these. The risk of exposure to infection, stress-induced lowering of the immune system, and the potential of exposure to previously encountered infectious agents, must be addressed to avoid seriously compromising the welfare of the individual animal. However, if the continued survival of a wild species at imminent risk of extinction, it may justify wild capture for captive breeding programmes with the aim of future reintroduction back to the wild, but this must be subject to a thorough ethical review and must comply with all applicable legislation. The Marine Aquarium Council (MAC) has developed a MAC Certification scheme, with audited welfare and environmental standards, to help regulate the ornamental marine fish trade and quality assurance schemes to help to promote positive animal welfare standards for wild caught animals, whilst also addressing conservation aims and promoting ecological sustainability. National certified programmes also exist for some freshwater fish and terrestrial invertebrates for acquisition from approved sustainable wild sources [36]. Details regarding the source of an acquired animal must be provided, in addition to appropriate individual animal records of health, nutrition, reproductive status and behavioural characteristics.

2.14 Animal management

The number of animals held within zoological institutions requires careful monitoring and regulation, to ensure that all animals can be appropriately accommodated, to avoid overcrowding, and/or to address requirements for captive wild animal conservation breeding programme. This may necessitate transactions of animals between institutions to promote genetically diverse and demographically healthy populations. In an effort to minimise the risk of inbreeding, controlled breeding may be necessary and can be achieved in a number of ways, including contraception, surgical sterilisation, single sex holdings, or the movement of individual animals to another institution or enclosure [16]. However, the affect that these various methods of breeding control may have on an animal's physical and psychological health and hence welfare, must be considered. For example, in certain species, single sex groups do not represent a natural social unit, and hence adverse behaviours, such as increased aggression, may result [16]. Contraception may yield undesirable side effects such as changes to behaviour and uncertain reversibility; additionally the ability to reproduce and raise young is considered as a natural animal behaviour denied to the animal due to contraception [36]. Importance is yet placed on the maintenance of, appropriate group size and sex ratio as this can highly influence positive welfare conditions [37]. Animal acquisition and transfers between institutions is disruptive to social groups and can negatively affect animal welfare, but often only for the short term. For example, the social group is disrupted when animals are separated and removed from their social groups, or new individuals are introduced into existing social groups or for the formation of new groups. Animals experience

separation anxiety from familiar individuals, the known environment or established home range, and are put in a completely novel situation with unfamiliar animals and people. [17]. Therefore, prior to any animal acquisitions or transactions, an assessment and ethical review by the management authority should be undertaken to ensure that animal welfare will be maintained and is the primary reason for such movements. When such a transfer is undertaken, appropriate measures are put in place to protect all involved, for example highly social animals should be acquired or transferred in appropriate groups or pairs [17].

3. Domain 3: Health

3.1 Animal Health and Veterinary Care

Prompt veterinary diagnosis and treatment are critical to minimise the adverse consequences of pain, injury and disease. When disease occurs in multiple individuals within a social group, particularly if it occurs over a prolonged time frame, consideration must be given to the husbandry system and standards as well as the nature of the disease, whether it is infectious or non-infectious, and its epidemiology.

Within institutions that do not have a resident veterinarian, it may be necessary for the visiting veterinarian to instruct a suitably competent member of personnel who has received appropriate training and experience, for example a veterinary nurse, to undertake the administration of certain treatments. Effective and clear communication between the veterinarian and institution personnel is important, and veterinary treatment must only be performed by appropriately trained personnel following specific veterinary instruction and under veterinary supervision. Institutional personnel should not undertake the veterinary treatment of or medicate any animal without veterinary consultation. The management, use and storage of all veterinary drugs must be in accordance with relevant local legislation.

In association with and complementing good veterinary provisions and husbandry techniques should be good stockmanship. Regardless of the husbandry system in place, a competent, observant and knowledgeable stockman is crucial to protect and maintain the health and welfare of captive animals. A keeper must have knowledge of species' biology, basic physical and behavioural needs, and requirements. Additionally, knowledge of the normal range behaviours and preferences for all age classes is essential as young animals may react to or show pain and discomfort in different ways. This level of knowledge and understanding is a vital component of the standard of husbandry offered to captive animals and in the recognition of behaviours that may indicate pain or suffering. Animals must therefore be frequently, regularly, and routinely observed and inspected by qualified personnel, and abnormalities in health or behaviour promptly reported to the relevant personnel. In situations where episodes of animal ill health or injury, recent introductions of animals, a change in animal management practice, or adverse weather conditions, more frequent checks may be required; staff may require direction regarding key observations

The pinioning of birds is a permanent, non-reversible mutilation involving damage to the muscles, tendons and bone of the wing; this procedure is carried out for management purposes to prevent flight. Preventing a bird from expressing natural flight behaviour, when flight is the primary method of locomotion, will negatively affect the psychological health and welfare of this animal [7], and the traumatic nature of the procedure itself will negatively impact the welfare of the animal. Therefore, the pinioning of birds should only be performed in exceptional circumstances and as a last resort, where the health and safety of the bird may be compromised and when there is no alternative form of management available. Where it is still practiced, regular ethical review by the Management Authority on the use of pinioning should be undertaken.

3.2 Preventative veterinary medicine

In addition to the provision of readily available emergency veterinary treatment, a preventative veterinary medicine programme must be documented and put in place following appropriate veterinary consultation; this should include regular monitoring of all of animals, on an individual basis, as well as consider social group health [38] [10]. Preventative medicine programmes are essential for safeguarding captive animal health. Such programmes should consider the diseases that commonly

occur in the country [19] and incorporate health screening protocols including, for example, regular blood, urine and faecal examinations, vaccinations as appropriate and parasite control [39] [17]. Regular advisory visits are recommended in situations where the institution does not have a resident veterinarian, in order that records may be reviewed and the implementation of the preventive veterinary medicine programme ensured. In addition to the statutory maintenance of detailed and accurate clinical veterinary records, a record of each veterinary advisory visit and any ensuing treatment recommendations must be kept. Veterinary records are important tools for assessing an individual both in the immediate moment and for tracking changes over time by providing a consistent format to observe and interpret trends in injuries or disease. Regular reviews of husbandry and preventative veterinary care practices and protocols by the Management Authority should be undertaken to minimize disease risks and to assure that adequate biosecurity arrangements are in place.

As a result of increases in the knowledge of zoo animal nutrition, management and veterinary care, resulting in longer lived animals, geriatric health is an emerging facet of care within zoological institutions, and one which must be addressed through veterinary medicine and the provision of appropriate husbandry [16] [40] [10]. Diseases such as degenerative joint disease and arthritis, and heart failure may be encountered [40] and the provision of species-specific long-term accommodation for aged animals must be considered [16]. Therefore, the issues concerning aged animals must be addressed within a veterinary health programme and regularly reviewed by the Management Authority, with veterinary consultation on an individual, case by case basis. Conversely, reduced longevity of some captive species, for example elephants, [41] [16] and cetaceans [24], which highlights the need to implement regular species-specific health screening protocols.

The post mortem examination of animals plays an important role in a preventative medicine programme and the surveillance of the health status of animals accommodated within zoological institutions [17]. Therefore, the post mortem examination of animals that die in the collection should be undertaken and appropriate measures must be taken to ensure that these examinations are carried out by experienced personnel, using suitable facilities and relatively promptly after the death of the animal. Records of post mortem examinations and the resultant findings should be kept and maintained. All carcasses and any tissue samples taken for laboratory examination must be stored and handled appropriately to minimise the risk of exposure of other animals in the zoological collection to any potential infectious diseases and to minimise the potential risk of the transmission of zoonoses to staff. The safe, hygienic and appropriate disposal of the bodies of all dead animals must be undertaken.

3.3 Biosecurity

Quarantine regulations regarding the import of animals into different countries vary between each country, but the quarantine of new animal acquisitions on arrival to an institution is critical to safeguard the health and welfare of the resident animals. Quarantine helps to prevent the introduction and spread of disease to other resident animals and enables the examination of the new arrivals [16]. In addition to their application in the management of animal acquisitions, quarantine facilities can be important for the isolation of sick or injured animals. Animals in quarantine should be deemed healthy and free from disease before introduction/reintroduction to the institution. It is important that quarantine facilities are designed and constructed to facilitate the safe observation, handling and examination of animals and enable the maintenance of a high standard of husbandry and hygiene, as well as biosecurity. Quarantine areas should also provide appropriate species-specific space to enable the animals to express their normal behaviours and allow for suitable exercise and enrichment opportunities.

A safe and effective pest control programme must also be developed and implemented since many different species of pest (for example, free-living rodents and invertebrates) are capable of transmitting harmful diseases to captive animals. The deterrence of predators, such as feral cats and other free-living carnivores, must also be considered to prevent predation and the risk of the spread of disease. Care must be exercised regarding the method of pest control and predator deterrent employed to minimise the risk to the captive wild animals accommodated within the institution. The issues concerning predator deterrent and pest control are important considerations in the design and maintenance of the secure perimeter fencing and individual animal enclosures.

3.4 Veterinary Facilities

Appropriate facilities must be readily available for the safe examination, diagnosis and treatment of animals. Suitable and appropriate equipment for the safe capture, handling and examination of animals shall also be available. Where there is a resident veterinarian on site, basic diagnostic and surgical equipment and instruments shall be available.

Veterinary facilities for the routine or emergency treatment of animals should be designed and maintained to minimise the potential zoonotic risks between animals and staff, and personnel must be trained in appropriate cleaning and disinfection procedures and protocols. The maintenance of a high standard of biosecurity is essential to help protect the health and welfare of the animals within the institution.

3.5 Euthanasia

One of the fundamental requirements for good welfare is the maintenance of good health. This can be achieved through preventative medicine programmes, the prompt recognition of pain and illness in different species and the rapid diagnosis and treatment of injury and disease. However, in certain circumstances where welfare is gravely compromised due to poor physical or psychological health which cannot be adequately improved and it is determined to be in the best interest of the individual animal concerned, euthanasia may be necessary.

Institutions should have a documented protocol detailing conditions in which euthanasia is appropriate and justifiable, and this protocol should be regularly reviewed by the institution's ethics committee and Management Authority. This document should clearly state approved and acceptable standard operating practices. The discussion with staff directly involved with the animal in each individual proposed circumstance of euthanasia is important and must take place [36].

Euthanasia must be carried out following appropriate, approved operating standards, and according to local legislation. Local customs and different cultural beliefs should also be considered provided that the parameters for the euthanasia or humane destruction of animals are not compromised. In all situations, the welfare of an animal and its quality of life should be the prime consideration [35] [42] [36].

To ensure minimal pain, discomfort and stress for the animal, the euthanasia of an animal should be undertaken under veterinary supervision or by competent personnel with appropriate training and experience in the technique to be used. Experience in the handling and appropriate restraint of the species is necessary to reduce the animal's stress and to ensure the safety of the operator [17]. Careful consideration must be given in each individual case to the manner and type of animal restraint required, in addition to the method of euthanasia. Factors that should be taken into account include the species, location of the animal, presence of injury or disease, personnel experience and safety aspects. Minimising animal stimulation by either sight, sound or touch can help to reduce stress and anxiety in animals. Distressed animals may vocalise which can cause agitation in other animals, hence other animals should not be present when an individual animal is to be euthanized.

Euthanasia must result in the death of the animal as rapidly and as painlessly as possible [35] [17] [36]. Following euthanasia, it is important that the death of the animal is confirmed, taking into account the species of animal and the method of euthanasia, prior to the appropriate disposal of the animal. An appropriate post mortem examination shall be undertaken.

4. Domain 4: Behaviour

Behavioural or interactive restriction through confinement in barren environments, or where there is long-term social isolation, is associated with emotional unresponsiveness and can lead to extreme boredom, frustration and the development of abnormal behaviour patterns. Consequently, the provision of species appropriate, complex and variable environments, space and resources that encourage exercise and enable the display of a range of natural behaviours, will promote behavioural, physical and mental health. Species appropriate environmental enrichment should also offer the animal the ability to make choices and hence exert a level of control over its environment; by encouraging decision-making, animals can express preferences and select environmental conditions which they favour, thus promoting a positive psychological state and hence good welfare. Appropriate positive reinforcement training is one aspect of an environmental enrichment program and should focus on and be used to encourage the display of natural behaviours, enhance the veterinary care program, promote appropriate social interactions, and facilitate husbandry and management.

Visitor presence can have both positive effects [7] and negative effects on the behaviour of some species [43] [16]: the welfare of the animals must always be of primary importance and must be considered at all times.

4.1 Environmental Enrichment and Stimulation

It is vital that consideration is given to incorporate appropriate environmental enrichment into the overall design and construction of the captive environment. Facilities must be designed to prevent restrictions in behaviour expression and must enable the animal to perform a full range of natural behaviours and movements, thereby meeting psychological and physiological needs. This is dependent upon accurate knowledge and understanding of the species' behavioural biology and scope of normal behaviours, although accurately interpreting behavioural abnormalities is crucial to promptly react to and address potential animal welfare compromises.

Behaviours can result from a strong internal drive or motivation with an absolute need to perform these particular types of behaviours; they promote behavioural and mental health and are necessary in the prevention of poor welfare. For example, an animal that is strongly motivated to nest build has a fundamental need to perform this behaviour; if restricted from doing so, serious welfare compromise will result. Furthermore, the natural behaviour tendencies of some species may increase their susceptibility to welfare compromises occurring in captivity. For example, some species of carnivores who naturally occupy large natural home ranges, demonstrate a high incidence of stereotypies and high neonatal mortality in captive populations [21] [10]. Also, the intelligence or cognitive capacity of different species must be taken into account in the design and provision of enriching, complex environments; species such as primates and elephants, need a high degree of mental stimulation and environmental complexity, to address their psychological needs and to prevent the development of behavioural pathologies. To improve the welfare of captive wild animals, careful attention must be paid to animal husbandry and management to provide a species specific, suitably stimulating and variable environment in which the expression of inherent natural behaviours is encouraged and environmental choices are offered, and hence a level of control by the animal over its environment is available.

4.2 Abnormal behaviours

Many animals housed in barren, unrewarding environments with limited ability to express natural movements and behaviours may not only develop abnormalities in their physical health [18], but may also increase the performance of abnormal behaviours directed at either themselves, for example hair pulling and body scratching, or their surroundings, such as bar licking. The development of stereotypies, defined as abnormal behaviours that are repetitive, persistent, recurrent and apparently purposeless activities, and other abnormal behaviours, such as frantic activity levels or lethargy, all reflect compromises in animal welfare and may occur in animals for a wide variety of different reasons, often associated with inappropriate animal-environment interaction. For example, stereotypies can occur in animals that are emotionally numb, if animals are chronically frustrated with or chronically stressed as a result of their confined environment and the associated imposed restrictions, or as a means of coping in the absence of the opportunity to perform other natural behaviours [7]. However, stereotypies may

persist in an animal's behavioural repertoire beyond the scope of their development and may not reflect the effect of present management or environmental conditions on welfare [44] [16] [7]. Common stereotypies in captive wild animals include locomotor (e.g. pacing or swimming along the barrier, head weaving and body rocking), self-directed (over grooming, self-clasping, self-injurious), oral (cribbing, regurgitation/re-ingestion). Locomotor stereotypies such as fence pacing, may occur due to space restriction, lack of a natural environment, confinement with an inability to escape or express roaming behaviours, or as a result of threats from conspecifics.

Stereotypies may have species-specific characteristics, but the performance of any stereotypy is suggestive of a negative welfare state. Stereotypies can also cause physical injuries and harm as a result of the performance of the repetitive actions and abnormal behaviours, such as chronic skin lesions caused by repeated escape attempts at enclosure boundaries and abnormal pressure on joints caused by repetitive movements leading to degenerative joint disease. Stereotypies are rarely observed in non-captive wild animals [16]. Yet, by giving animals the opportunity to show preferences and make choices within a complex environment, and enabling varied behavioural expression and ranges of movement, this may help to reduce the development of pathological behaviours.

4.3 Enrichment programmes

Environmental enrichment is an important management technique to help increase the expression of normal behaviours and reduce the development of stereotypies and abnormal behaviours [43] and alleviate frustration. It can also provide the animal with a degree of choice about its environment and offer the animal preferred resources. Environmental enrichment is a dynamic process that involves the use of appropriate structures, enclosure furniture and husbandry procedures and techniques to create a stimulating and appropriately complex environment which increases the opportunity for, and encourages the performance of, species-specific natural behaviours, movements, exercise and exploration, resulting in an improved mental and physical state and ultimately improved animal welfare.

Enrichment is a dynamic process for enhancing animal environments within the context of the animals' behavioural biology and natural history. Environmental changes are made with the goal of increasing the animals' behavioural choices and drawing out their species-appropriate behaviours, thus enhancing animal welfare (1999 AZA Behaviour Scientific Advisory Group)

Before the implementation of environmental enrichment programmes, appropriate planning discussions between the animal keeper personnel and the Management Authority should be undertaken. Enrichment programmes may involve the use of the overall structural design of the enclosure, its furnishings and different management practices in order to provide novel stimulating experiences and to encourage the performance of natural behaviours such as foraging, natural locomotion patterns exercise, resting and sleeping. For example, the enclosure design should incorporate structures that functionally mimic the natural environment such as pools, mature trees and suitable vegetation, rocks, ground cover and a varied landscape, in order to provide the opportunity for exploration, and promote natural behaviours and movements. Enclosure furniture should be suitable for the species and consist of various items, such as branches, logs, log piles, substrates, nest boxes, resting platforms, scratching posts, perches, cardboard boxes or climbing facilities, all of which may be used to encourage the performance of natural behaviours including exercise, self-maintenance, nesting, climbing, foraging, play and exploration. Where pools are provided for species that require both a terrestrial and aqueous environment, animals must be given sufficient appropriate access and exit points and they must be able to easily move in and out of the pool [17] without hindrance from conspecifics.

4.4 Environmental security

Physical barriers within enclosures can not only offer privacy, but also provide individual animals with the opportunity to escape or avoid conflict from other individuals in the social group. The suitable use of vertical space should be considered during enclosure design to maximise exercise opportunities and provide a stimulating environment, and offer appropriate refuges from conspecifics [44] [23]. For example, a suitable complex vertical space is important for arboreal apes for obtaining food, to explore, for nesting and sleeping, and also to enable escape from aggressive interactions from conspecifics [7]. Arboreal primates have a vertical flight response, climbing when they are alarmed, which emphasizes the fundamental requirement for the provision of appropriate and sufficient vertical space [23]. For aquatic and marine species, the water depth serves as the vertical space and when appropriately sized,

allows animals to experience changes in pressure, light levels, and more aptly simulates the natural environment.

The social environment or social grouping will likely impact the welfare of individual animals. Complex social groups are important for naturally social species, such as primates, ungulates, birds, fishes, and elephants, and when appropriate groups are formed, provide social stimulation, enrichment and companionship [16] [7] and a sense of security. For animals that usually live in social groups, long-term isolation from conspecifics can have detrimental effects on animal welfare. For example, animals that live in family groups, herds or flocks gain security from the social contact with their conspecifics, providing the animals with a positive mental state, therefore deprivation of this social contact can lead to negative states and hence decreased welfare. Chronic social isolation or an absence of appropriate social partners, for social species, correlates to an increased risk of the development of stereotypies and behavioural pathologies. There are adverse effects of social isolation on animals that lead a naturally solitary lifestyle for part of their lives. Although species may live a solitary lifestyle they will encounter and interact with conspecifics and therefore total social isolation is inconsistent with the behaviour of wild counterparts. Species that live in monogamous pairs, also require adequate social complexity [7].

Although species appropriate social environments can positively affect welfare, social groups can result in occasions of negative experiences for individual subordinate animals, especially if the enclosure restricts the opportunity to avoid or escape adverse behaviours from dominant group members [45]. Social group sizes and structures must be appropriate for the species concerned. Aggression between conspecifics can be increased if there is inappropriate group composition and changes in the existing social group composition, for example through the temporary removal of a group member or the introduction of a new born animal, can result in conflict [39]. Furthermore, stress arising from sudden changes in the social environment has been documented to cause arteriosclerosis (heart disease) in some captive wild animal species, negatively effecting animal health and hence welfare. Therefore, the behaviour and the severity, frequency and duration of any aggressive interactions between conspecifics, should be monitored and appropriate action taken, when necessary, to safeguard the welfare of individual animals within a social group.

4.5 Environmental challenges and novelty

The greater the environmental complexity, the greater the potential for a wider variation in expressed natural behaviours, which in turn, can increase the degree of control an animal has over its environment through the variety of behavioural choices it can make [7], resulting in improved welfare. Species-specific problem solving items, puzzle feeders or objects that require physical manipulation can encourage decision-making, provide environmental enrichment and increase exploration [45] [44]. However, the use of species appropriate furniture objects such as swings, cardboard boxes and other 'toys' should be suitably rotated to maintain variety and a change in the animal's environment. Although this should follow an appropriate length of time of the object being in the enclosure to allow for acclimatisation by the animal to the object's presence, and hence minimise any stress experienced by the animal on the removal of the object [46]. The use of enrichment structures, furniture and techniques should be regularly recorded and monitored by keeper personnel to assess their continued novelty to the species and the individual animals and hence the positive welfare benefits of their use [16].

The manner by which appropriate nutritional food is provided should additionally be incorporated into an enrichment programme, as many species are strongly motivated to explore their environment and in the wild can spend a large part of their daily routine foraging for food.; Offering food in a varied and appropriate way to satisfy the animal's species-specific natural feeding behavioural needs and motivations, and encourages activity, is important to prevent poor welfare, in addition to ensuring that the nutritional requirements of the animal are met. In some species, scatter feeding, for example, can provide the opportunity for foraging, as well as increased exercise opportunities, whereas the supply of appropriate vegetation for browsing can be enriching for grazing and browsing animals. However, social group dynamics should be considered when food is used as part of an enrichment programme, for example if feeding methods are used that enable dominant animals to exert control over the food, then the subordinate animals may subsequently suffer negative experiences [16].

Another management technique that can offer psychological enrichment to captive wild animals is the interaction of the animals with their keepers during positive reinforcement training [45] [44].

4.6 Environmental complexity

Appropriate facilities and enrichment programmes must suitably provide for an animal's behavioural and psychological needs throughout all stages of its life and development [17]. Species appropriate environmental enrichment programmes are essential to achieve the optimum level of environmental stimulation and behavioural variability, needed to safeguard animal welfare. Appropriate environmental enrichment can promote good welfare by affording the opportunity to express a variety of natural, species-specific behaviours, movements, locomotion, and exercise resulting from improved quality of the space. Mental stimulation is increased through the provision of learning opportunities, exploration and interaction with a complex and variable environment, and by increasing control over environmental factors.

A lack of sensory stimulation arising from a lack of complexity in the environment can negatively affect welfare, as can inappropriate sights, smells or sounds [47]. For example, inappropriate odours from cleaning agents can occur during hygiene practices [47],); these should be mitigated through appropriate [7]. Unsuitable loud noise can also compromise animal welfare; crowd noise or noise created by steel structures in accommodation buildings can negatively impact upon elephant welfare [7], whilst inappropriate mechanical noise in dolphinariums associated with the loud music that may accompany visitor show performances or from the captive environment (e.g. from pumps or filters) may negatively affect cetaceans [25]. Where applicable, inappropriate sights that may create negative states should be avoided; some species may suffer distress if housed in close visual, olfactory, or auditory proximity to other species. For example, the housing of tigers in view of other tigers i can have a negative effect on tiger wellbeing and may result in an increase in stereotypic pacing [48].

However, the provision of appropriate sounds, sights and smells, such as natural sounds and edible vegetation [45], can create a stimulating sensory environment for animals and have a positive effect on welfare; appropriate sound and odour enrichment can contribute to positive welfare states in captive wild animals such as gorillas and elephants [16]. Ensuring the suitability of sensory information in the animals' environment and increasing in the complexity of the environment contribute to improved welfare.

The provision of appropriate lighting is essential to prompt some species to display natural behaviours and activity levels. For example, nocturnal species should be provided with appropriately reversed lighting in a nocturnal exhibit (if activity is required during daytime hours) to prevent sleep deprivation and behavioural restriction [17].

4.7. Multi-species exhibits

Multi-species exhibits can create a stimulating environment through increased complex interactions, however careful consideration must be given to the species selected for mixing and enclosure features that will accommodate all individuals. When mixing species, there is the potential undesirable encounters such as aggressive interactions between the different species, or competition for food [16] and among closely related species, there exists the risk of interspecific reproduction. Therefore, the provision of sufficient species-specific space and appropriate furnishing to afford opportunities for escape are necessary to reduce the risk of conflict between species. When considering species for mixed enclosures, there are many considerations that must be taken into account, including but not limited to territorial behaviours and defence of territory, use of space (shared niche can lead to increased competition for resources), feeding strategies, reproductive biology, and social behaviours. Accordingly, the interactions between individuals of the different species should be regularly monitored and assessed, and appropriate action taken to separate the species if aggressive conflicts result in a welfare compromise. Consequently, thorough research should be undertaken with appropriate review by the Management Authority before a mixed-species exhibit is created to prevent any compromises in animal welfare.

4.8. Animal Training

Training should be founded on and used to encourage the display of natural behaviours including movements and socialization, reduce anxiety or fear, and/or behaviours necessary to enhance daily husbandry care and veterinary practices. Establishing training goals and objectives will help focus efforts towards the promotion of positive welfare. All training techniques and objectives should be thoroughly researched and regularly assessed to safeguard animal welfare and must not be harmful to the individual animals involved. The training of captive wild animals should only be undertaken after detailed appropriate research and consultation, with the ultimate aim of improving the well-being of the animals. Providing the opportunity and capacity to express natural behaviours is a fundamental physical and psychological need. Appropriate training is part of an enrichment program and can be used to facilitate the provisioning of a more robust and comprehensive enrichment program. Training animals helps to meet psychological needs by facilitating both exercise and mental stimulation to reflect intellectual and physical abilities and gives animals the opportunity to have a degree of control over their surroundings and environment. Appropriate training is also important facilitate routine husbandry and health management procedures essential in the care of captive wild animals. Appropriate training is also important to assist with the undertaking of routine husbandry and health management procedures that may be necessary in the care of captive wild animals. Training can enhance socialization, improve introductions, and assist animals as they learn to navigate assorted social situations.

Training can help reduce stress commonly associated with routine husbandry practices and veterinary procedures. When animals are willing participants in daily husbandry and veterinary practices, the need for physical and chemical restraint or forced procedures is greatly reduced or eliminate, thereby facilitating a relaxed examination and treatment wherein the animal experiences reduced stress during the procedure [39] [49] [7]. Positive reinforcement training techniques have been successfully used to train innumerable species to readily present or show different parts of their body for examination [7]. Consequently, by assisting with routine veterinary procedures, training can help improve the overall health and well-being of animals.

The welfare of the animal should always be the prime consideration during training sessions and the development of training programmes. Poor training and handling methods will compromise an animal's welfare. The use of physical punishment in training may result in the development of undesirable behaviours such as aggression and increased anxiety [50] [51], self-directed and introverted behaviours, and is harmful to the individual animal, negatively affecting animal well-being. Training techniques and practices that compromise an animal's normal physical or behavioural health, development, psychological well-being, or welfare may not be used.

Animal-training methods should primarily rely on positive reinforcement techniques. The use of positive reinforcement training involves offering the animal something it enjoys, for example a food reward, for performing the desired behaviour. It is the voluntary cooperation of the animal during positive reinforcement training that affords the animal more choice and control over its environment and can additionally increase the animal's psychological stimulation [45].

Patience, composure, kindness and the use of rewards are key principles for humane, effective and successful training [50] and there should be the development of a positive, collaborative relationship between the animal and trainer. The trainer should respect the animal, have a good understanding of the species' natural behaviours and biology and should also regard each animal individually so as to effectively monitor progress. Personnel must be competent in the undertaking of acceptable animal training practices and should receive appropriate regular tutoring in approved training techniques [39].

The nature of the relationship between keepers and animals may be enhanced by the keeper interacting with the animal through a barrier rather than via entry into the enclosure [52] which may intimidate or frighten some animals. Working with animals from the other side of a barrier is referred to as 'protected contact', which is routinely used in the management of elephants and further emphasizes the significance of positive reinforcement training methods in the management of captive wild species [7].

Protected contact is a system for managing elephants that uses positive reinforcement training as the primary method to modify behaviour; directing the positioning and movement of the elephant is achieved through the use of targets. Keeper safety is achieved by elephant and keeper positioning relative to each other and to a barrier, which typically separates human and animal spaces. Trainers function outside the elephant social hierarchy and do not attempt to establish a position of social dominance.

All training methods and objectives, programmes and educational talks should be documented and approved by the Management Authority prior to their implementation, regularly assessed, and have an appropriate ethical review. Training policies should detail the philosophy of animal training practices, the application of all animal training programmes, be in accordance with any local legislation, and should be regularly reviewed. Appropriate records should be kept detailing the objectives, goals and method of an animal training programme, as well as the actual undertaking and its progress [53].

Educational talks may incorporate trained animals and these public demonstrations should responsibly promote visitor understanding of natural animal behaviours, responsible animal management practices and should always be a positive experience for the individual animals concerned. Animal demonstrations or presentations must not be detrimental to the physical health of the animals or result in negative mental experiences for the animals involved [17].

4.9 Animal Contact

Visitor encounters with live animals, for example via touch pools, walk-through exhibits and hands-on education lessons, can offer informative and educational experiences for the public, but the welfare of the animals must be considered at all times to maintain positive welfare. Public and staff safety must never be compromised. In all situations where contact with captive wild animals occurs, it must focus on educating visitors about natural animal behaviours, animal biology and conservation issues, and it must be strictly regulated and controlled to adequately protect the welfare of the animals, as well as the health and safety of members of the public.

Walk-through exhibits may involve a number of different species including birds, bats, lemurs, marmosets, butterflies and lizards, whilst drive-through exhibits are a component of safari parks. In order to safeguard the welfare of the animals within these exhibits, it is important for visitors to understand the need to keep to the designated pathways/roads and not to feed, touch or interfere with the animals and animals must have refuge areas to escape from visitors. Additional strict and specific safety measures must be enforced for visitors to drive-through exhibits, including remaining in a secure vehicle at all times [54] and local legislation specifically relating to drive-through exhibits must be adhered to. Children's petting zoos or touch paddocks may feature domestic farm animals and permit visitors to enter some of the enclosures and touch and feed the animals with authorised food provided by the institution. To protect the animals' health, only appropriate food supplied by the institution should be fed to permitted animals in touch paddocks and the consumption of food by visitors in any animal contact area must not be allowed. Walk-through and drive-through exhibits and petting areas must be designed with appropriate barriers and double gated entrances and exits to prevent the animals escaping from the exhibit. Diving in zoos and aquaria and swim-through experiences are other situations where visitors may experience contact with captive wild animals. In all institutions where diving is carried out, a dive manual must be maintained, detailing, for example, standard operating diving procedures, diver conduct and risk assessments, and within which the welfare of the animals is a fundamental element of the operating practices.

In situations where visitors may encounter free-ranging animals via, for example, walk-through exhibits, swim-through drive-through exhibits, or in circumstances where there is direct animal contact, such as touch pools, hands-on education or petting areas/touch paddocks, the health, safety and welfare of the animals and the visitors must be ensured. This can be achieved by stationing trained staff members within enclosures at all times; needed numbers of personnel will be determined by the situation. Appropriate staff supervision and staffing levels, taking into account the species of animal involved, are essential in all circumstances where there is contact with animals in order to protect the welfare of the animals [17] [55]. Appropriate documented emergency protocols must be instigated in the event of unauthorised visitors inside an animal enclosure.

All staff involved in animal contact situations should be appropriately trained in animal handling, and must recognise signs of ill health, injury or disease and behaviours indicative of compromised animal

welfare. Any abnormal behaviours or signs of ill health must be promptly and appropriately reported. If there is any indication that the health and welfare of an animal used in a contact situation is compromised, then the episode of contact should stop immediately. Animals involved in contact situations with the public must be trained through desensitization or habituation to tolerate such interactions and must be under the direct control of an experienced keeper. Care should be taken when removing approved animals from their home cages for visitor hands-on contact; the behaviour of all animals can become less predictable when they are in unusual surroundings or uncomfortable, and therefore animals must always be accompanied by suitably competent person [54]. Animals should not be removed from environments and surroundings that are fundamental for their survival. For example, animals that are dependent on a water environment must not be removed from that environment or else poor welfare will result. All animal handling should be undertaken with the animal's welfare in mind and should not cause the animal any unnecessary discomfort, fear, distress or injury.

Personnel should be trained in and understand the importance of good hygiene practices and of minimising disease risks, in accordance with the institution's hygiene protocols. With all situations where there is contact with animals or objects touched by animals, hygiene is paramount and appropriate hand-washing facilities must be provided. Staff and visitors should wash their hands before and after animal contact to reduce the risk of exposure to infectious agents, as well as minimising the risk of exposure of members of the public and personnel to zoonotic diseases. Hand-washing is particularly critical in contact situations that involve invertebrates; nicotine is fatal for many invertebrates, hence it is vital for people who smoke to adequately wash their hands before coming into contact with these animals [55]. With regards diving- or swim-through experiences, appropriate measures should be taken to minimise the spread of disease to animals in different tanks by divers, such as freshwater showers between diving in different marine tanks.

Individual records for all animals used in contact circumstances should be kept up to date and include details of husbandry, health status (including deaths), behaviours and frequency of handling and use in contact encounters [55]. Records enable the monitoring of the effects of contact encounters on well-being and the early identification of any problems and subsequent implementation of measures to rectify them. Mortalities of animals in contact areas or of those involved in contact experiences should be investigated by post mortem examination and appropriate disease screening undertaken.

All contact between animals and visitors should be supervised and contact time restricted. Neonates and breeding animals should not be used in contact situations [55]. There must be sufficient rest periods that allow animals to be fully away from direct visitor contact. This may be facilitated by rotating animals used for contact and by ensuring that the frequency with which the animals are used for contact is appropriate [55]. All walk-through exhibits, touch pools and touch paddocks/children's petting areas should be of a suitable size and have suitable refuge areas which the animals can readily access to move away from visitors. If touch pools allow direct contact, they should be continuously monitored by a competent member of staff, and the animals rotated to help reduce stress. Painful procedures, to make animals safer to handle, are unacceptable and must not be performed; these include but are not limited to the removal of teeth, claws or stingers [55].

All events involving contact between the animals and public should be documented and approved by the Management Authority prior to their implementation and regularly assessed. An appropriate ethical review should occur.

4.10 Visitor impacts

Although animal contact encounters can offer educational experiences for visitors, the effect of general visitor presence on captive wild animal well-being must be considered. Visitor presence may create a positive or enriching experience for some animals [7]), but the presence of the public can also have deleterious effects on the behaviour and hence welfare, of some species, such as primates [43] [16]. Disturbances in the group dynamics of chimpanzees and other primates have been documented during peak visitor numbers, with increased aggressive contact observed [43]. For some primates, combining positive training techniques with social unstructured play sessions may help improve animal well-being and social group dynamics, and may result in a reduction of negative behaviours observed during visitor presence [43]. It has been suggested that large enclosures may help reduce the detrimental effects of visitors on zoo animal behaviour. Lessening animal disturbance from visitors can be accomplished by

increasing the distance between the animals and the visitors [22]. Furthermore, for animals that seem particularly sensitive to visitor presence, exposure to visitors and any associated negative effects can be reduced by obscuring view point windows (e.g. with camouflage netting), providing sufficient appropriate areas within the enclosure for seclusion and refuge from visitors, or by masking enclosure perimeters [16]. The overall design of enclosures should also take into account minimising the negative effects of visitor presence on animals; lowering the height of visitor viewpoints can reduce aggressive behaviours in arboreal primates when visitors are present [56].

4.11 Mental Components

Good mental health and well-being are associated with the animal's biological and physical requirements (as represented by the four physical domains), and can be accomplished when all these needs are met, and positive welfare states can be achieved when the individual's psychological or mental needs (fifth domain), as well as the physical needs, are addressed [6] [8] [10]. Yet, animals may experience different ranges of emotional and mental states according to their sentience and different cognitive capacities. Not only do animals vary in relative sentience, which is the ability to experience positive states, such as happiness, and negative states, such as pain and fear [57], but sentient animals may experience different emotions from one point in time to the next. In addition, within a species, individual differences in personalities and behaviours may occur, which can result in individual animals responding differently to aspects of their captive environment [4]. Therefore, when considering the management of wild animals in captivity and how to best ensure that their psychological needs and requirements are met, it is important to take into account species' differing cognitive capacities and their sentience, in addition to variances of individual animal traits, and these must be considered throughout the animals' lifetime.

5. Domain Five: Mental State

An individual's mental state may be determined by the physical and biological health of the animal, the type of sensations it experiences, whether they be positive or negative, along with cognitive feedback from external environmental stimulation [6] [8], which, in turn, can affect the animal's overall welfare state. Suffering is a term referring to an unpleasant mental state: a level of cognition is necessary for mental suffering, as well as sentience. With this in mind, taking into account the animal's cognitive capacity, there can be a large range of differing negative mental states that may lead to suffering and a poor state of welfare, including pain, frustration, fatigue, boredom, distress and loneliness. Pain, can cause aggression, as can overcrowding, inappropriate social grouping and fear. Prolonged and extreme pain, fear or stress negatively affects the welfare of individual animals.

Pain is a sensory input that protects the body from damage and harm, but physical pain is an unpleasant sensation and can lead to suffering. The ability to recognise the range of behaviours that may indicate pain in animals and the knowledge that different ages of animals may have different behavioural expressions of pain is fundamental in animal management and husbandry in order to appropriately offer relief of pain. Trauma and injuries may occur for variety of reasons, for example, from abnormal self-mutilation behaviours, aggressive conflicts, damage from rough surfaces in accommodation enclosures (e.g. poorly maintained flooring), or from poor handling during transport, and different types of trauma and injuries can cause different experiences of pain. Additionally, disease is a significant cause of suffering and there is often pain associated with the diseased area. The degree of suffering experienced as a result of disease depends on the nature of the particular disease, and can negatively affect the mental state of an animal by causing a range of negative experiences, such as breathlessness, fatigue, nausea and pain [8], thereby resulting in poor animal welfare. Therefore, appropriate measures must be taken to ensure good physical health through the prompt detection and treatment of illness or injuries to minimise unpleasant sensations and hence safeguard positive welfare.

Animals can also experience positive emotions, including a sense of security, playfulness, calmness and contentment, which may result from good physical health and positive interactions with the environment and other animals and conspecifics [58] [8].

A positive state of welfare may be achieved by ensuring that captive wild animals are provided with appropriate situations and environmental conditions that enable them to meet their physical and biological needs. For example, social groupings that are appropriate for the species and ages of the animals can facilitate play, companionship and a sense of security. Yet if specific circumstances in social groups are sub-optimally managed, such as overcrowding or an unnatural ratio of males to females, individual animals may experience distress with a resultant adverse psychological state. If negative emotions are severe or prolonged and the individual animal, because of its circumstances, cannot escape or avoid them, welfare will become poor.

Additionally, the use of environmental enrichment techniques to provide a more complex and stimulating environment can help prevent frustration and boredom [59] with the quality of the environment being an important factor in reducing stress [16] [60]. An increase in the expression of a range of natural behaviours, such as exploration, foraging and play, can be associated with a suitably stimulating and variable environment promoting a positive mental state, and ultimately improving the welfare status of the animal. Providing individual animals with choices and the ability to make decisions within their environments is essential for creating positive affective states

Consequently, the core function of captive wild animal husbandry and management should be to promote positive experiences, to minimise stress and negative experiences, and to provide opportunity for natural behaviour and for making choices within environment that allow the exertion of some measure of control. Promoting positive, pleasurable experiences for the animals may also offset any unavoidable negative experiences [59].

5.1 Choice and Control

In addition, and consequent to the above, provisions should be made for an animal to have choice and control within the confines of its environment, helping to promote conditions of optimal welfare. Traditionally, where zoo-housed animals spend their time, whether on- or off-exhibit, is determined by humans and animals have less choice and control than they would in the wild [61]. Choice can be limited in captivity as a result of both the social and physical environment. Limited opportunity for appropriate social interactions, a limited diet, lack of physical activity diverse space, and limited control over using such spaces are all examples where the choices an animal has are reduced compared to wild counterparts. Removing the ability to choose how to behave can be detrimental to an animal's well-being; therefore, protocols and practices should promote as many choices as possible within the captive environment.

Providing choices offers individuals the opportunity to select preferences and encourages more rewarding. For example, captive chimpanzees will exert extra effort to receive preferred foods [62]. Zoo-housed giant pandas and African elephants have responded better to training requests when they are rewarded with preferred foods [63].

Research also indicates that the opportunity to have choices is more important than actually using the choices. When giant pandas, which were typically kept in their outside enclosure at a zoo, were given the choice to go into a small room out of the public eye, they were less agitated and showed a decrease in stress, as measured by urinary cortisol, even when they chose to remain outside [64]. When given a similar choice over where to spend time in their exhibit, polar bears also showed positive behavioural changes – their positive social behaviour increased, and their abnormal behaviours, including pacing, decreased [65]. In both studies, the animals benefited from the additional choice to go to an inside area, even though they rarely went to these other areas. The pandas used their off-exhibit room 33 per cent of the available time, and the polar bears used theirs less than 2 per cent of the available time

While choice lets an animal react to its environment, control allows the animal to proactively change its environment [65]. It is critical that an animal is able to react to its environment in a manner that feels comfortable. And having control over the environment helps to ensure this. We can facilitate control by providing plenty of species appropriate choices such as resting sites, feeding and foraging options, numerous and varied locomotion pathways, and environmental gradient choices.

5.2 Welfare evaluation

As previously discussed, the 'Five Domains' concept offers a useful template for the general assessment of animal welfare, addressing the need to consider physiological and behavioural indicators of animal well-being, in association with the various mental states an animal may experience [8] [10]. Yet, the assessment of animal welfare and an individual animal's affective state or psychological health provides challenges as it cannot be measured directly. Although assessment of the affective state can be performed indirectly via observations of its physical state and behaviour and may indicate the presence of positive or negative experiences or sensations. Experienced observation and interpretation of species-specific behaviours is required. Therefore, assessments of animal welfare should involve reviewing animal-based measures, as well as resource-based measures. Animal based measures, which can provide guidance to the welfare state of the individual animal, are important for understanding and ultimately achieving good animal welfare and must therefore be taken into account when considering the overall welfare of captive wild animals, in addition to resource based measures that involve an assessment of the provisions of the animal's environment, such as appropriate nutrition, suitable shelter, etc, as depicted in the four physical domains (nutrition, health, environment and behaviour).

Animal based measures may incorporate a number of different assessment techniques which in general involve behavioural measures, physiological measures, health assessments (injury occurrence, disease presence and mortalities) and animal group or population data analysis [10]. However, each of these four animal based measures or assessment techniques should not be considered alone, since independently each one has limitations, where as if outcomes from more than one assessment method are used, a more reliable indication of an animal's welfare state may be achieved [10]. For example, an individual animal may be in good physical health with normal physiological measures, yet its mental state and hence welfare may be poor if its fundamental need to burrow or nest cannot be met. Population data is useful when assessing the welfare of big groups of animals where it may be difficult to determine the identification of individuals.

Observing what behaviours different animals perform, the duration of the expressed behaviours and comparing these observations to the behaviours displayed by wild counterparts has been used as a method to assess welfare [66]. Behavioural measures of an individual's welfare may include the observation of abnormal behaviours such as stereotypies, avoidance, over-grooming, self-harming, excessively low levels of activity, poor maternal care, or hyper-aggression [67]. Yet, poor maternal care may occur for a variety of reasons; it can be associated with stress or result from ill health of the mother and therefore may not be a lone indicator of diminished welfare.

The performance of stereotypies is suggestive of a negative welfare state; they are considered indicators of poor animal welfare. Stereotypies may develop in animals for a variety of different reasons, but are often associated with suboptimal environmental provision, chronic social isolation and chronic stress or frustration as a result of the confined environment and its associated imposed restrictions [7]. Stereotypies can cause physical injuries and harm that result from the animal's repetitive actions and abnormal behaviours. Although, stereotypies may help the animal cope in its current environment and situation, they remain suggestive of diminished welfare [60]. However, if the occurrence of stereotypies is used as an animal based measure of welfare, it should also be noted that stereotypies can reflect previous, historical experiences in the animal's lifetime and therefore may not represent the effect of present management or environmental conditions on welfare [44] [16] [7]; where the observation of stereotypies is used as a welfare assessment method, other measures of welfare should be used in conjunction with stereotypy observation to give a more reliable indication of an animal's welfare state.

Physiological measures such as heart rate, measures of stress hormones (corticosteroids such as cortisol) and other biological parameters of physical health and stress, can provide insight. Cortisol can be measured via blood samples, saliva, faeces or urine, although like other physiological measures, changes in cortisol levels may not specifically relate to negative experiences; they also indicate positive experiences by the animal and hence should be interpreted in association with the specific environmental circumstances and conditions at the time of sampling [66]. Body weight changes may result from a number of different causes, such as seasonal fluctuations, changes associated with age

or the presence of disease, and hence, alone, should not be used as a reliable measure of animal welfare.

It is imperative that the interpretation of all animal-based assessments be carefully considered with specific reference to the environmental and management conditions experienced by the animal at the time of observation or sampling.

6. Miscellaneous

Peripheral to the Five Domains, other elements that are significant factors contributing to animal health and well-being are a documented institutional policy on animal welfare, the maintenance of good animal records, the prevention of an animal escape, and documented contingency plans for the management of an escape.

6.1 Governance

Mellor [68] recommends that each facility develop an animal welfare charter for the organisation that reflects a clear commitment to animal welfare principles. Such a charter may be in the form of a policy statement or a more detailed document of commitment outlining procedures and protocols. All animal care personnel within a facility should be familiar with this commitment and apply its doctrine to their daily work routines.

6.2. Record Keeping

The maintenance of accurate, well documented records forms a necessary element of good animal husbandry and care. In some jurisdictions it is a legal requirement for zoos to keep records [16]. Records must be kept by such a method that enables quick and easy access to the information. Computerised records are especially constructive in that information may be easily incorporated into web-based, global zoo animal databases such as the Zoological Information Management System (ZIMS) offered by the USA-Based Species360 organisation. However, stand-alone computerised records must be adequately and securely backed up.

Records detailing health, husbandry and behavioural observations enable the assessment and monitoring of patterns, whilst also providing a method of assessing animal welfare. Health records, alongside recorded daily behavioural observations, can facilitate the interpretation of trends in disease and observed mental health and hence may be used as indicators of general welfare. Demographic or population data is also valuable for the assessment of welfare in groups of animals). However, when considering individual animal welfare, the observations and records of individual animals should be interpreted collectively alongside the records of other individuals within the social grouping; enhancing the behaviour in one individual, can negatively affect the welfare of another individual in the group.

In addition to monitoring of the health and welfare of both individuals and groups of animals, records also play a role in breeding management. Many zoos and aquaria actively participate in co-operative breeding programmes. Whether the aim is to maintain genetic diversity of captive populations of species, or as part of a reintroduction programme, accurate records are vital [39].

In order for accurate records to be kept, the identification of each individual animal is vital. Individual animal identification of some species can be done through distinctive natural markings or appearance of the pelage. However, most animals can be individually marked using a suitable marking system [69] [70]. Only those marking systems that have minimal adverse effects on the animal should be used [69] [70]. Individual identification using the subcutaneous implantation of a unique microchip is frequently used. Where the permanent marking of animals using external marks or microchips is undertaken, it should only be performed by trained and competent personnel, using suitable equipment, under hygienic conditions. Marking systems for individuals should be appropriate, easy to apply with negligible discomfort to the animal, and the tag or microchip should not cause any impairment or irritation [70]. It is essential that the health, locomotor patterns and natural behaviour of the animal are not compromised through the identification system used [16].

6.3 Escapes

The prevention of the escape of captive wild animals from their enclosures is vital to safeguard the health and welfare of each individual animal accommodated within the enclosure. Furthermore, escape prevention ensures the safety of personnel and members of the public and protects the local biodiversity and the viability of local ecosystems. The escape of an animal from an enclosure may not only result in potentially serious injury to persons or damage to property, it also has the likely consequence of the escaped animal itself being subject to significant injury and harm. Therefore, it is imperative that sufficient thought and consideration are given to the secure design and maintenance of animal enclosures, and the facility's perimeter fencing. These represent primary containment barriers and must be of appropriate height, strength and construction. Entries to all animal enclosures must be locked not only to prevent animal escape but equally significantly, to prevent the unauthorised access by members of the public.

The deployment of a documented emergency animal escape protocol with scheduled review is indispensable. The protocol must further cover the procedures undertaken in the event of an unauthorised person entering an enclosure, or accidental or deliberate unauthorised contact with an animal. All personnel must be familiar with the protocol, comprehend its implementation, and documented training and practise drills regularly undertaken. Under certain circumstances, the humane destruction of the escapee may be necessary: the protocol must incorporate this possibility and ensure that an experienced member of staff with the necessary authority is available at all times to make such a decision. This emergency protocol must additionally address the requirements of local legislation and the notification of the local authority within required time frames.

Environmental disasters, climatic extremes and other catastrophes have the potential to severely compromise animal welfare. Each species of animal is adapted to living within particular environmental conditions that include specific thermal ranges and humidity levels. Severe changes in weather patterns will compromise welfare by exposing animals to thermal stress. Consequently, fires, extreme weather, natural disasters and other catastrophes must be planned for and incorporated into documented emergency protocols. To make the point: it is critical to ensure that appropriate contingency measures to safeguard the welfare of the animals held at the institution are devised and ready for immediate implementation should such events occur.

The welfare of an escapee free-roaming a local natural environment may be compromised through physical and/or psychological injury, and also through potential exposure to novel pathogens against which it may have little immunity. Therefore, every effort must be made to effect recovery of all escapees. Upon live recovery, the potential risk to the health and welfare of the other resident animals should be considered and mitigated through quarantine

APPENDIX ONE - GLOSSARY

NOTE: The meaning of definitions is determined by context

Acceptable

Acceptable in terms of international norms

Adequate

Sufficient and suitable for the intended purpose

Animal

Any mammal, bird, reptile, amphibian, fish, invertebrate or other sentient organism that is not a plant or a fungus

Aquaculture

The managed production either through intervention in the breeding process, or through stocking, feeding or predator control programmes, of aquatic animals

Barrier

Structure built to contain or prevent passage

- **Containment barrier**
The primary barrier that in its effect confines the animal
- **Safety barrier**
The barrier designed to keep humans at a safe distance from the animal enclosure and to prevent human / animal conflict

Behavioural enrichment

Is a concept which describes how the behavioural repertoires of animals under human care can be managed and enhanced for their well-being

Behavioral Management

Is a comprehensive, pro-active approach to enhancing the care and well-being of captive animals that involves four elements including positive reinforcement training, environmental enrichment, operational considerations, and facility design

Biosecurity

Is a means of reducing the risk of disease occurring or being transmitted to other animals

Captivity

State wherein animals are kept in confinement by human beings, whereby the animals' day-to-day needs, welfare and wellbeing are subject to the provision of human intervention and care

Cognition

The mental process of acquiring knowledge through the senses, experience, understanding and thought and which involves reasoning, perception, awareness, intuition and judgement.

Commercial breeding centre

A facility where live animals are bred, produced or cultured for purely commercial purposes

Commercial exhibit facility

A legal facility where living animals are exhibited to the public for exclusively commercial purposes

- **Pet shop**
A mercantile facility for the retail sale of live animals and related goods or services

Competent

Capable of executing one's duties effectively

Conspecific

An animal belonging to the same species as another

Domesticated animal

An animal that has been genetically modified through selective breeding over many generations in order to serve various human objectives

Domesticated pet

A domesticated animal kept by humans for household/personal companionship

Environmental enrichment

A dynamic process for enhancing animal environments within the context of the animals' behavioural biology and natural history. Environmental changes are made with the goal of increasing the animals' behavioural choices and drawing out their species-appropriate behaviours, thus enhancing animal welfare

Epidemiology

The investigation of disease as it affects groups of animals

Exotic pet

An animal kept by humans that is not fully domesticated and that belongs to a species not indigenous to the geographical area where it is kept, but which is kept by humans for household/personal companionship and pleasure

Euthanasia

The humane, painless and distress-free termination of an animal's life where it is considered to be in the best interest of the individual animal concerned, using a method which produces concurrent loss of consciousness and central nervous system functioning

Feral animal

A domestic animal that is living in a wild state which has poor habituation to, and fear of, humans. Placing such an animal into a typical household situation would, as such, have detrimental effects on its wellbeing.

Justifiable

Supportable by argument

Longevity

The length or duration of life

Management authority

Senior Personnel within the facility responsible for day-to-day management and administration

Normal behaviour

Behaviour that occurs at a frequency, duration and intensity within the range expressed by free-living wild conspecifics

Operant Conditioning

A type of learning in which the probability of a behavior recurring increases or decreases based on the consequences associated with that action or behavior; reinforcement, punishment and extinction are the consequences that either strengthen or weaken a behavior.

Private collection

A collection of animals without visiting public access, for the exclusive benefit to a private individual or individuals

Punishment

Anything that decreases the chance of a behaviour recurring

Rehabilitation centre

A permanently-sited facility without visiting public access, exclusively administered for the short term, temporary care of indigenous wild animals with the primary aim of their return to the wild

Reinforcement

Anything that increases the chance of a behaviour recurring

- **Positive reinforcement**

Following an act with something the subject wants, thereby increasing the chance of the act recurring

- **Negative reinforcement**

Following an act with the removal of something aversive that the subject wants to avoid, thereby increasing the chance of the act recurring; this is also called escape-avoidance training

Sanctuary

A permanently-sited facility exclusively administered for on-site, long term or lifelong, individual animal care. A sanctuary is a facility that rescues and provides care for animals that are in need of appropriate care, or have suffered abuse, injury or have been abandoned.

Sentience

Is the capacity to have subjective experiences and feel and perceive emotions such as pain and pleasure. It implies a level of conscious awareness and the ability to suffer.

Species

A kind of animal that does not normally interbreed with individuals of another kind and includes any sub-species, cultivar, variety, geographic race, strain, hybrid or geographically separate population

Specimen

Any living or dead animal, egg, gamete, or propagules or part of an animal, capable of propagation or reproduction or in any way transferring genetic traits; any derivative of any animal

Stereotypy

The persistent repetition of a behaviour for no obvious purpose

Suffering

An adverse mental state that negatively affects the welfare status of an animal and is associated with negative experiences such as pain, distress, extreme boredom, injury and disease.

Suitable

Appropriate for the intended purpose

Taming

This is a process which involves changing a wild animal's behaviour, but not its genetic characteristics. Taming is different from domestication, which is a process that changes the genetics of the animal over a long period of time by selective breeding. Tamed wild animals do not lose their innate wild characteristics.

Technical

According to principle; formal rather than practical and relating to, or employing the methodology of science

Veterinarian

Any person legally registered as a veterinarian with the appropriate legislative body in the country within which the institution is located.

Welfare

Animal welfare refers to a state that is specific for every individual animal; it is how the animal experiences its own world and life through its association with pleasant experiences specific for that

species such as vitality, affection, safety and excitement or unpleasant experiences such as pain, hunger, fear, boredom, loneliness or frustration.

Wellbeing

A state of harmony between the animal's physical and psychological functioning

Wild animal

A species of animal not domesticated in terms of this document and which retains its wild traits

Zoo/aquarium

A permanently-sited facility primarily open to and administered for the visiting public, where living animals are maintained under predominantly ex situ circumstances.

- **Bird park**
A facility specialising in the public exhibition of live birds
- **Reptile park**
A facility specialising in the public exhibition of live reptiles

Zoonosis

A disease that is communicable between vertebrate animals and man. (Zoonoses – plural).

Literature cited

- [1] F. A. Lee C, Doyle R, "Measuring Cognition and Emotion of Animals to Understand their Welfare," 2008.
- [2] H. Proctor, "Animal sentience: Where are we and where are we heading?," *Animals*, vol. 2, no. 4, pp. 628–639, 2012, doi: 10.3390/ani2040628.
- [3] E. Boyle, "Neuroscience and Animal Sentience," *Neuroscience*, no. March, pp. 1–12, 2009.
- [4] K. Horvath, D. Angeletti, G. Nascetti, C. Carere, and) Royal, "Invertebrate welfare: an overlooked issue," *Ann Ist Super Sanità*, vol. 49, no. 1, pp. 9–17, 2013, doi: 10.4415/ANN_13_01_04.
- [5] The National Archives, "Five Freedoms," *Farm Animal Welfare Council, Five Freedoms*, 1979.
- [6] T. C. Green and D. J. Mellor, "Extending ideas about animal welfare assessment to include 'quality of life' and related concepts," *N. Z. Vet. J.*, vol. 59, no. 6, pp. 263–271, 2011, doi: 10.1080/00480169.2011.610283.
- [7] P. B. Maple TL, *Zoo Animal Welfare*. Springer, 2013.
- [8] Mellor DJ, "When coping is not enough – promoting positive welfare states in animals," in *Proceedings of the RSPCA Australia Scientific Seminar, Canberra, Australia, 26th February 2013*, 2013, pp. pp2-13.
- [9] D. Mellor and C. Reid, "Concepts of animal well-being and predicting the impact of procedures on experimental animals," *Improv. well-being Anim. Res. Environ.*, pp. 3–18, 1994, doi: 10.4274/tjo.14602.
- [10] T. Portas, "Achieving positive animal welfare outcomes in zoos and aquariums," in *When Coping is not enough - promoting positive welfare states in animals*, 2013, pp. 46–50, [Online]. Available: www.kb.rspca.org.au.
- [11] K. S. DJ Mellor, "Quality of life: A valuable concept or an unnecessary embellishment when considering animal welfare?," 2008.
- [12] D. J. Mellor, "Affective States and the Assessment of Laboratory-Induced Animal Welfare Impacts," *ALTEX Spec. Issue*, vol. 1, no. 12, pp. 445–449, 2012, [Online]. Available: <https://pdfs.semanticscholar.org/8192/0b992d4d1060e6972a09ef8fcc6f6132738e.pdf>.
- [13] Animal Companion Welfare Council, "THE REPORT ON COMPANION ANIMAL WELFARE ESTABLISHMENTS : SANCTUARIES , SHELTERS AND RE-HOMING CENTRES," 2004.
- [14] N. Gregory, "Attitudes to animal welfare and the environment," 2001.
- [15] European Association of Zoos and Aquaria, "EAZA Standards for the Accommodation and Care of Animals in Zoos and Aquaria," 2014. [Online]. Available: <https://www.eaza.net/assets/Uploads/Standards-and-policies/Standards-for-the-Accommodation-and-Care-of-Animals-2014.pdf>.
- [16] P. A. Rees, *An Introduction to Zoo Biology and Management*. 2011.
- [17] New Zealand Ministry for Primary Industries: Regulation and Assurance Branch, *Code of Welfare: Zoos*, no. October. 2018.
- [18] Universities Federation for Animal Welfare (Great Britain), *Management and welfare of farm animals : the UFAW handbook*. 1988.
- [19] Department of Local Government and Regional Development and W. Australia, "Code of Practice for farmed Buffalo in Western Australia," 2003. [Online]. Available: [https://www.agric.wa.gov.au/sites/gateway/files/Code of Practice for Farmed Buffalo in Western Australia_0.pdf](https://www.agric.wa.gov.au/sites/gateway/files/Code%20of%20Practice%20for%20Farmed%20Buffalo%20in%20Western%20Australia_0.pdf).

- [20] P. Le Neindre *et al.*, "Space, environmental design and behaviour: Effect of space and environment on animal welfare," in *Global conference on animal welfare: An OIE initiative*, 2004, vol. 21, no. 2, pp. 134–140, [Online]. Available: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.135.2685&rep=rep1&type=pdf#page=143>.
- [21] R. Clubb and G. J. Mason, "Natural behavioural biology as a risk factor in carnivore welfare: How analysing species differences could help zoos improve enclosures," *Appl. Anim. Behav. Sci.*, vol. 102, no. 3–4, pp. 303–328, 2007, doi: 10.1016/j.applanim.2006.05.033.
- [22] D. L. Forthman, "Towards optimum care for confined ungulates," in *Second Nature – environmental enrichment for captive animals*, 1998, pp. 236–261.
- [23] C. Caws, S. Wehnelt, and F. Aureli, "The effect of a new vertical structure in mitigating aggressive behaviour in a large group of chimpanzees (*Pan troglodytes*)," *Anim. Welf.*, vol. 17, no. 2, pp. 149–154, May 2008.
- [24] L. Marino and T. Frohoff, "Towards a New Paradigm of Non-Captive Research on Cetacean Cognition," *PLoS One*, vol. 6, no. 9, p. e24121, Sep. 2011, doi: 10.1371/journal.pone.0024121.
- [25] Born Free, Endcap, and Wale and Dolphin Conservation Society - WDCCS, "EU ZOO INQUIRY 2011 - DOLPHINARIA: A review of the keeping of whales and dolphins in captivity in the European Union and EC Directive 1999 / 22 , relating to the keeping of wild animals in zoos .," p. 39, 2011.
- [26] J. A. Mench, "Management, handling, and transport of farm animal," in *Global conference on animal welfare: an OIE initiative*, Feb. 2004, pp. 149–155, Accessed: Jul. 15, 2020. [Online]. Available: <http://europa.eu.int>.
- [27] N. Animal Welfare Advisory Committee, "Code of Welfare Transport within New Zealand," 2018.
- [28] European Food Safety Authority, "Opinion of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to animal health and welfare in fattening pigs in relation to housing and husbandry," *EFSA J.*, vol. 44, pp. 1–36, 2004, doi: 10.2903/j.efsa.2007.564.
- [29] P. Linhart, D. B. Adams, and T. Voracek, "Vet Ital." Accessed: Jul. 16, 2020. [Online]. Available: www.izs.it/vet_italiana.
- [30] D. of L. G. and R. D. W. Australia, "Code of Practice for Camels in Western Australia," 2003. Accessed: Jul. 16, 2020. [Online]. Available: <http://www.dlgrd.wa.gov.au>.
- [31] "Transport of live specimens | CITES." https://www.cites.org/eng/prog/imp/Transport_of_live_specimens (accessed Jul. 16, 2020).
- [32] AATA, *AATA Manual for the Transportation of Live Animals. 2 ed.* Harris Associates Limited, 2000.
- [33] "Welfare of Animals During Transport Council Regulation (EC) No 1/2005 on the protection of animals during transport and related operations. The Welfare of Animals (Transport) (England) Order 2006 and parallel national legislation in Scotland, Wales and Northern Ireland. Guidance on implementation in the United Kingdom," 2011. [Online]. Available: www.defra.gov.uk/website/www.gov.uk/defra.
- [34] Ezemvelo KwaZulu-Natal Wildlife, "PROCEDURES AND STANDARD TERMS AND CONDITIONS KEEPING WILD ANIMALS CAPTIVITY, KWAZULU-NATAL, SOUTH AFRICA ," Oct. 30, 2013. <https://docplayer.net/53850143-Procedures-and-standard-terms-and-conditions-keeping-wild-animals-captivity-kwazulu-natal-south-africa-for.html> (accessed Jul. 16, 2020).
- [35] World Association of Zoos and Aquariums, "WAZA Code of Ethics and Animal Welfare," 2003. [Online]. Available: http://www.waza.org/files/webcontent/1.public_site/5.conservation/code_of_ethics_and_animal

_welfare/Code of Ethics_EN.pdf.

- [36] BIAZA, "BIAZA Animal Transfer Policy (ATP)," 2019.
- [37] H. Lewandowski, "Surplus animals: the price of success," in *Animal Welfare Forum: The Welfare of Zoo Animals*, 2003, pp. 981–983, Accessed: Jul. 16, 2020. [Online]. Available: https://ebusiness.avma.org/Files/ProductDownloads/2002_the_welfare_of_zoo_animals.pdf.
- [38] L. Reese *et al.*, "Deflighting zoo birds and its welfare considerations," *Anim. Welf.*, vol. 29, no. 1, pp. 69–80, 2020, doi: 10.7120/09627286.29.1.069.
- [39] B. Kohn, "Zoo animal welfare," 1994.
- [40] M. R. Loomis, "Common Disorders and Procedures of Zoo Animals," *MSD Manual - Veterinary Manual*, May 2015. <https://www.msddvetmanual.com/exotic-and-laboratory-animals/zoo-animals/common-disorders-and-procedures-of-zoo-animals> (accessed Jul. 17, 2020).
- [41] R. Clubb and G. Mason, "A Review of the Welfare of Zoo Elephants in Europe."
- [42] J. D. Edwards, "The role of the veterinarian in animal welfare - A global perspective ," in *Global conference on animal welfare: an OIE initiative*, 2004, pp. 27–32.
- [43] L. Carrasco, M. Colell, M. Calvo, M. T. Abelló, M. Velasco, and S. Posada, "Benefits of training/playing therapy in a group of captive lowland gorillas (*Gorilla gorilla gorilla*)," 2009.
- [44] R. R. Swaisgood and D. J. Shepherdson, "Scientific approaches to enrichment and stereotypies in zoo animals: What's been done and where should we go next?," *Zoo Biology*, vol. 24, no. 6. pp. 499–518, Nov. 2005, doi: 10.1002/zoo.20066.
- [45] G. A. Laule, "Positive reinforcement training and environmental enrichment: enhancing animal well-being," *J. Am. Vet. Med. Assoc.*, vol. 223, no. 7, pp. 969–973, 2003, [Online]. Available: <https://avmajournals.avma.org/doi/pdf/10.2460/javma.2003.223.969>.
- [46] G. D. Fairhurst, M. D. Frey, J. F. Reichert, I. Szelest, D. M. Kelly, and G. R. Bortolotti, "Does environmental enrichment reduce stress? An integrated measure of corticosterone from feathers provides a novel perspective," *PLoS One*, vol. 6, no. 3, 2011, doi: 10.1371/journal.pone.0017663.
- [47] R. R. Swaisgood, "Current status and future directions of applied behavioral research for animal welfare and conservation," *Appl. Anim. Behav. Sci.*, vol. 102, no. 3–4, pp. 139–162, Feb. 2007, doi: 10.1016/j.applanim.2006.05.027.
- [48] L. Miller, T. Bettinger, and J. Mellen, "The reduction of stereotypic pacing in tigers (*Panthera tigris*) by obstructing the view of neighbouring individuals," *Anim. Welf.*, vol. 17, no. 3, pp. 255–258, 2008, Accessed: Jul. 22, 2020. [Online]. Available: <https://www.ingentaconnect.com/content/ufaw/aw/2008/00000017/00000003/art00004>.
- [49] J. O'Brien, S. Heffernan, P. Thomson, and P. McGreevy, "Effect of positive reinforcement training on physiological and behavioural stress responses in the hamadryas baboon (*Papio hamadryas*)," *Anim. Welf.*, vol. 17, no. 2, pp. 125–138, 2008, Accessed: Jul. 23, 2020. [Online]. Available: <https://www.ingentaconnect.com/content/ufaw/aw/2008/00000017/00000002/art00004>.
- [50] N. Waran, P. McGreevy, and R. A. Casey, "Training Methods and Horse Welfare," in *The Welfare of Horses*, N. Waran, Ed. Springer Netherlands, 2007, pp. 151–180.
- [51] L. Kane, D. Forthman, and D. Hancocks, "Optimal Conditions for Captive Elephants: A Report by the Coalition for Captive Elephant Well-Being," 2005.
- [52] K. Carlstead, "A Comparative approach to the study of Keeper-Animal Relationships in the zoo," *Zoo Biol.*, vol. 28, no. 6, pp. 589–608, Nov. 2009, doi: 10.1002/zoo.20289.
- [53] EAAM, "The European Association of Aquatic Mammals Standards and Guidelines for the management of aquatic mammals under human care (version March 2019)," 2019. Accessed: Jul. 23, 2020. [Online]. Available: <https://eaam.org/wp-content/uploads/2019/06/EAAM->

Standards-and-guidelines-2019.pdf.

- [54] "EAZA Standards for the Accommodation and Care of Animals in Zoos and Aquaria," 2019.
- [55] BIAZA, "BIAZA Close Contact Policy 2019," 2019.
- [56] A. S. Chamove, G. R. Hosey, and P. Schaetzel, "Visitors excite primates in zoos," *Zoo Biol.*, vol. 7, no. 4, pp. 359–369, Jan. 1988, doi: 10.1002/zoo.1430070407.
- [57] D. Broom, "Cognitive ability and sentience: Which aquatic animals should be protected?," *Dis. Aquat. Organ.*, vol. 75, pp. 99–108, Accessed: Jul. 24, 2020. [Online]. Available: https://www.academia.edu/28207994/Cognitive_ability_and_sentience_Which_aquatic_animals_should_be_protected.
- [58] D. Mellor, "Affective States and the Assessment of Laboratory-Induced Animal Welfare Impacts," in *Proceedings of the 8th World Congress on Alternatives and Animal Use in the Life Sciences*, 2011, pp. 445–449, Accessed: Jul. 24, 2020. [Online]. Available: http://www.altex.ch/resources/445449_Mellor121.pdf.
- [59] I. J. H. Duncan, "Pain, fear and distress," in *Global conference on animal welfare: an OIE initiative*, 2004, pp. 160–169, Accessed: Jul. 24, 2020. [Online]. Available: <http://europa.eu.int>.
- [60] A. Tribe, "Zoos and animal welfare," 2008, Accessed: Jul. 24, 2020. [Online]. Available: https://www.researchgate.net/publication/43528772_Zoos_and_animal_welfare.
- [61] G. R. Hosey, "How does the zoo environment affect the behaviour of captive primates?," *Appl. Anim. Behav. Sci.*, vol. 90, no. 2, pp. 107–129, 2005, doi: 10.1016/j.applanim.2004.08.015.
- [62] L. M. Hopper, S. P. Lambeth, S. J. Schapiro, S. F. Brosnan, and L. E. Fisher, "When given the opportunity, chimpanzees maximize personal gain rather than 'level the playing field,'" *PeerJ*, 2013, doi: 10.7717/peerj.165.
- [63] D. E. Gaalema, B. M. Perdue, and A. S. Kelling, "Food Preference, Keeper Ratings, and Reinforcer Effectiveness in Exotic Animals: The Value of Systematic Testing," *J. Appl. Anim. Welf. Sci.*, vol. 14, no. 1, pp. 33–41, 2011, doi: 10.1080/10888705.2011.527602.
- [64] M. A. Owen, R. R. Swaisgood, N. M. Czekala, and D. G. Lindburg, "Enclosure Choice and Well-Being in Giant Pandas: Is It All About Control?," *Zoo Biol.*, vol. 24, pp. 475–481, 2005, doi: 10.1002/zoo.20064.
- [65] S. R. Ross, "Issues of choice and control in the behaviour of a pair of captive polar bears (*Ursus maritimus*)," *Behav. Processes*, vol. 73, pp. 117–120, 2006, doi: 10.1016/j.beproc.2006.04.003.
- [66] Kagan R and Veasey J., "Challenges of zoo animal welfare," in *Wild Mammals in Captivity - Principles and Techniques for Zoo Management*, 2nd ed., no. 1, Kleiman DG, Thompson KV, and C. Baer, Eds. Oxford University Press (OUP), 2012, pp. 11–21.
- [67] C. Draper and S. Harris, "The assessment of animal welfare in British zoos by government-appointed inspectors," *Animals*, vol. 2, no. 4, pp. 507–528, Dec. 2012, doi: 10.3390/ani2040507.
- [68] David J. Mellor, Susan Hunt, and Markus Gusset, "THE WORLD ZOO AND AQUARIUM ANIMAL WELFARE STRATEGY CARING FOR WILDLIFE," 2015. Accessed: Jul. 24, 2020. [Online]. Available: www.waza.org.
- [69] N. J. Beausoleil, D. J. Mellor, K. J. Stafford, and Massey University. Animal Welfare Science and Bioethics Centre., *Methods for marking New Zealand wildlife : amphibians, reptiles and marine mammals*. Dept. of Conservation, 2004.
- [70] D. J. Mellor and A. C. D. Bayvel, "The application of legislation, scientific guidelines and codified standards to advancing animal welfare," in *Global conference on animal welfare: an OIE initiative*, 2004, pp. 249–256, Accessed: Jul. 24, 2020. [Online]. Available: <https://www.oie.int/doc/ged/D706.PDF>.

- [71] "Secretary of State's Standards of Modern Zoo Practice," 2012. [Online]. Available: www.defra.gov.uk.
- [72] Desmond, Tim (1994). Behavioral management: An integrated approach to animal care. AZA Proceedings, 1994

Literature consulted

1. B Algers (2004) "Injury and disease". In: Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health), 23–25 February 2004, Paris, pp179-184
2. Archard GA, Goldsmith AR. (2010). 'Euthanasia methods, corticosterone and haematocrit levels in *Xenopus laevis*: evidence for differences in stress?' *Animal Welfare* 19: 85-92.
3. Baines F. (2008). "Photo-kerato-conjunctivitis in reptiles". In: Proceedings of the Autumn BVZS meeting, held on 8-9th November 2008 at Stretton, Cheshire, UK.pp43
4. Beausoleil, N.J., Mellor, D.J. and Stafford, K.J (2004). Methods for marking New Zealand wildlife: amphibians, reptiles and marine mammals. ISBN 0-478-22631-4, Department of Conservation, Wellington, pp 1-147
5. Birkett LP, Newton-Fisher NE (2011) "How Abnormal Is the Behaviour of Captive, Zoo-Living Chimpanzees?" *PLoS ONE* 6(6): e20101. doi:10.1371/ journal.pone.002010
6. Boyle, E. (2009). "Neuroscience and animal sentience." www.animalsentience.com. Accessed on 20th November 2013 at <http://www.animalmosaic.org/sentience/knowledge/articles/default.aspx?page=3&sentientopic=&globalissue=&date=&audio=tcm:46-28617>
7. Broom DM (1986) "Indicators of poor welfare." *Brit Vet J* 142: 524–526
8. Broom DM (2007). "Cognitive ability and sentience: Which aquatic animals should be protected?" *Diseases of Aquatic Organisms*. Vol 75: 99–108.
9. Brambell FWR (1965) "Report of the technical committee to enquire into the welfare of animals kept under intensive livestock husbandry systems." Cmnd. 2836. London, HMSO
10. Breuer T, Ndoundou-Hockemba M, Fishlock V (2005) "First observation of tool use in wild gorillas." *PLoS Biol* 3(11): e380
11. CAMBRE RC and BUICK WW. (1996). "Special challenges of maintaining wild animals in captivity in North America". *Rev. sci. tech. Off. int. Epiz.*, 15 (1), 251-266
12. Campbell TW (1991a). "Physical Restraint of exotic patients". *Veterinary Technician* vol 12, number 1. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp206-208
13. Campbell TW (1991b). "Husbandry concerns for pet reptiles". *Veterinary Technician* vol 12, number 9. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp144-146
14. Campbell TW (1993). "Raptor rehabilitation in the private veterinary hospital". *Veterinary Technician* vol 14, number 2. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp121-125
15. Campbell TW (1993). "Rehabilitation of sea turtles". *Veterinary Technician* vol 14, number 3. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp173-177
16. Campbell TW (1993). "Amphibian husbandry and medical care". *Veterinary Technician* vol 14, number 10. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp157-160
17. Carlstead K (2009). A comparative approach to the study of keeper-animal relationships in the zoo. *Zoo biology* 28:589-608

18. Carrasco L, Colell M, Calvo M, Abello MT, Velasco M, Posada S. (2009) "Benefits of training/playing therapy in a group of captive lowland gorillas (*Gorilla gorilla gorilla*)". In *Animal Welfare*, 18(1): 9-19
19. Caws CE, Wehnelt S, Aureli F. (2008). "The effect of a new vertical structure in mitigating aggressive behaviour in a large group of chimpanzees (*Pan troglodytes*).". *Animal Welfare* 17 (2): 149-154
20. Chamove AS, Hosey GR, Schaetzel P. (1988) Visitors excite primates in zoos. *Zoo Biology*, vol 7, issue 4, pp359-369
21. Chitty J (2002). Birds of Prey. In *BSAVA Manual of Exotic pets*. Fourth edition. P179-192. Eds A Meredith, S Redrobe. British Small Animal Veterinary Association (BSAVA) Publications, Gloucester.
22. Chitty J. (2006a). "The injured bird of prey. Part 1: legal and logistical issues". UK Vet volume 11, number 3. In: *UK Vet Compendium of rabbit and exotic articles – a collection of rabbit and exotic related articles published in UK Vet 1998-2006*. UK Vet Publications and Bayer plc. Pp84-90
23. Chitty J. (2006b). "The injured bird of prey. Part 2: Decision-making, feeding and biosecurity". UK Vet volume 11, number 4. In: *UK Vet Compendium of rabbit and exotic articles – a collection of rabbit and exotic related articles published in UK Vet 1998-2006*. UK Vet Publications and Bayer plc. Pp91—95
24. S Chung (2008) "Appropriate maze methodology to study learning in fish" *Journal of Undergraduate Life Sciences* Vol 2, no 1, pp52-55. Accessed at www.juls.library.utoronto.ca/index.php/juls/article/download/2990/1802 on 29th August 2013.
25. Clubb R, Mason G. (2002). "A Review of the Welfare of Zoo Elephants in Europe - A report commissioned by the RSPCA." Royal Society for the Prevention of Cruelty to Animals (RSPCA). Accessed at <http://www.rspca.org.uk/ImageLocator/LocateAsset?asset=document&assetId=1232714741738&mode=prd> on 27th April 2013.
26. Clubb R and Mason GJ (2007). "Natural behavioural biology as a risk factor in carnivore welfare: how analysing species differences could help zoos improve enclosures". *Applied Animal Behaviour Science*, 102:303-328
27. Clubb R, Rowcliffe M, Lee P, Mar KU, Moss C, Mason GJ. (2009). "Fecundity and population viability in female zoo elephants: problems and possible solutions." In *Animal Welfare*, 18 (3): 237-247.
28. Collins SA, Archer JA, Barnard CJ (2008). "Welfare and mate choice in zebra finches: effect of handling regime and presence of cover". *Animal Welfare* 17 (1): 11-17
29. Drewe J, Mwangi D, Cromie R, Donoghue H. (2005). "Use of reed beds to manage avian tuberculosis in waterbird collections". In: Proceedings of the spring BVZS meeting, held on 14-15th May 2005 at Chester, Cheshire, UK. pp24-25
30. Draper C, Harris S. (2012). "The Assessment of Animal Welfare in British Zoos by Government appointed Inspectors." *Animals*, 2:507-528
31. Duncan IJH (2004) "Pain, fear and distress". In: Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health), 23–25 February 2004, Paris, pp163-172
32. Eatwell K (2013) "Achieving stress free reptile consultations" BSAVA Congress Times, Birmingham, UK, April 2013, p34-35.
33. Edwards, JD.. (2004). "The role of the veterinarian in animal welfare — A global perspective" In: Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health), 23–25 February 2004, Paris, pp27-32.
34. Ewert JP, Cooper JE, Langton T, Matz G, Reilly K, Schwantje H. (2004a). "Species specific provisions for Amphibians. Background information for the proposals presented by the Group of Experts on Amphibians and Reptiles. Part B". WORKING PARTY FOR THE PREPARATION OF THE FOURTH MULTILATERAL CONSULTATION OF PARTIES TO THE EUROPEAN CONVENTION FOR THE PROTECTION OF VERTEBRATE ANIMALS USED FOR EXPERIMENTAL AND OTHER SCIENTIFIC PURPOSES (ETS 123). Council of Europe.

Accessed at <http://www.rspca.org.uk/search?searchKey=amphibians&x=0&y=0> on 23rd April 2013

35. Ewert JP, Cooper JE, Langton T, Matz G, Reilly K, Schwantje H (2004b). "Species specific provisions for Reptiles. Background information for the proposals presented by the Group of Experts on Amphibians and Reptiles. Part B" WORKING PARTY FOR THE PREPARATION OF THE FOURTH MULTILATERAL CONSULTATION OF PARTIES TO THE EUROPEAN CONVENTION FOR THE PROTECTION OF VERTEBRATE ANIMALS USED FOR EXPERIMENTAL AND OTHER SCIENTIFIC PURPOSES (ETS 123). Council of Europe. Accessed at <http://www.rspca.org.uk/search?searchKey=amphibians&x=0&y=0> on 23rd April 2013
36. Fairhurst GD, Frey MD, Reichert JF, Szelest I, Kelly DM, Bortolotti GR. (2011) "Does Environmental Enrichment Reduce Stress? An Integrated Measure of Corticosterone from Feathers Provides a Novel Perspective." *PLoS ONE* 6(3): e17663. doi:10.1371/journal.pone.0017663
37. Ferdowsian HR, Durham DL, Kimwele C, Kranendonk G, Otali E, et al. (2011) "Signs of Mood and Anxiety Disorders in Chimpanzees." *PLoS ONE* 6(6): e19855. doi:10.1371/journal.pone.0019855
38. Fernando P, Leimgruber P, Prasad T, Pastorini J (2012) "Problem-Elephant Translocation: Translocating the Problem and the Elephant?" *PLoS ONE* 7(12): e50917. doi:10.1371/journal.pone.0050917
39. Flecknell P. (2002). Chapter 6 "Guinea pigs", in BSAVA Manual of Exotic Pets, 4th Edition, edited by A Meredith and S Redrobe. British Small Animal Veterinary Association (BSAVA) Publications, Gloucester.
40. Forthman DL (1998). "Toward optimum care for confined ungulates". In *Second Nature – environmental enrichment for captive animals*, eds Shepherson DJ, Mellen JD, Hutchins M, pp236-261.
41. Fraser, D. (2004) "Applying science to animal welfare standards". In: *Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health), 23–25 February 2004, Paris*, pp121-127
42. Gaalema, D.E., Perdue, B.M. & Kelling, A.S. (2011). Food preference, keeper ratings, and reinforcer effectiveness in exotic animals. *Journal of Applied Animal Welfare Science*, 14(1), 33–41.
43. Galhardo L, Correia J, Oliveira RF. (2008). "The effect of substrate availability on behavioural and physiological indicators of welfare in the African cichlid (*Oreochromis mossambicus*)." In *Animal Welfare* 17 (3): 239-254.
44. Gelling M, Montes I, Moorhouse TP, Macdonald DW (2010) "Captive Housing during Water Vole (*Arvicola terrestris*) Reintroduction: Does Short-Term Social Stress Impact on Animal Welfare?" *PLoS ONE* 5(3): e9791. doi:10.1371/journal.pone.0009791
45. Gelling M, Johnson PJ, Moorhouse TP, Macdonald DW (2012) "Measuring Animal Welfare within a Reintroduction: An Assessment of Different Indices of Stress in Water Voles *Arvicola amphibius*." *PLoS ONE* 7(7): e41081. doi:10.1371/journal.pone.0041081
46. Girling SJ. (2008). "Back to basics – the reptile consult". In: *Proceedings of the Autumn BVZS meeting, held on 8-9th November 2008 at Stretton, Cheshire, UK*.pp57-71
47. Baker, Robert M., Mark Fisher, and Paul H. Hemsworth. 2001. *Farm animals in research: can we meet the demands of ethics, welfare, science and industry? : Proceedings of the conference held at the Waite and Roseworthy campuses of the University of Adelaide, 30 November - 1 December, 2000*. [Adelaide] S. Aust: ANZCCART.
48. Green TC and Mellor DJ (2011). Extending ideas about animal welfare assessment to include 'quality of life' and related concepts. *New Zealand Veterinary Journal*, 59:6, 263-27
49. Håstein T (2004). "Animal welfare issues relating to aquaculture." In: *Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health), 23–25 February 2004, Paris*, pp219-227

50. Hawkins P, Hubrecht R, Buckwell A, Cubitt S, Howard B, Jackson A, Poirier GM. (2010). "Refining rabbit care – a resource for those working with rabbits in research". UFAW and RSPCA, UK.
51. Hawkins P, Bairlein F, Duncan I, Fluegge C, Francis R, Geller J, Keeling L, Sherwin C. (2004). "Species-specific provisions for birds - Background information for the proposals presented by the Group of Experts on birds. PART B". WORKING PARTY FOR THE PREPARATION OF THE FOURTH MULTILATERAL CONSULTATION OF PARTIES TO THE EUROPEAN CONVENTION FOR THE PROTECTION OF VERTEBRATE ANIMALS USED FOR EXPERIMENTAL AND OTHER SCIENTIFIC PURPOSES (ETS 123). P50-97. Council of Europe. Accessed at <http://www.rspca.org.uk/ImageLocator/LocateAsset?asset=document&assetId=1232725857530&mode=prd> on 9th October 2013.
52. Heard D, Fleming G, Lock B, Jacob E. (2002). "Lizards". In *BSAVA Manual of Exotic pets* (2002). Fourth edition. Eds. A Meredith, S Redrobe. British Small Animal Veterinary Association (BSAVA) Publications, Gloucester, chapter 19, p223-240.
53. Hoffmann KA (1992). "Llamas: an overview". *Veterinary Technician* vol. 13, number 2. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp96-103
54. K Horvath, D Angeletti, G Nascetti and C Carere. (2013) 'Invertebrate welfare: an overlooked issue'. *Ann Ist Super Sanità* 2013. Vol. 49, No. 1: 9-17. Accessed on 6th august 2013 at www.iss.it/binary/publ/cont/ANN_13_01_04.pdf
55. Hosey, G.R. (2005). How does the zoo environment affect the behaviour of captive primates? *Applied Animal Behaviour Science*, 90(2), 107–129
56. Hopper, L.M., Lambeth, S.P., Schapiro, S.J. & Brosnan, S.F. (2013). When given the opportunity, chimpanzees maximize personal gain rather than 'level the playing field'. *PeerJ*, 1, e165
57. Houpt K, Houpt TP, Johnson JL, Erb HN and Yeon SC. (2001). "The effect of exercise deprivation on the behaviour and physiology of straight stall confined mares." *Animal Welfare* 10 (3), 257-267
58. Johnston C and Jungalwalla P. (2005) "AQUATIC ANIMAL WELFARE GUIDELINES - Guidelines on welfare of fish and crustaceans in aquaculture and/or in live holding systems for human consumption" *National Aquaculture Council of Australia*.
59. Kagan R, Veasey J. (2010). "Challenges of zoo animal welfare". In: *Wild Mammals in captivity: Principles and Techniques for Zoo Management*. Second edition. Eds. Kleiman DG, Thompson KV, Baer, CK. pp11-21.
60. Kane L, Forthman D, Hancocks D (2005). "Optimal Conditions for Captive Elephants: A Report by the Coalition for Captive Elephant Well-Being." Accessed at <http://www.elephantcare.org/protoman.htm> on 28th May 2013.
61. Kasanen IHE, Sorensen DB, Forkman B, Sandoe P. (2010). 'Ethics of feeding: the omnivore dilemma'. *Animal Welfare* 19: 37-44.
62. Kimminau KM. (1993). "Introducing the ostrich". *Veterinary technician* vol. 14, number 8. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp83-90
63. Kirkwood JK, Kichenside C and James WA (1989). "Training zoo animals." In: *Proceedings of an Animal Training Symposium organised by Universities Federation of Animal Welfare (UFAW)*, 26-27th September 1989, Cambridge, UK. UFAW, UK.
64. Kohn B. (1994) "Zoo Animal Welfare". *Rev. sci. tech. Off. int. Epiz.*, 13 (1), 233-245
65. Laule G. (2003). "Positive reinforcement training and environmental enrichment; enhancing animal well-being". In: "Animal Welfare Forum: the welfare of zoo animals."(2003) *Proceedings of the AVMA Animal Welfare Forum*, 11th October 2002, Milwaukee, Wisconsin. *Journal of the American Veterinary Medical Association* 223 (7), 957-983.
66. Leal M and Powell BJ. (2012). "Behavioural flexibility and problem solving in a tropical lizard." *Biology Letters* 8, 28-30.

67. Lee C, Doyle R, Fisher A (2008). "Measuring cognition and emotion of animals to understand their welfare" In: *The Welfare of Animals – It's everyone's business*. Proceedings of the Australian Animal Welfare Strategy International Conference, Conrad Jupiters, Gold Coast, Queensland, Australia, 31 August to 3 September 2008. Accessed on 19th November 2013 at http://www.daff.gov.au/animal-plant-health/welfare/aaws/aaws_international_animal_welfare_conference
68. Le Neindre P, Guémené D, Arnould C, Letierrier C, Faure JM, Prunier A, Meunier-Salaün MC (2004). "Space, environmental design and behaviour: Effect of space and environment on animal welfare". In: *Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health)*, 23–25 February 2004, Paris, pp135-141.
69. Lewandowski A (2003) "Surplus animals: the price of success". In: "Animal Welfare Forum: the welfare of zoo animals." (2003) Proceedings of the AVMA Animal Welfare Forum, 11th October 2002, Milwaukee, Wisconsin. *Journal of the American Veterinary Medical Association* 223 (7), 981-983
70. Lewbart GA. (1993). "Care and handling of pet fish". *Veterinary Technician* vol. 14, number 8. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp161-165
71. Linhart P, Adams DB, Voracek T (2008). "The International transportation of zoo animals: conserving biological diversity and protecting animal welfare." *Veterinaria italiana* 44 (1) 49-57.
72. Loomis MR (2012). 'Common Disorders and procedures of zoo animals' in the Merck Veterinary Manual on-line, accessed on 23rd May 2013 at http://www.merckmanuals.com/vet/exotic_and_laboratory_animals/zoo_animals/common_disorders_and_procedures_of_zoo_animals.html
73. Maclean B. (2002). "Ornamental fish". In *BSAVA Manual of Exotic pets*, fourth edition. Eds A Meredith, S Redrobe. British Small Animal Veterinary Association (BSAVA). Chapter 22, p267-279.
74. Manrod JD, Hartdegen R, Burghardt GM. (2008). "Rapid solving of a problem apparatus by juvenile black throated monitor lizards (*Varanus albigularis albigularis*). *Anim Cogn* 11:267-273.
75. Marino L, Frohoff T (2011) "Towards a New Paradigm of Non-Captive Research on Cetacean Cognition." *PLoS ONE* 6(9): e24121. doi:10.1371/journal.pone.0024121
76. Masi S, Chauffour S, Bain O, Todd A, Guillot J, et al. (2012) "Seasonal Effects on Great Ape Health: A Case Study of Wild Chimpanzees and Western Gorillas." *PLoS ONE* 7(12): e49805. doi:10.1371/journal.pone.0049805
77. Meagher RK, Mason GJ (2012) "Environmental Enrichment Reduces Signs of Boredom in Caged Mink." *PLoS ONE* 7(11): e49180. doi:10.1371/journal.pone.0049180
78. A Melino. (2010) "Animal transport and animal reaction during transport". Animal Transportation Association. Accessed in April 2013 at <http://www.animaltransportationassociation.org/Default.aspx?pagel=1355977>
79. Mellor DJ, Reid CSW. (1994) Concepts of animal wellbeing and predicting the impact of procedures on experimental animals". In: Baker R, Jenkin G, Mellor DJ (eds) *Improving the wellbeing of animal in the research environment*, Australian and New Zealand Council for the care of Animals in Research and Teaching, Glen Osmond, South Australia, p3-8.
80. D J Mellor, A C D Bayvel (2004) "The application of legislation, scientific guidelines and codified standards to advancing animal welfare." In: *Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health)*, 23–25 February 2004, Paris, pp249-256.
81. Mellor DJ, Beausoleil NJ, and Stafford KJ. (2004). *Marking amphibians, reptiles and marine mammals: animal welfare, practicalities and public perceptions in New Zealand*. ISBN 0-478-22563-6, Department of Conservation, Wellington, New Zealand.
82. Mellor DJ and Stafford KJ. (2008). "Quality of life: A valuable concept or an unnecessary embellishment when considering animal welfare?" In: *The Welfare of Animals – It's everyone's business*. Proceedings of the Australian Animal Welfare Strategy International Conference, Conrad Jupiters, Gold Coast, Queensland, Australia, 31 August to 3 September 2008.

Accessed on 19th November 2013 at http://www.daff.gov.au/animal-plant-health/welfare/aaws/aaws_international_animal_welfare_conference

83. Mellor DJ (2011). Affective States and the Assessment of Laboratory-Induced Animal Welfare Impacts. In: Proceedings of the 8th World Congress on Alternatives and Animal Use in the Life Sciences, Montreal 2011, pp445-450. Accessed on 20th January 2014 at <http://www.altex.ch/ALTEX-Proceedings/Proceedings.98.html?iid=2>.
84. Mellor DJ (2013). Chairman's Introduction: Setting the Scene – coping, cognition, quality of life improvement. In: "When coping is not enough – promoting positive welfare states in animals" Proceedings of the RSPCA Australia Scientific Seminar, Canberra, Australia, 26th February 2013, pp2-13. Accessed on 16th April 2013 at http://www.rspca.org.au/sites/default/files/website/The-facts/Science/Scientific-Seminar/2013/SciSem_2013_Proceedings.pdf.
85. Mellor, D. J., Hunt, S. & Gusset, M. (eds) (2015) Caring for Wildlife: The World Zoo and Aquarium Animal Welfare Strategy. Gland: WAZA Executive Office, 87 pp.
86. Menargues A, Urios V, Mauri M. (2008) "Welfare assessment of captive Asian elephants (*Elephas maximus*) and Indian Rhinoceros (*Rhinoceros unicornis*) using salivary cortisol measurement." In *Animal Welfare* 17 (3): 305-312.
87. Mench JA (2004) "Management, handling, and transport of farm animal." In: Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health), 23–25 February 2004, Paris, pp149-155
88. Meredith A. (2005a). "Feather plucking in psittacine birds. Part 1: medical causes". UK Vet volume 10, number 4. In: *UK Vet Compendium of rabbit and exotic articles – a collection of rabbit and exotic related articles published in UK Vet 1998-2006*. UK Vet Publications and Bayer plc. Pp71-74.
89. Meredith A. (2005b). "Feather plucking in psittacine birds. Part 2: psychological, behavioural and physical causes". UK Vet volume 10, number 5. In: *UK Vet Compendium of rabbit and exotic articles – a collection of rabbit and exotic related articles published in UK Vet 1998-2006*. UK Vet Publications and Bayer plc. Pp75-78
90. Meredith A. (2005c). "Feather plucking in psittacine birds. Part 3: a rational approach to diagnosis and therapy". UK Vet volume 10, number 6. In: *UK Vet Compendium of rabbit and exotic articles – a collection of rabbit and exotic related articles published in UK Vet 1998-2006*. UK Vet Publications and Bayer plc. Pp79-82
91. Miller LJ, Bettinger T, Mellen J. (2008) "The reduction of stereotypic pacing in tigers (*Panthera tigris*) by obstructing the view of neighbouring individuals." In *Animal Welfare* 17 (3): 255-258.
92. Miller LJ, Mellen J, Greer T, Kuczaj SA. (2011). "The effects of education programmes on Atlantic bottlenose dolphin (*Tursiops truncatus*) behaviour." In *Animal Welfare*, 20 (2): 159-172.
93. Miller P (1991). "An introduction to llamas". Veterinary Technician vol. 12, number 1. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp91-95
94. Molina-Lo ´pez RA, Casal J, Darwich L (2011) "Causes of Morbidity in Wild Raptor Populations admitted at a Wildlife Rehabilitation Centre in Spain from 1995-2007: A Long Term Retrospective Study." *PLoS ONE* 6(9): e24603. doi:10.1371/journal.pone.0024603
95. Morris AL, Livengood EJ, Chapman FA. (2010). "Sharks for the aquarium and considerations for their selection". University of Florida, Institute of Food and Agricultural Sciences (IFAS) extension. Accessed at <http://edis.ifas.ufl.edu/fa179> on 28th August 2013.
96. Muehlenbein MP, Ancrenaz M, Sakong R, Ambu L, Prall S, et al. (2012) "Ape Conservation Physiology: Fecal Glucocorticoid Responses in Wild *Pongo pygmaeus morio* following Human Visitation." *PLoS ONE* 7(3): e33357. doi:10.1371/journal.pone.0033357
97. EJ Narayan, JF Cockrem, JM Hero. (2013) "Sight of a predator induces a corticosterone stress response and generates fear in an amphibian". *PLoS ONE* 8(8): e73564. doi:10.1371/journal.pone.0073564.

98. Owen, M.A., Swaisgood, R.R., Czekala, N.M. & Lindburg, D.G. (2005). Enclosure choice and well-being in giant pandas: Is it all about control?. *Zoo Biology*, 24(5), 475–481.
99. JK O'Brien, S Heffernan, PC Thomson, PD McGreevy (2008). "Effect of positive reinforcement training on physiological and behavioural stress responses in the hamadryas baboon (*Papio hamadryas*)". *Animal Welfare* 17 (2): 125-138
100. J Parry Jones (1989). "Practical and ethical problems of training birds of prey." In: Proceedings of an Animal Training Symposium organised by Universities Federation of Animal Welfare (UFAW), 26-27th September 1989, Cambridge, UK. UFAW, UK.
101. Parry-Jones J. (2000). "Management guidelines for the welfare of zoo animals – falconiformes". The Federation of Zoological Gardens of Great Britain and Ireland.
102. JC Petherick and J Rushden (1997) 'Behavioural restriction' in Appleby, MC and Hughes, BO (eds) *Animal Welfare*. Wallingford, CAB International
103. Pinches M. (2003). "Non-infectious diseases of invertebrates". UK Vet volume 8, number 7. In: *UK Vet Compendium of rabbit and exotic articles – a collection of rabbit and exotic related articles published in UK Vet 1998-2006*. UK Vet Publications and Bayer plc. Pp138-141
104. Poole, V.A. and S. Grow (Eds.). 2012. Amphibian Husbandry Resource Guide, Edition 2.0. Association of Zoos and Aquariums, Silver Spring, MD. Accessed on 29th July 2013 at http://www.aza.org/uploadedFiles/Conservation/Commitments_and_Impacts/Amphibian_Conservation/Amphibian_Resources/AmphibianHusbandryResourceGuide.pdf
105. Pond J (1993). "The veterinary technician's role in a zoological park or aquarium". *Veterinary Technician* vol. 14, number 2. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp182-189
106. T Portas (2013). "Achieving positive animal welfare outcomes in zoos and aquariums" In: "When coping is not enough – promoting positive welfare states in animals", Proceedings of the RSPCA Australia Scientific Seminar, Canberra, Australia, 26th February 2013, pp46-50. Accessed on 16th April 2013 at http://www.rspca.org.au/sites/default/files/website/The-facts/Science/Scientific-Seminar/2013/SciSem_2013_Proceedings.pdf.
107. Helen Proctor (2012). "Animal Sentience: Where Are We and Where Are We Heading?" *Animals*. 2: 628-63
108. Pyykonen T, Ahola L, Hanninen S, Mononen J. (2010). 'Nest provision influences reproductive success in breeding blue fox vixens: a preliminary study'. *Animal Welfare* 19: 101-105
109. Raftery A. (2008). "The aquatic environment". In: Proceedings of the Autumn BVZS meeting, held on 8-9th November 2008 at Stretton, Cheshire, UK, pg. 38.
110. Rahman SA. (2004). "Animal Welfare: a developing country perspective". In: Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health), 23–25 February 2004, Paris, pp101-112
111. Raiti P. (2002). "*Snakes*". In: *BSAVA Manual of Exotic pets* (2002). Fourth edition. Eds. A Meredith, S Redrobe. British Small Animal Veterinary Association (BSAVA) Publications, Gloucester. Chapter 20, p241-256.
112. Ralston TL (1987). "Management of tropical fish". *Veterinary Technician* vol. 8, number 9. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp166-172
113. A B M Raj (2004). "Cultural, religious and ethical issues associated with animal welfare." In: Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health), 23–25 February 2004, Paris, pp235-241
114. Rees Davies R. (2002). "Post hibernation management of Mediterranean tortoises". UK Vet volume 7, number 1. In: *UK Vet Compendium of rabbit and exotic articles – a collection of rabbit and exotic related articles published in UK Vet 1998-2006*. UK Vet Publications and Bayer plc. Pp107-109
115. Rees Davies R. (2004). "Respiratory disease in snakes. Part 1". UK Vet volume 9, number 4. In: *UK Vet Compendium of rabbit and exotic articles – a collection of rabbit and exotic related articles published in UK Vet 1998-2006*. UK Vet Publications and Bayer plc. Pp115-120
116. Richardson T. (1999). "Waterfowl Management Guidelines". Wildfowl and Wetland Trust.

117. Roberts V (2008) Galliform birds: health and husbandry. In *BSAVA Manual of farm pets*. Eds. Roberts V, Scott-Park F. p190-214 British Small Animal Veterinary Association (BSAVA) Publications, Gloucester
118. Ross, S.R. (2006). Issues of choice and control in the behaviour of a pair of captive polar bears. *Behavioural Processes*, 73(1), 117–120
119. Ryan TP (1987). “An introduction to pet iguanas”. *Veterinary Technician* vol. 8, number 9. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp155-156
120. Ryan SJ, Walsh PD (2011) “Consequences of Non-Intervention for Infectious Disease in African Great Apes.” *PLoS ONE* 6(12): e29030. doi:10.1371/journal.pone.0029030
121. Leah Scott (1989). “Training non-human primates – meeting their behavioural needs.” In: *Proceedings of an Animal Training Symposium organised by Universities Federation of Animal Welfare (UFAW)*, 26-27th September 1989, Cambridge, UK. UFAW, UK
122. Salvanes AGV, Moberg O, Ebbesson LOE, Nilssen TO, Jensen K H, Braithwaite VA. (2013). “Environmental enrichment promotes neural plasticity and cognitive ability in fish”. *Proc R Soc B* vol 280, number 1767 20131331
123. Shen-Jin L, Todd PA, Yan Y, Lin Y, Hongmei F, Wan-Hong W. (2010). ‘The effects of visitor density on sika deer (*Cervus nippon*) behaviour in Zhu-Yu-Wan Park, China’. *Animal Welfare* 19: 61-65
124. Smith A and Rodriguez Barbon A (2008) Waterfowl: medicine and surgery. In *BSAVA Manual of farm pets*. Eds Roberts V, Scott-Park F. British Small Animal Veterinary Association (BSAVA) Publications, Gloucester.
125. Steinmetz HW, Zingg R, Ossent P, Eulenberger U, Clauss M, Hatt JM. (2011). “Comparison of indoor and captive, free-roaming management in golden headed lion tamarins (*Leontopithecus chrysomelas*) at Zurich Zoo.” In *Animal Welfare* 20 (2): 201-210.
126. Stamper E. (2004). “Animal transportation — An industry perspective” In: *Proceedings of the Global Conference on Animal Welfare: an OIE initiative (World Organisation for Animal Health)*, 23–25 February 2004, Paris, pp77-78
127. Stanford M. (2002) Cage and aviary birds. In: *BSAVA Manual of Exotic pets*. Fourth edition. Eds A Meredith, S Redrobe, p 157-167. British Small Animal Veterinary Association (BSAVA) Publications, Gloucester
128. Swaisgood RR and Shepherdson DJ (2005). “Scientific Approaches to Enrichment and Stereotypies in Zoo Animals: What’s Been Done and Where Should We Go Next?” *Zoo Biology*, 24:499–518
129. Swaisgood RR (2007). “Current status and future directions of applied behavioural research for animal welfare and conservation.” *Applied Animal Behav Sci* 102: 139-162.
130. A Tribe (2008). “Zoos and animal welfare”. In: *The Welfare of Animals – It’s everyone’s business*. Proceedings of the Australian Animal Welfare Strategy International Conference, Conrad Jupiters, Gold Coast, Queensland, Australia, 31 August to 3 September 2008. Accessed on 19th November 2013 at http://www.daff.gov.au/animal-plant-health/welfare/aaws/aaws_international_animal_welfare_conference
131. Vasconcellos AS, Guimaraes MABV, Oliveira CA, Ades C. (2009). “Environmental enrichment for maned wolves (*Chrysocyon brachyurus*): group and individual effects.” In *Animal Welfare*, 18(3): 289-300.
132. J Vitti. (2010). “The Distribution and Evolution of Animal Consciousness” Unpublished BA thesis. Harvard University. Accessed in June 2013 at scholar.harvard.edu/files/jvitti/files/animalconsciousness_cr_0.pdf
133. Vogt SL (1991). “Basic Avian health care and nutrition for the new bird owner”. *Veterinary Technician* vol 12, number 6. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp104-109
134. Walshaw SO (1983). “Reptilian management and medical care”. *Veterinary Technician* vol 4, number 3. In: *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA., pp147-154

135. Waran N, McGreevy P and Casey RA, (2002). "Training methods and Horse Welfare". In 'The Welfare of the Horse'. Kluwer Academic Publishers, pp151-180
136. Warwick C, Arena P, Lindley S, Jessop M and Steedman C (2013) "Assessing reptile welfare using behavioural criteria" *In Practice*, BVA. 35:123-131
137. DL Wells, RM Irwin (2008) "Auditory stimulation as enrichment for zoo-housed Asian elephants (*Elephas maximus*)."
Animal Welfare 17 (4): 335-340
138. Williams DL (2002). "Amphibians". In: *BSAVA Manual of Exotic pets* (2002). Fourth edition. Eds A Meredith, S Redrobe. British Small Animal Veterinary Association (BSAVA). Chapter 21, p257-266
139. Wobber V, Hare B (2011) "Psychological Health of Orphan Bonobos and Chimpanzees in African Sanctuaries". *PLoS ONE* 6(6): e17147. doi:10.1371/journal.pone.0017147
140. DGM Wood Gush (1985) 'The attainment of humane housing for farm livestock' in Fox MW, and Mickley LD (eds) *Advances in Animal Welfare science*. Washington DC, the Humane Society of the United States. P47-55.
141. Yamanashi Y, Matsuzawa T. (2010). 'Emotional consequences when chimpanzees (*Pan troglodytes*) face challenges: individual differences in self-directed behaviours during cognitive tasks'. *Animal Welfare* 19: 25-30.
142. "Compulsory operational standard of the African Association of Zoos and Aquaria" (2010). *African Association of Zoos and Aquaria* (PAAZAB). Accessed at <http://www.zoosafrika.com/operational-standards.html> on 22nd April 2013.
143. "2000 Report of the AVMA Panel on Euthanasia." (2001). *Journal of the American Veterinary Medical Association* (AVMA), 218 (5), 671-696.
144. "Animal Welfare Forum: the welfare of zoo animals." (2003) Proceedings of the AVMA Animal Welfare Forum, 11th October 2002, Milwaukee, Wisconsin. *Journal of the American Veterinary Medical Association* 223 (7), 957-983.
145. "Australian animal welfare standards and guidelines: exhibited animals. Version 5 – Stakeholder review draft." June 2009. Australian Government, Department of Agriculture, Fisheries and Forestry (DAFF). Accessed at http://www.daff.gov.au/animal-plant-health/welfare/model_code_of_practice_for_the_welfare_of_animals#exhibited on 28th May 2013
146. "Animal Welfare position statement". (2013). *Australasia Zoo and Aquarium Association*.
147. "Guidelines for Animal Close contact in member collections of the BIAZA." (2012a). *British and Irish Association of Zoos and Aquariums* (BIAZA). Accessed at <http://www.biaza.org.uk/animal-management/animal-management-resources/> in April 2013.
148. "Animal Transaction Policy." (2012b). *British and Irish Association of Zoos and Aquariums* (BIAZA). Accessed at <http://www.biaza.org.uk/animal-management/animal-management-resources/> in April 2013.
149. "Good Zoos and Aquaria, A Guide to BIAZA Zoos and Aquariums." (2013). *British and Irish Association of Zoos and Aquariums* (BIAZA)
150. "Ornamental fish keeping - YOUR GUIDE TO KEEPING FISH HAPPY AND HEALTHY" (2012) *British Veterinary Association - Animal Welfare Foundation* (BVA-AWF).
151. "Understanding Animal Welfare - A GUIDE TO THE FIVE FREEDOMS AND THEIR APPLICATION TO WILD ANIMALS IN CAPTIVITY." (2006). *Born Free Foundation*. Accessed at <http://www.bornfree.org.uk/campaigns/zoo-check/captive-wildlife-issues/> in April 2013.
152. "The EU Zoo inquiry 2011 - An evaluation of the implementation and enforcement of EC Directive 1999/22, relating to the keeping of animals in zoos. Report findings and recommendations." (2012) Written for the European coalition ENDCAP by the Born Free Foundation. Accessed at <http://www.bornfree.org.uk/campaigns/zoo-check/zoos/eu-zoo-inquiry/country-reports/> in April 2013.
153. "CAZA Animal care and Housing Manual". (2008a). *Canadian Association of Zoos and Aquariums* (CAZA). Accessed at http://www.caza.ca/en/about_caza/policies_and_position_statements/ on 22nd April 2013.

154. "CAZA Policy: Animal Acquisition and Disposition." (2008b). *Canadian Association of Zoos and Aquariums* (CAZA). Accessed at http://www.caza.ca/en/about_caza/policies_and_position_statements/ on 22nd April 2013.
155. "CAZA Policy: Human and Animal Contact." (2008c). *Canadian Association of Zoos and Aquariums* (CAZA). Accessed at http://www.caza.ca/en/about_caza/policies_and_position_statements/ on 22nd April 2013.
156. "CAZA Policy: Animal Transport." (2008d) *Canadian Association of Zoos and Aquariums* (CAZA). Accessed at http://www.caza.ca/en/about_caza/policies_and_position_statements/ on 22nd April 2013
157. "CAZA Position Re: Use Of Wild or Exotic Animals for Performance, Shows or Acts." (2008e). *Canadian Association of Zoos and Aquariums* (CAZA). Accessed at http://www.caza.ca/en/about_caza/policies_and_position_statements/ on 22nd April 2013.
158. CITES: (1997): CITES Guidelines for the Disposal of Confiscated Live Specimens of Species included in the Appendices (Resolution Conf. 10.7, adopted at the 10th Meeting of the Conference of the Parties, Harare (Zimbabwe), 9-20 June 1997). Accessed at <http://www.cites.org/eng/res/10/10-07R15.php> in April 2013.
159. "Report on the welfare of non-domesticated species kept for companionship". (2003). *Companion Animal Welfare Council*, UK.
160. "Companion animal welfare assessment" (2009). *Companion Animal Welfare Council*, UK.
161. Guidelines for transport and preparation for shipment of live wild animals and plants. (2004). CITES (CONVENTION ON INTERNATIONAL TRADE IN ENDANGERED SPECIES OF WILD FAUNA AND FLORA)
162. "DEFRA Code of Recommendations for the welfare of livestock – Pigs". (2003). DEFRA (*Department for Environment, Food and Rural Affairs*) Publications, London, UK.
163. "Animal Health and Welfare Strategy for Great Britain." (2004). DEFRA (*Department for Environment, Food and Rural Affairs*) London, UK.
164. Zoos Forum: Handbook (2008). DEFRA (*Department for Environment, Food and Rural Affairs*) London, UK. Accessed at <http://www.defra.gov.uk/wildlife-countryside/protection/zoo/zf-handbook.htm> on 15th April 2013.
165. "Welfare of Animals During Transport." (2011). Council Regulation (EC) No 1/2005 on the protection of animals during transport and related operations. The Welfare of Animals (Transport) (England) Order 2006 and parallel national legislation in Scotland, Wales and Northern Ireland. Guidance on implementation in the United Kingdom. DEFRA (*Department for Environment, Food and Rural Affairs*) London, UK. Accessed at: www.defra.gov.uk/publications/2011/06/13/pb13550-animal-welfare-transport/ in April 2013.
166. "Zoo licensing Act 1981 – Guide to the Act's provisions". (2012a). DEFRA (*Department for Environment, Food and Rural Affairs*) London, UK. Accessed at <https://www.gov.uk/government/publications/zoo-licensing-act-1981-guide-to-the-act-s-provisions> in April 2013.
167. "Secretary of State's Standards of Modern Zoo Practice" (2012b). DEFRA (*Department for Environment, Food and Rural Affairs*) London, UK.
168. "EAZA - Minimum Standards for the Accommodation and Care of Animals in Zoos and Aquaria" (2008). *European Association of Zoos and Aquaria* (EAZA). Accessed at <http://www.bornfree.org.uk/campaigns/zoo-check/zoos/euzoos/methodology-and-rational/> in April 2013.
169. *The European Association of Aquatic Mammals* (EAAM) 2009. "Standards and Guidelines for the management of bottlenose dolphins (*Tursiops sp*) under human care." Accessed at http://www.eaam.org/index.php?option=com_content&view=article&id=56&Itemid=61 on 28th May 2013
170. "A new Animal Health Strategy for the European Union (2007-2013) where 'Prevention is better than cure'". (2007). Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. *European Commission*. Accessed at

- http://ec.europa.eu/food/animal/diseases/strategy/docs/animal_health_strategy_en.pdf in April 2013.
171. "The welfare of animals during transport" - Scientific Report of the Scientific Panel on Animal Health and Welfare on a request from the Commission related to the welfare of animals during transport (2004). *European food safety authority* (EFSA). Accessed at www.efsa.europa.eu/en/scdocs/doc/44ax1.pdf in April 2013.
 172. "General approach to fish welfare and to the concept of sentience in fish - Scientific Opinion of the Panel on Animal Health and Welfare" (2009). *The EFSA Journal*, 954, 1-27. Accessed on 7th May 2013 at <http://www.efsa.europa.eu/en/efsajournal/pub/954.htm>.
 173. "Keeping wild animals in captivity, Kwazulu-natal, South Africa. Registration, permits, and licenses for keeping wild animals in captivity and for the exhibition, breeding or relocation, or trade, sale or exchange (alienation), of such animals." (2013). Draft document. *Ezemvelo KZN Wildlife*.
 174. "Five Freedoms" (1979). *FAWC*. Accessed at <http://www.fawc.org.uk/freedoms.htm> on 25th June 2013.
 175. "Glossary and Statements of Principle" (2013). *International Fund for Animal Welfare*, (IFAW). Accessed at <http://www.ifaw.org/european-union/resource-centre/glossary-and-statements-principle> on 19th November 2013.
 176. "IUCN Technical Guidelines on the Management of Ex-situ populations for Conservation" (2002). Approved at the 14th Meeting of the Programme Committee of Council, 10 December 2002, Gland Switzerland. Accessed at www.iucn.org/dbtw-wpd/edocs/Rep-2002-017.pdf in April 2013.
 177. "Code of recommendations and minimum standards for the welfare of ostriches and emu" (1998). *New Zealand Animal Welfare Advisory Committee* (Biosecurity New Zealand), pp 1-21
 178. "Code of Practice for farmed Buffalo in Western Australia" (2003a). *Department of Local Government and Regional Development* (DLGRD), Western Australia, pages 1-12
 179. "Code of Practice for Camelids in Western Australia" (2003b). *Department of Local Government and Regional Development* (DLGRD), Western Australia, pages 1-7
 180. "Animal welfare (Zoos) Code of Welfare 2005". *National Animal Welfare Advisory Committee* (NAWAC), New Zealand. Accessed at <http://www.biosecurity.govt.nz/reggs/animal-welfare/codes/alphabetically> in April 2013.
 181. "Transport within New Zealand"; Animal Welfare (Transport within New Zealand) Code of Welfare 2011 - A code of welfare issued under the Animal Welfare Act 1999. *National Animal Welfare Advisory Committee* (NAWAC), New Zealand. Accessed at <http://www.biosecurity.govt.nz/reggs/animal-welfare/codes/alphabetically> in April 2013.
 182. "Standards for Exhibiting Captive Raptors in New South Wales - Exhibited Animals Protection Act" (2010). Director-General, New South Wales Department of Primary Industries. Accessed on 8th August 2013 at: <http://www.dpi.nsw.gov.au/agriculture/livestock/animal-welfare/exhibit/raptors>
 183. "Guidance on the keeping of Venomous Snakes and Lizards - Dangerous Wild Animals (Northern Ireland) Order 2004." (2009a). *Northern Ireland Environment Agency* (NIEA). Accessed at http://www.doeni.gov.uk/niea/snakes_a5_rebranded_2009.pdf on 21st August 2013.
 184. "Guidance on the keeping of Venomous Spiders and Scorpions (Venomous invertebrates) - Dangerous Wild Animals (Northern Ireland) Order 2004." (2009b). *Northern Ireland Environment Agency* (NIEA). Accessed at http://www.doeni.gov.uk/niea/invertebrates_a5_rebranded_2009.pdf on 21st August 2013.
 185. "Animal Training - A review and commentary on current practice." (1990). Proceedings of a Symposium organised by Universities Federation of Animal Welfare (UFAW), 26-27th September 1989, Cambridge, UK. UFAW, UK.
 186. "Code of ethics and animal welfare." (2003a). *World Association of zoos and aquariums* (WAZA). Adopted at the WAZA Plenary Session of November 2003, San José, Costa Rica.
 187. "Guidelines on the acceptance of seized or confiscated animals." (2003b) *World Association of zoos and aquariums* (WAZA). Adopted at the WAZA Plenary Session of 20th November

- 2003, 58th Annual Meeting, San José, Costa Rica. Accessed at <http://wildpro.twycrosszoo.org/S/00Ref/MiscellaneousContents/d275.htm> in April 2013.
188. "Responsible Reproductive Management: Guiding Principles" (2005). *World Association of zoos and aquariums* (WAZA). Accessed at <http://www.waza.org/ethics/consensus.pdf>, in May 2006.
 189. "A guide to the biosecurity and husbandry standards required for the safe and responsible management of ex situ populations of amphibians" (2008). These standards are based upon those reported in the proceedings of the CBSG/WAZA Amphibian Ex situ Conservation Planning Workshop, El Valle, Panama, 12-15th February 2006. Accessed on 29th July 2013 at <http://www.amphibianark.org/pdf/Husbandry/A%20guide%20to%20husbandry%20and%20biosecurity%20standards%20for%20amphibians.pdf>
 190. "EU ZOO INQUIRY 2011 DOLPHINARIA - A review of the keeping of whales and dolphins in captivity in the European Union and EC Directive 1999/22, relating to the keeping of wild animals in zoos." *Whale and Dolphin Conservation Society* (WDCS) for the European coalition ENDCAP in association with the Born Free Foundation. Accessed at www.wdcs.org/submissions_bin/Eu_Dolphinaria_Report.pdf on 22nd April 2013.
 191. "A complete guide to using the Zoo Exhibit Quick Audit Process (ZEQAP) – Zoo Exhibit Quick Audit Process; Auditing terrestrial mammal exhibits". *World Society for the Protection of Animals* (WSPA, 2005).

Books:

1. Appleby MC, Cussen V, Garcés L, Lambert LA, Turner J. (2008). *Long distance transport and welfare of farm animals*. Wallingford: CABI.
2. AATA, 2000. Animal Transportation Association. *Manual for the Transportation of Live Animals*, 2nd ed. Redhill: Harris Associates Limited
3. Gregory NG. (2004). *Physiology and behaviour of animal suffering*. Universities Federation of Animal Welfare (UFAW). Blackwell Publishing.
4. *Management and welfare of farm animals – The UFAW Handbook*. (1988). Third edition. Bailliere Tindall, London.
5. Rees PA. (2011). *An introduction to zoo biology and management*. Wiley Blackwell Publishing.
6. Maple TL, Perdue BM. (2013). *Zoo Animal Welfare*. Springer.
7. Mellor DJ, Patterson-Kane E & Stafford KJ. (2009) *The Sciences of animal welfare*. Wiley Blackwell, Oxford, UK.
8. McArthur S. (1996). *Veterinary management of tortoises and turtles*. Blackwell Science Ltd.
9. *Exotic Animals – a veterinary handbook. A collection of articles from Veterinary Technician*. (1995). Veterinary Learning Systems Co., Inc. USA.
10. *BSAVA Manual of farm pets* (2008). Eds Roberts V, Scott-Park F. British Small Animal Veterinary Association (BSAVA) Publications, Gloucester
11. *BSAVA Manual of Exotic pets* (2002). Fourth edition. Eds A Meredith, S Redrobe. British Small Animal Veterinary Association (BSAVA) Publications, Gloucester
12. *BSAVA Manual of Wildlife Casualties* (2003). First edition. Eds E Mullineaux, D Best, JE Cooper. British Small Animal Veterinary Association (BSAVA) Publications, Gloucester
13. Girling S. (2003). *Veterinary nursing of exotic pets*. Blackwell Publishing.