4 Animal welfare and its assessment in zoos

Contents

Acknowledgements

PB 11229 (Part of PB 8095) This chapter issued September 2005

1.   Introduction

The zoo community considers animal welfare to be a matter of great importance. The EC Zoos Directive (1999/22/EC) provides that animals must be accommodated under conditions which aim to satisfy the biological and conservation requirements of the individual species and, in the UK, the Secretary of State's Standards of Modern Zoo Practice set out guidance as to how this should be achieved. Although there is an extensive literature on welfare assessment methods, especially for farm and laboratory animals (e.g. Webster & Main (2003), practical guidance on the assessment of welfare of zoo animals appears scant (but see Kirkwood, 1999; Wielebnowski, 2003; Smith, 2004).

This Chapter aims to assist zoos and zoo inspectors evaluate the welfare of zoo animals and, in so doing, to help promote high standards of animal husbandry in line with the requirements of the Directive. It was compiled by a Working Group of the Zoos Forum, the membership of which is listed in Appendix 1.

1.1   What is concern for welfare about?

The term 'animal welfare' was not coined by scientists in response to a need to express a precisely-defined concept. Furthermore, in contrast to the term 'cruelty' the meaning of 'welfare' has not been explicitly defined in British law (Radford, 2001).   The term arose in society and is one of those that, at least in common use, can represent any one of an assortment of somewhat vague notions. These may be to do with health, pleasant feelings, pastoral harmony or other concepts. Fraser et al (1997) defined three distinct (if overlapping) ethical concerns that have been encompassed by some in their use of the term:

> *(1)   'that animals should lead natural lives through the development and use of their natural adaptations and capabilities,*
> *(2)   that animals should feel well by being free from prolonged and intense fear, pain, and other negative states, and by experiencing normal pleasures, and*
> *(3)   that animals should function well, in the sense of satisfactory health, growth and normal functioning of physiological and behavioural systems*.'

Therefore, when discussing and assessing animal welfare, it is important to be clear what precisely we mean, i.e. which of these, or other, ethical frameworks are being referred to and why.

It is our view the second of these concerns, *the quality of subjective feelings*, is the central issue. The problem with this is, however, that feelings cannot be measured directly but can only be inferred based on our knowledge of the biology of the animal and its physical state and behaviour. Of course, both state of health and the nature of the environment can affect how animals feel and therefore affect welfare.

Suboptimal health often causes poor welfare but not always. Although many diseases cause pain, discomfort and other unpleasant feelings, not all do. For example, a small, benign and static lipoma (benign tumour of fat) beneath the skin is a defect of health (a lipoma being a type of disease) but it is unlikely to cause any harm to how an animal feels.

Concern that an environment should be natural is rather more to do with aesthetics or education than a welfare concern. If animals feel well and are healthy, then if they are in an environment that does not meet the expectations of some human observers about naturalness, this may be relevant to the feelings of these human observers but is not relevant to the feelings of (i.e. the welfare of) the animals.

The central concern of animal welfare is that animals should feel well and the best approach to ensuring this, and thus good welfare, is to provide an environment that as fully as possible meets their immediate needs and those for their future welfare (See Box 1 for discussion of feelings in the animal kingdom). It is hard to imagine anyone disagreeing with this principle and, on the face of it, it sounds simple and straightforward. However, some aspects of the issue of what an animal's needs are for its welfare have been the subject of considerable dispute. It has been argued, for example, that mink that are farmed for fur do not need water in which to swim. That, although they are adapted to a river bank environment and swim frequently in the wild, they can be maintained in good health in captivity without having access to swimming water. This argument has been dealt a very serious blow by recent work which showed that not only were captive mink prepared to work hard to gain access to swimming water but that, denied access to it, their urinary cortisol levels (an index of stress) increased in a way comparable to that seen in mink denied access to food (Mason et al, 2001). The implication being that mink value swimming water very highly and that their welfare could not be considered good without it.

It is to be hoped that there will be much more research of this kind, aimed at helping us to gain insight into what animals themselves rank as important, in the future. Although the results of such work are not the only information we need to make sound judgements for animal welfare (because animals, including humans, do not always make choices that are in their best long-term interests), they can be very helpful – they provide a way of enabling the animals to 'tell' us their own views.

However, it is not realistic to think that such detailed scientific approaches can be used to help establish the needs of the animals of all the many wild species maintained in captivity (at least for a very long time). In the meantime, we suggest that a good guiding principle is that, as far as possible animals should be provided with habitats that enable them to perform behaviours that they have evolved to perform commonly in their daily lives in the wild. And that, where there is uncertainty, we should, where we can, err on the side of giving them the benefit of the doubt. This is in line with one of the five key principles set out in the Secretary of State's Standards of Modern Zoo Practice (Defra, 2004): *'provision of an opportunity to express most normal behaviour'*.

Box 1   Do all animals have feelings?

The animal kingdom is very diverse. It includes species with very large and complex brains and species that have no nervous systems at all. We know, from personal experience, that we humans have conscious awareness of feelings and thus the capacity to suffer but it seems very reasonable to doubt that our earliest, unicellular ancestors did. It is very unclear, however, at what point along the way, the capacity for conscious awareness of feelings evolved and which extant taxa have it (Kirkwood & Hubrecht, 2001). The Animals (Scientific Procedures) Act 1986, gives protection to vertebrate animals (and just one invertebrate, the common octopus), reflecting the view that, with few exceptions, the capacity for conscious awareness of feelings is probably limited to vertebrates. However, it has been argued that there is no clear scientific case for drawing the line at this point (e.g. Sherwin, 2001).

It is right to, as far as possible, give all animals the benefit of the doubt and to care for them as if they do have the capacity to suffer. But, even in zoos, there are limits to how far this approach can be taken: it would not seem reasonable, for example, to favour the well-being of parasitic nematodes in the gut of, say, an elephant over that of their host.

1.2   The purpose of the chapter

The purpose of this chapter is to provide information about the assessment of animal welfare in zoos for zoo inspectors, zoo personnel, and others who may be interested.

The provisions relevant to animal welfare in the Zoo Licensing Act 1981 (Amendment) (England and Wales) Regulations 2002 require zoos to be:

> 5. 1A. (c) *accommodating their animals under conditions which aim to satisfy the biological and conservation requirements of the species to which they belong, including-*
>
>> (i) *providing each animal with an environment well-adapted to meet the physical, psychological and social needs of the species to which it belongs; and*
>>
>> (ii) *providing a high standard of animal husbandry with a developed programme of preventative and curative veterinary care and nutrition;*

(Specific clauses are included also in the Act (in Section 16E) about '*Welfare of animals following closure of zoo*' but these do not define or discuss what is meant by welfare.)

The inspection system under this Act provides a mechanism for formal inspection and auditing of standards relating to these and other subjects. However, although the Secretary of States Standards of Modern Zoo Practice (SSSMZP) set out various provisions relevant to the welfare of animals in zoos (based loosely on the Five Freedoms), they include rather little information on how welfare should be assessed. A central aim of this chapter is to provide more information about this and, specifically, to outline a 'toolkit' of methods for welfare assessment.

Assessment of welfare, and the auditing the quality of animals' environments for their welfare, usually involve checking a combination of 'resource-based indices' and 'animal-based indices'. Resource-based indices are features of the environment, for example: presence of constant supply of fresh water, presence of suitable bedding, and provision of an appropriate thermal environment. Animal-based indices are indices of the welfare of the animals themselves, such as: presence or absence of pain-causing disease or injury or of behavioural or other signs that may be indicative of poor welfare (see Table 1.1).

Resource-based indices are easy to check, easily measurable and quantifiable but provide no direct information about animals' welfare. Animal-based indices tend to be inherently more difficult to obtain, because, for example, it is quicker and easier to check that drinking water is provided than that the animal is drinking it. Furthermore, using animal-based indices may involve making subjective judgments about, for example, whether or not certain behavioural or other signs are indicative of compromised welfare.

Table 1.1: Examples of resource-based and animal-based indices that are or could be used in assessing zoo welfare standards

Animal-based indices	Resource-based indices
The SSSMZP include none at present The Inspection Form includes only one question of this kind: *3.1 Do all animals on display to the public appear in good health?'* Various questions could be included in future, for example: Do the animals appear to be well-fed and in good body condition? Do any animals show signs of untreated disease or injury? Do the veterinary records indicate unacceptable incidence of any welfare or health problems?	The SSSMZP specifies many resource based indices, for example: '*1.3 supplies of food and drink to be kept and prepared under hygienic conditions…* *3.7 a comprehensive programme of (veterinary) care must be established...* *4.4 enclosures should be equipped in accordance with the needs of the animals...* *5.5 suitable, separate if appropriate, accommodation for pregnant animals and animals with young should be available....*'

1.3   Welfare goals in zoos

What animal welfare goals should zoos strive to achieve? The welfare of free-living animals is often very poor. In the 'struggle for existence' conditions that probably cause severe pain, stress, fear and other unpleasant feelings are commonplace and routine. The welfare of free-living wild animals can range from good to extremely bad. The goal of zoos must be to emulate the good end of this spectrum and to ensure that, as far as possible, the risks of bad welfare are minimised.

It is not possible to prevent all welfare risks. For example, even under ideal conditions, painful spontaneous diseases can occur. A zoo's goal should be to carefully manage and minimise those risks that can be managed, and to detect and deal promptly with the unavoidable welfare problems that inevitably arise. More than this, zoos should strive to

contribute to research and developments aimed at advancing the welfare of wild animals in captivity.

In short, zoos should aim to:

- minimise risks of poor welfare;
- recognise and deal promptly with welfare problems; and
- play a role in advancing knowledge of zoo animal welfare.

Zoos need effective strategies, procedures and management in order to ensure effective deployment of their resources in pursuit of these objectives.

1.4   A word about euthanasia

Because resources are not infinite and have to be used carefully if species are to be effectively conserved and individual animals cared for to high standards, it may often be necessary to euthanase animals in zoos (for example if there are welfare or conservation disadvantages in maintaining an aged animal). Providing it is carried out humanely, euthanasia does not compromise welfare, and providing it is carried out with respect, and for a proper purpose (e.g. welfare or conservation benefit), we believe it is part of the job in a well-run zoo. We believe it important to set this out clearly as the subject is one about which there is often confusion.

1.5   Breeding management

The breeding of animals in captivity has to be controlled. Where all their needs for breeding are met, animal populations increase geometrically. In the wild, population sizes are regulated by factors such as limits to food or territory availability or the effects of predation and disease. There are two ways by which captive populations can be regulated once the zoo community's carrying capacity for the species has been reached: (i) by preventing breeding and (ii) by euthanasing surplus stock. The decision as to which approach to adopt has not been an easy one for zoos.

There may be welfare advantages in allowing animals to breed and euthanasing surplus animals produced, providing euthanasia is done without causing fear or pain to the animal itself or to others that may in some way depend upon it. This is because:
(i)   breeding provides the opportunity for animals to display a wider range of behaviours that may have welfare benefits and
(ii)   because it avoids the need for contraceptive methods such as keeping males and females apart, castration, vasectomy, and the use of hormonal implants all of which may present some welfare risks. However

these are sensitive issues with zoo staff and wider society and need to be discussed carefully (WAZA, 2003).

1.6   Transport

In order to maintain genetic diversity, zoo animal populations are typically managed at national or international level with individuals being moved between zoos for breeding. Transport of animals is an integral part of zoo animal management. Transport is a potentially stressful experience for animals and it is important that it is carried out to high welfare standards. The legal framework providing protection for the welfare of animals during transport is established in Europe by the Council Regulation EC 1/2005 of 22nd December 2004 on the protection of animals during transport and related operations (EC Regulation, 2005). Valuable guidance on animal transport is provided by IATA (2004).

It is beyond the scope of this chapter to deal specifically with zoo animal transport but, in any review of zoo animal welfare, the methods and standards of the transport procedures employed should be also be taken into consideration.

1.7   Some general comments about assessing welfare

Generally, challenges that cause unpleasant feelings (e.g. fear or pain) that are brief, relatively mild and which are not repetitive, or at least not repeated often, are not considered to have a significant impact on welfare. Such challenges are often unavoidable side effects of procedures undertaken for animals' benefits, such as, for example, vaccinations by injection or being moved to a new and better enclosure. In fact, for those animals, captive or free-living, that have the capacity for unpleasant feelings, such feelings are to some extent unavoidable side effects of the very business of living.

Welfare becomes a matter of concern when unpleasant feelings are more severe, and/or of longer duration, and when the animal is unable to react to limit them, either because it is prevented from doing so by its circumstances or because it lacks the capacity to do so. For example, the mild discomfort that an animal may feel in cold weather when it goes outside despite having the choice of staying in heated indoor accommodation cannot be construed to be a welfare problem. On the other hand, having to endure a colder environment than that to which it is adapted and with which it is able to cope certainly would be. In assessing welfare, therefore, it is clearly important to consider the severity and duration of the effects on the animal.

In prioritising the tackling of welfare problems it is appropriate to consider also the numbers of animals affected. All else being equal, it makes sense to address problems that affect the largest numbers of animals first.

1.8   What kinds of problems may threaten the welfare of zoo animals?

Adequate welfare is dependent upon meeting animals' needs: for food; water; thermal environment; lighting; space; environmental features (for foraging, resting, sleeping, exercise, escape from disturbance, etc); social interactions; and for the maintenance of good health (Companion Animal Welfare Council, 2003). As with other animals, domesticated or wild, that are dependent upon humans, welfare problems may arise through either a lack of knowledge of these needs or how they can best be met, or through the absence or application of the resources with which they may be met. See Box 2 for discussion of how welfare needs may vary with sensory and cognitive capacities between species.

Lack of knowledge may be absolute, that is, unknown to anyone (e.g. the required dietary concentration of the species for vitamin A may be unknown) or, in other cases, it may be that the knowledge exists somewhere in the world but is not accessible, understood, or applied where it is needed. These issues are discussed in the Companion Animal Welfare Council's (2003) Report on *The welfare of non-domesticated animals kept for companionship* (at pages 28-29 in the CAWC Report).

Box 2   Variation between species in sensory and cognitive capacities and how this may affect welfare needs

Welfare is about: '*the balance of the quality, throughout life, of the complex mix of feelings associated with brain states induced by various sensory inputs and cognitive processes'.*
(Kirkwood, 2004). Feelings are the content of consciousness and there is almost certainly variation, among those animals that have the capacity for feelings, in the range of senses, emotions and cognitive processes of which they can be aware. The capacity for feelings of pain and fear may, for example, have arisen early in evolution and be widespread, whereas other feelings may be associated with sensory systems or cognitive abilities that are not widespread.

In the words of the Companion Animal Welfare Council's report on the welfare of non-domesticated animals kept for companionship:

'*amongst those species that share our capacity for conscious awareness, there are…likely to be differences in the ranges of sensory or cognitive phenomena which they are able to experience, and which might therefore cause suffering. For example, animals belonging to species which do not possess eyes cannot suffer photophobia; those which are non-territorial are less likely to be stressed by the close proximity of conspecifics; and it is likely that only those which can perceive ultrasound will be at risk of mental discomfort from exposure to high intensities of it.*

In a recent review of the use of primates in scientific procedures, the Boyd Group (2002)
considered that there was strong and clear evidence that great apes have complex mental abilities similar in some important ways to those of humans including: 'a sense of self and insight into their own thoughts and feelings, a developed sense of time and purpose, so that they can think about the future and reflect on the past, and an ability to empathise with the thoughts and feelings of other members of their own species. The Group concluded that these mental abilities are likely to enhance the capacity of these animals for suffering to such an extent that it is unethical to confine them in laboratories for research or testing. It would seem reasonable to take this enhanced capacity for suffering into account whenever these animals are maintained in captivity, regardless of where or the reason for which they are kept.

To summarise, there are grounds for believing it likely that differences exist between species in their capacity to suffer when kept in less than ideal circumstances..… Animals with greater cognitive powers may be able to suffer in ways that others with simpler minds cannot. The needs of all animals should be met as fully as possible and, as a general proposition, there may be a greater risk of failing to meet the psychological needs of those with more complex minds.'

1.9   The development of animal welfare in zoos

Since the early 1800s, when interest in zoological collections began to develop internationally, attitudes as to what constitute acceptable and good standards of animal care have changed a great deal. Systems of animal keeping in zoos, on farms, in laboratories, and as pets in the home have been subject to scrutiny, re-evaluation, and re-development in the light of growing knowledge of animal biology and the ethical implications of the deeper understanding of welfare needs that this has brought about (Kirkwood, 2003).

Developments in animal welfare law reflect these changes in attitude. The aim of the first animal protection legislation in the 1800s was merely to prevent cruelty, whereas modern laws (e.g. the UK's Zoo Licensing Act, 1981 (as amended 2002) and the EC Zoos Directive 1999/22/EC) require that animals are accommodated under conditions which aim to satisfy their biological requirements.

Many factors have played a part in stimulating the great emphasis now given to animal welfare but zoos contributed to this. There is little doubt that, as a result of the growing interest in animal welfare science in zoos and elsewhere, there will be many further developments for the improved welfare of captive wild animals in the coming years.

1.10 Dealing with situations in which the use of animals for conservation, research or education may not be in the best interests of the animals involved.

There can be occasions when the use of animals in conservation programmes may not be in the best interests of the welfare of the animals involved. For example, where animals are translocated from the wild or released from captivity to re-stock habitat from which the species had become extinct, this may be very important from the perspective of preserving biodiversity but at some welfare risk to the translocated/ released animals. Such conflicts can occur also with the use of animals in research and education. Ethical dilemmas like these or similar to these cannot be avoided in zoos or in any other circumstances in which we are responsible for animals. Dealing properly with these dilemmas is an important matter. However, it is not addressed in this chapter as the matter is covered by the existing chapter on 'The Ethical Review Process' in the Zoos Forum Handbook (Zoos Forum, 2003).

2. The 'toolbox' of welfare assessment methods

2.1 Introduction

In the following sections a variety of 'tools' are described that can be used in reaching an assessment of the welfare status of animals. As far as possible the descriptions of each 'tool' and its use for welfare assessment have included the following (as appropriate):

- a title making clear what the tool is (e.g. 'determination and measurement of stereotypic behaviour as a tool for welfare assessment', 'the measurement of corticosteroid levels as a tool for welfare assessment', 'interpretation of skin lesions as a tool for welfare assessment', 'the review of disease prevalence records as a tool for welfare assessment');

- further background and explanation about the tool where necessary;

- why it is useful or potentially useful for welfare assessment;

- caveats and limitations in its use;

- where necessary, mention of what other measures would help in interpreting the results that this tool yields; and

- example(s) showing clearly how the tool can be used in practice.

We cannot know how another animal feels, we can only make inferences about this based on our assessment of their physical state and behaviour, taking into account our knowledge of their neural capacities and in the light of our own experiences (Kirkwood, 2004). In view of the obvious difficulties, it is appropriate to be cautious about making such inferences. In the sections below various methods used in the assessment of physical state and behaviour relevant to this process are outlined.

Some of these 'tools', used alone, can enable reliable welfare assessment. For example, if review of disease prevalence reveals that a high proportion of individuals of one species have been chronically and severely lame, there is nothing to be gained by looking for subtle physiological indices of compromised welfare also. In other cases, it is important to use more than one method or approach in making an assessment of welfare. Behavioural observations are often crucial in being able to properly interpret physiological measurements. For example, heart rate may be raised when animals are playing or when they are fearful and trying to escape. Without behavioural observations, the welfare significance of an elevated heart rate could be wrongly interpreted.

Some tools address different facets of the same underlying problem (e.g. behavioural observations may identify excessive licking and observations of physical state may identify skin wounds due to excess licking).

Judgment has to be exercised in deciding which of these tools, or which sets of them, should be used. The most appropriate combination will depend on the species and individual circumstances. The sections below provide will hopefully be helpful in providing guidance about which are the most applicable in various situations.

As noted above, some of the tools expanded upon in this section can give instant feedback as to whether an individual is suffering from poor welfare (e.g. whether the animal has a broken leg). Others may reveal signs of a history of welfare problems (e.g. stereotypies) but require other information before it can be determined whether the welfare problem is ongoing or historical. Others tools involve proactive sample collection and may be particularly useful in comparisons of how different husbandry practices affect welfare (e.g. cortisol levels).

Some lend themselves for use in initial or preliminary assessments, others to deeper, more detailed or specific assessments that may be useful, particularly, where simpler measures have indicated that there may be a problem.

Some lend themselves for routine use in monitoring welfare. Others cannot be readily used in this way (because of technical challenges or because data on normal parameters and the factors affecting these have not yet been established) but may be valuable in research into specific welfare issues, for example, to investigate the impact of particular changes to husbandry practices or changes to the environment.

Three categories of welfare assessment tools are outlined below. These are:
- Behavioural indicators of welfare;
- Physiological indicators of welfare; and
- Clinical and pathological signs as indicators of welfare.

Whilst it is useful here to categorise the tools under these three headings, there is in many cases some overlap between them. For example, observations of an animal's demeanour and behaviour may provide information both on its psychological state and on whether it is suffering from disease or injury.

2.2 Behavioural indicators of welfare

2.2.1 Assessment of approach/avoidance behaviour

Background and why this tool can be useful

Approach and avoidance behaviours generally indicate stimuli that cause positive or negative emotional states, respectively. Evidence includes results of neuroscience research, showing that signals of emotional value play key roles in selecting behaviour (e.g. Rolls, 1999); humans' reported feelings while performing preferred or non-preferred behaviours (e.g. Cabanac, 1971; Small et al., 2001); and data from preference studies in mink, which showed that they have elevated cortisol outputs when denied strongly preferred resources, but not when denied less preferred ones (Mason et al., 2001). Approach and avoidance are thus potentially useful for assessing the value of enrichments, or the aversiveness of e.g. crowd noise.

Caveats and limitations

There are several 'cautions' in the use of approach and avoidance in welfare assessment. For example: (i) animals may sometimes approach stimuli that elicit aggression or fear (e.g. when inspecting predators or rivals); and (ii) simple measures of time spent with a stimulus does not reveal the strength of preference (cf. e.g. Mason et al. 2002) - an important point when evaluating environmental enrichments.

Example of use

If observations of an animal (of a sort that we believe likely to have conscious feelings) reveal that it persistently avoids certain parts or features of its environment then it is possible that this aversion is associated with unpleasant feelings (e.g. fear, apprehension). Judgment about the welfare consequences will depend upon whether or not the animal appears to be able to distance itself sufficiently from the aversive feature and the intensity of the aversive behaviour shown.

Conversely, if animals show no signs of apprehension in approaching features or parts of their environments that might be suspected to cause aversion (e.g. fence lines where they may in close proximity to humans), then there is no reason to infer that they are aversive. Clearly, in drawing such inferences all the circumstances need to be taken carefully into account.

2.2.2 Assessment of incidence and intensity of stereotypies

Background and why this tool is useful for welfare assessment

Stereotypies are repetitive, unvarying behaviour patterns with no obvious goal or function, typical examples including repeatedly following the same path, or head-swaying. They are considered to be indicators of poor welfare for three main reasons: (i) they are linked with environmental conditions generally considered aversive, for example restricted feeding (e.g. Bildsøe et al. 1991, Rushen et al, 1993) and social isolation; (ii) they often develop from attempts to perform specific behaviours, suggesting frustration (e.g. repeated escape attempts in caged laboratory mice); and (iii) they are often linked with other signs of stress, such as enhanced corticosteroid outputs (e.g. von Borell & Hurnick 1989; Wielebnowski et al. 2002; Mason & Latham, 2004). In addition to their role as indicators of poor welfare, stereotypic behaviours may lead to further harm for example through persistent skin abrasion caused by repetitive behaviour.

Caveats and limitations

Stereotypies do seem to be reliable signs that an environment is, or has been, inadequate. There are two caveats when using stereotypies in welfare assessment: (i) stereotypies may help the animal to cope, and (ii) occasionally, they represent 'scars' of past poor conditions. Thus non-stereotyping animals may sometimes be even worse off than stereotypers. Physically preventing a stereotypy may be counter-productive. Because of these limitations other welfare indicators should ideally be used also in welfare assessment (see Mason & Latham, 2004).

Example of use

Careful observations should be made to determine if an animal is showing stereotypic behaviours and, if so, to determine when, under what circumstances, how often and for how long. If the stereotypy has developed recently then it is likely that this is a reflection of some recent or current environmental problem for the animal. If the animal has behaved this way for a long period, and particularly if it developed the behaviour whilst in another environment (e.g. another zoo) then it may be a behavioural 'scar' rather than an indication of current environmental deficits. However, great care should be taken in making this assumption.

2.2.3 The relevance of observations on overgrooming and other self-harming behaviours to assessment of welfare

Self harming behaviours are known to occur in humans who are suffering from a range of psychological disturbances and have also been observed

in animals. They can range from mild self-harms such as overgrooming to severe bite wounds.

Over-grooming can result in areas of bald skin or clipped fur or feathers. Before it is assumed that the cause is psychological, the many infectious and non-infectious causes of skin irritation have to be ruled out. This behaviour is not completely understood, but seems a likely welfare indicator for two main reasons. First, it is typically more prevalent in conditions that seem sub-optimal; for example fur-biting is seen in farmed mink, but has never been seen in free-living wild mink (reviewed Mason, 1995), and isolation and/or barren housing conditions increase feather-plucking in parrots (Meehan et al, 2003). Second, these behaviours appear to resemble obsessive-compulsive-type behaviours in humans (e.g. Garner et al, 2003; Garner et al, 2004), an issue of welfare significance because obsessive-compulsive disorders are often associated with elevated anxiety. Excessive over-grooming type behaviour may lead to skin wounds.

Caveats and limitations

As mentioned above, there are many other possible causes of damage or loss to pelage and these need to be ruled out before it can be concluded that the overgrooming has a psychological cause related to poor welfare. Animals may over-groom themselves or conspecifics, and it should not be assumed that the animal with the affected pelage is the one with the problem: careful observations must be made to identify the over-groomer.

Example of use

Detection of over-grooming should raise the suspicion that some aspect or aspects of the environment are suboptimal. Determination of the cause of the problem is likely to require other observations and investigations about the animal and its environment.

Other potentially self-harming behaviours that may reflect poor welfare include abnormalities of eating and drinking.

The consumption of substances that are potentially harmful can be a result of an inadequate diet but is also associated with inadequate captive environments. Coprophagia, the eating of faeces occurs naturally in some species, particularly herbivores but where this is not a normal behaviour or is done excessively it can be an indicator of poor welfare. The eating of vomit is rare in wild animals and may be indicative of health or psychological problems.

Polydipsia is the excessive consumption of water and can be spread over a period or may be concentrated over a relatively short period of two or three hours. Excessive drinking (apart from that related to renal and other

diseases), with a two to four-fold increase above normal intake has been seen in some animals in close confinement (Fraser and Broom 1990).

2.2.4 Apathy as an indicator of welfare status

Background

In humans, behavioural apathy (low levels of activity, excessive sleeping/resting) can be caused by chronic stress, depression and anhedonia (impaired abilities to feel pleasure) (e.g. Feil et al. 2003; Pruessner et al, 2003; Leonard 2002)*,* and in laboratory animals, similar depression-like states can be induced by isolating animals*,* exposing animals to repeated aggression and defeat, or repeatedly disrupting the cage environment (see e.g. Gambarana et al. 2001). Excessive inactivity could therefore indicate apathy. However, high levels of resting/sleeping may also be adaptive; animals have evolved to minimize unnecessary energy expenditure (see any optimal foraging text, for example), and activity levels can also be affected by e.g. reproductive state (e.g. Joergensen 1985), and ambient temperatures. To identify welfare-related apathy, one therefore needs additional data on libido, and interest in food 'treats' and/or environmental enrichments.

Caveats and limitations

Levels of activity vary greatly between species and within species. Determining abnormally high or low levels of specific behaviours or of state of arousal in general is therefore not easy and requires data on normal levels against which comparisons can be made. Within species, levels of activity in healthy individuals can vary with age, sex, breeding status, season, environmental temperature, social environment and other factors.

Use in practice

Where one of a group of animals persistently shows a much lower level of activity than the rest a welfare problem should be suspected. States characterised by low levels of activity are seen in a wide variety of systemic diseases (often associated with feelings of malaise) and, as suggested above, may be caused by some types of repeated stresses.

2.2.5 Poor maternal care/infanticide

Background

Poor maternal care and infanticide are warning signs that there may be welfare problems for three reasons: (i) in humans, it is linked with stress and depression; (ii) in a range of other species, it is increased by manipulations that are probably sub-optimal/stressful, e.g. changes to the social or physical environment, low ambient temperatures, and food restriction (reviewed Clubb & Mason 2002); and (ii) in zoo gorillas, it is associated with elevated cortisol outputs (Bahr et al. 1998).

Caveats and limitations

Many factors may affect infant mortality rates and determining the role of maternal competence in specific situations can be difficult. Experience is a major determinant of maternal behaviour, and this needs to be controlled for when making welfare inferences based on assessment of maternal competence. Whether or not normal maternal care was received in infancy affects maternal competence in adulthood, and having prior experience of infants can also be important for full maternal competence, especially in naturally social animals (see discussion for various primates in Kirkwood & Stathatos, 1992).

Use in practice

Infanticide and poor maternal quality may indicate poor welfare. They may be secondary, for example to maternal disease or be caused by stress to the mother or a suboptimal physical or social environment. Many other factors have to be carefully taken into account before concluding that infant mortality or failure to thrive can be ascribed to poor welfare of the dam.

2.2.6 Hyperaggression

Background

Aggression is a normal part of the behavioural repertoire of social species. However aggressive interactions that result in injury pose a welfare problem. A high level of non-injurious aggression also has the potential of reducing welfare and the threat of aggression can have harmful psychological effects on potential recipients and reduce access to resources such as food or resting areas.

The welfare of individuals of group-housed animals unable, because of the restrictive nature or design of their captive environment, to avoid exposure to the aggression of a conspecific may be compromised. This may exacerbated when group composition differs from that usually occurring in the wild. Frustration, associated with some suboptimal factor in the environment, may be causal factor in high levels of aggression (Carlstead 1986). Pain and frustration result in increased aggression in a number of species (Morton and Griffiths 1985).

Caveats and limitations

The diagnosis of hyperaggression (excessive aggression) depends upon knowledge of normal levels of aggression in terms of frequency and intensity of aggressive behaviours. Frequency and intensity of aggressive behaviours are affected by many factors (e.g. age, sex, season) and so making a firm diagnosis that aggression is excessive and a firm inference that this is due to some suboptimal aspect of the environment is difficult. Other investigations are necessary (for example to rule out that the observed aggression is outside normal limits or that it is not due to some underlying painful condition) before such conclusions can be drawn.

Use in practice

For the reasons outlined above, levels of aggression judged to be abnormal should be further investigated as they may be a reflection of underlying welfare problems.

2.3   Physiological indicators of welfare

2.3.1 Physiological changes associated with stress in zoo animals

Stress affects all living creatures and is a normal and important aspect of life. Effective response to environmental challenges is paramount for biological fitness. However chronic stress, characterised by the longer lasting, adverse affects of a stressor, or extreme but short term levels of stress such as that associated with a novel and/or an extremely aversive or frightening situation, are obviously of concern since they may lead to pathological changes such as immuno-suppression, weight reduction, depression, apathy and long term behavioural changes.

Physiological indicators of stress are frequently used in studies of the welfare of farm and laboratory animals but have only quite recently begun to be applied for welfare studies in zoos. The development of non-invasive techniques has raised the possibility of their more widespread use in future for welfare monitoring (Hawkins et al, 2003).

It is not in the scope of this chapter to describe the various physiological changes associated with exposure to a stressor and how responses are controlled via the central nervous system (CNS) and the endocrine system. A stress response can be measured as a change in the animal's behaviour and the associated changes in its autonomic and neuro-endocrine systems. Currently most scientists agree that the animals' perception of the nature of the stressful situation is a major determinant of the intensity of its response. For example, where an animal has some control of its environment, and/or can predict the occurrence of the stressor, there is a reduced stress response. One of the main stressors for many captive wild animals, particularly those kept in a zoo environment, is a lack of control or predictability within the environment. Potentially this may lead to a situation where the animal experiences chronic stress.

The function of the stress response is to maintain homeostasis, and so behavioural and physiological changes that enable the animal to cope with or adapt to a stressful situation should not be viewed as a problem in themselves. Significant welfare challenges occur when the animal is unable to cope or adapt fully. However, establishing the values of the various physiological parameters that reflect this point is not easy. This a relatively new area for research, and there is much more to be learned about the causes of stress in zoo animals and the way that animals differ at both species and individual level in their methods for coping. In addition, levels of stress are extremely difficult to assess, and the way that a stressor is perceived may differ between individuals, for example, depending on their previous experiences.

Although various techniques are available for the measurement of physiological responses to stress there are problems with using many of these for assessing zoo animal welfare. These problems include those related to obtaining the required samples and the effects on the animal of their collection.

The main methods for measuring physiological stress responses are based on investigations of the following endocrine systems and indices of fitness and reproduction.

- Sympathetic-Adrenal-Medulla axis (SA)

  a. Adrenalin/Noradrenalin
  b. Heart rate
  c. Respiration rate
  d. Body temperature

- Hypothalamic-Pituitary-Adrenal axis (HPA)

  e. Adreno-corticotropic hormone (ACTH)
  f. Corticosteroids (e.g. Cortisol)

g. Vasopressin (VASO)
h. Follicle stimulating hormone (FSH)
i. Testosterone
j. Prolactin
k. Oxytocin
l. Body temperature
j. Immune function

- Neurotransmitters

  m. Dopamine
  n. Serotonin

- Fitness/Reproductive ability

  o. Body weight changes
  p. Feed and water intake
  q. Number of offspring
  r. Reproductive hormone levels
  s. Immune responses

Only a few of the physiological measures used in studies of farm and laboratory animal welfare have the potential for practical use for welfare assessment within the zoo environment. In general the limitations include those associated with catching and restraining animals to fit the necessary monitoring devices or to collect samples as these may procedures themselves may be associated with welfare costs. Many controlled studies of farm animal welfare require the animal to be constrained in some way (e.g. to be kept away from other members of the social group to prevent damage to equipment), or to be caught and sampled regularly. This is obviously problematic if the animal is unused to handling, is dangerous, or becomes easily stressed.

A selection of the physiological measurements that have previously, or may in the future, have potential for assessing Zoo animal stress are discussed below.

2.3.2 Heart rate as a tool for assessing zoo animal welfare

Heart rate measurement has been used effectively for tracking changes associated with particular stressors using radio telemetry. Typically the animal must be fitted with a transponder that transmits heart rate, ECG or other data for analysis. Where heart rate has been used to assess transport stress in wild ungulates (Roe deer, Montane et al., 2002), it has proven to be of limited value.

Why is heart rate useful for assessing welfare?

When viewed in conjunction with behavioural data, heart rate can provide additional information that may be helpful in drawing inferences about the animal's subjective feelings.

What are the limitations of this tool?

Many factors affect heart rate, e.g.: size, age, sex, environmental temperature, activity level, and emotional state. It can be raised under circumstances in which animals are probably feeling pleasure (e.g. in a predator that has just successfully chased and caught its prey) and in which they probably have unpleasant feelings (e.g. in the prey that has just been caught). So the relevance to welfare state of elevated (or reduced) heart rate cannot be interpreted without knowledge of the animal's circumstances and its behaviour.

Other drawbacks for heart rate changes as a measure of zoo animal welfare are that unless the transponder is implanted it is possible for other members of a group, or the animal itself to damage the equipment. Implanting devices requires surgery, which causes discomfort or pain and requires licensing when conducted for scientific purposes and may not be possible in the Zoo situation. The use of ECG equipment is costly and impractical, and the usefulness of simple telemetric devices (e.g. Polar Electro Heart rate meters) depends on the model used; some not designed for animal use (and so there are problems with electrode placement), there are problems with 'noise' (due to movement of animals, hair etc) and since the researcher cannot manually detect errors there is no certainty that the recording is accurate. An additional problem is that heart rate changes are often almost immediate, as they are under SA control and as such it is often difficult to determine what the cause of the change may have been.

Use in practice

Because of the complications listed above, measurements of heart rate are unlikely to be helpful in routine assessment of the welfare status of animals. They may certainly have a role in research. Where monitoring devices can be attached to animals, observations of changes in heart rate can be helpful in signalling features of their environments or aspects of their management routine which elevate heart rate as part of a stress response.

Measurement of heart rate is frequently used in clinical investigations and can be helpful in indicating various disease states that may have welfare implications.

2.3.3 Cortisol as a tool for the assessment of zoo animal welfare

Cortisol has been successfully measured in blood plasma, saliva, faeces and urine. Cortisol responses were used in a study of the effects of transportation on captive vicunas (Bonacic et al., 2003) but this study was carried out under experimental conditions since it required that blood samples were taken from the animals. An alternative to this for zoo-kept species, is the use of new techniques for assessing levels of cortisol in saliva, urine and faeces. Faecal cortisol has been used sucessfully in a number of zoo housed species including chimpanzees (Galindo et al., 1999) and felids (Brown et al, 1994; Carlstead et al,1993; Jurke et al, 1997) and birds (Wasser et al, 2000; Shepherdson et al, 2004). An alternative approach is to use salivary cortisol, such as has been used in a pilot study on elephants by Dathe et al., 1992), but this relies on keepers being able to handle their animals in order to collect the samples.

Why is Cortisol useful for assessing Zoo animal welfare?

Measurements of cortisol have proved to be invaluable for researchers assessing stress responses in farm animals. Cortisol has proven to be particularly useful because it shows a graduated response. This means that the effect of a variety of stressors can be compared in terms of their aversiveness to an animal.

What are the limitations?

As with changes in heart rate, changes in cortisol concentrations signal responses to events that the animal may perceive as pleasant or unpleasant. Without knowing the circumstances, it is not possible to draw inferences about welfare state (how an animal feels) just from data on cortisol concentrations.

Non invasive techniques such as salivary and faecal cortisol offer huge potential for assessing the impact of the physical and social environment on an animal, but more work needs to be done to develop this as an effective and practical technique for all species. As with many hormones, cortisol secretion varies during the 24 hour day. Thus effective use of cortisol as a welfare indicator depends on acquiring samples frequently during both a baseline and treatment period, without stressing the animal during collection of the sample. In the zoo situation this is often difficult and the longer term studies that have been done, for example on polar bears in the US (see Shepherdson et al., 2004), have relied on samples taken once every two weeks. It may be that faecal sampling over an extended time period can offer a possibility for monitoring stress levels of individuals, but there are obvious limitations, such as the time involved, and ensuring that the cortisol profiles of all members of a group are identifiable. For example in a study of faecal cortisol levels in captive Hawaiian honeycreepers (see Shepherdson et al., 2004) samples could

only be taken from pairs of birds (i.e. cage levels of cortisol) and not individuals. An additional problem involves the cost involved in analysing samples. Various independent and university laboratories have the facilities and expertise to carry out assays, but the costs involved may vary and may mount up if sampling is to be carried out regularly.

Some faecal cortisol studies on zoo macaws and rhinos have been undertaken recently at the Central Science Laboratory, York (see Talling et al, 2004; Gomm et al, 2004).

2.3.4 Prolactin as a tool in the assessment of zoo animal welfare

The prolactin concentration in the blood has been found to be a useful index of stress in farm animal research. The concentration of this hormone rises in response to a variety of stressors.

Why is this a useful measure?

In studies of farmed animals, measurements of blood prolactin concentrations have been used to help identify the least stressful methods for capture and restraint as it has been found that prolactin concentration tends to increase in response to a variety of stressors.

What are the limitations?

As with HR and cortisol, prolactin levels do not give a direct indication of welfare state (how an animal feels). Inferences about the significance of raised or lowered concentrations can only be made in the light of other information about the animal and its circumstances.

Another problem with this measurement is that it requires blood samples to be taken, and so the limitations are the same as for sampling cortisol in blood. However if combined with other health checks before and after transportation or restraint this could be a useful indicator of the level of stress associated with the techniques used for moving zoo animals.

Without detailed knowledge of species-specific normal prolactin levels and the (many) factors affecting these, measurements of prolactin levels could not be interpreted. At the present time, these data are not available for zoo animals and so, whilst prolactin measurement could have a role in research, it cannot be used in routine welfare assessment in zoos.

2.3.5 Immune measures (e.g. Neutrophil/Lymphocyte ratio) as a tool for zoo animal welfare assessment.

There is some evidence that the relative concentrations of neutrophils and lymphocytes in the blood may be affected by hormonal responses to stress. Measuring neutrophil/lymphocyte ratio may provide an index of adrenal cortex activity associated with the impact of potential stressors. In a recent study of the effects of captivity on vicunas, Bonacic et al (2003) used a range of haematological measurements to characterise the responses of the wild ungulates to various challenges.

Why is it a useful potential measure of zoo animal welfare?

The induced stress response is usually characterised by an increase in neutrophils and decrease in lymphocytes. Thus a change in the neutrophil/lymphocyte ratio is a useful indicator of a stress response, and has potential for use in zoo animals, where blood samples are routinely taken as part of a health screening programme.

What are the limitations?

Interpretation of neutrophil/lympocyte ratios depends upon having reliable data on normal values and information on the factors that may affect this. Neutrophil and lymphocyte concentrations are known to be change in many disease conditions and interpretation of the significance of these changes to welfare is not straightforward.

2.3.6 Reproductive hormones as a tool in the assessment of zoo animal welfare

Measurement of testosterone, oestrogen, and progesterone can be used in investigations of reproductive abnormalities. Endocrine profiles for each individual can be useful for determining their reproductive state and for tracking changes over time. For example, ovarian activity was investigated in this way, in captive felids, by Brown and others (1994). .

Why is this a useful measure?

It has been reported that some stresses that may affect welfare can result in disturbances to reproductive hormone concentrations. Detection of such abnormalities could therefore be an indication of welfare challenges.

What are the limitations?

Apart from assessing concentrations of hormones in urine or faeces, the assessment of hormonal profiles requires invasive and stressful procedures such as restraint and blood sampling. There is also the

expense of laboratory assay procedures to consider. For most species, there is an inadequate knowledge base to support the use of this as a tool for welfare assessment.

2.3.7 Body temperature changes as a tool in the assessment of animal welfare

Body temperature can be a useful indicator of a stress response since in some species of mammals it rises in response to an acute stressor due to activation of the Sympathetic-Adrenal-Medulla axis (SA). The adrenalin/noradrenalin response is accompanied by an increase in heart rate, respiration rate and body temperature, associated with the 'fight or flight' response. Measurement of body temperature may also help gauge the adequacy of the environment in poikilotherms ('cold blooded') animals.

Why is this a useful measure?

Data on normal body temperature are relatively easily obtained as body temperature is often assessed as part of a normal veterinary examination. In addition the use of infrared thermometers can be useful for easily assessing the skin temperature of poikilothermic animals, so that management procedures can be monitored and changed if necessary.

What are the limitations?

Measurement of body temperature without restraining animals (which may itself result in temperature change) is rarely possible. Telemetric methods are available but fitting sensors may also present challenges which may have welfare consequences themselves (Hawkins et al, 2003).

Changes in body temperature often occur during normal physiological processes (e.g. exercise, basking in reptiles, pregnancy etc. Body temperature may be found to be either elevated or depressed in disease and these factors can be confounding variables. Drawing inferences about welfare status from body temperature measurements can only be done with regard to other information about the animal and its circumstances. Measurement of body temperature does not lend itself therefore as a tool for routine welfare assessment in zoos.

2.3.8 Weight changes as a tool in the assessment of animal welfare

Changes in weight are regularly used for monitoring the health status of farm animals. If animals are weighed regularly then any changes in weight (especially sudden changes) will be readily accessible to the animal carers.

Why is this a useful measure?

Many zoo animals can be trained to use weighing scales for a food reward, thus making this a stress free method for gaining objective data regularly. This is certainly a useful aid in assessing health and welfare in zoo animals and in assessing the effects of diet changes, movement between enclosures and zoos and during breeding.

What are the limitations?

Weight changes can occur as a result of a wide variety of normal or pathological factors. There may be normal diurnal or seasonal weight changes, or changes due to age or reproductive status. Interpreting weight changes therefore depends upon knowledge of normal patterns of variation. Weight changes, up or down, can occur in many diseases. If animals cannot be trained to enter, stand on or hang from suitable weighing devices, and have to be captured and restrained for weighing, this has the potential to cause stress.

2.3.9 Concluding comment

There have been relatively few studies in zoos in which physiological measurements have been used for assessing welfare. There are obvious limitations to using physiological parameters, including the collection of samples for measuring the various indicators currently used for assessing farm and laboratory animal welfare, and the lack of information on normal values and the factors affecting them. New techniques and improved health screening via regular blood sampling may offer the zoo community measures that can be used alongside behavioural techniques to give a fuller and more accurate picture of the welfare status of individuals for each zoo kept species.

2.4   Clinical and pathological signs as indicators of welfare

2.4.1 Hands-off inspection of animals as a tool for assessing welfare

Description

Regular (at least daily) visual inspection of animals is the mainstay of good stockmanship and is a requirement under the SSSMZP. It involves observing the animals and identifying those that are either behaving differently or look different from the norm. Extensive knowledge and experience of the species concerned, during all its life stages and in different situations is required to pick up some of the more subtle changes but others, such as a broken leg, should be obvious to all.

These differences from the norm are often indicators of underlying health problems and their identification forms the first part of any veterinary examination. Examples of the parameters that can be observed and the physical and behavioural changes that might be seen are shown in Table 2.4.1.

Once an abnormal attribute has been identified the observer then needs to come to a decision as to whether this feature is a likely indicator of poor welfare – and to what extent welfare is likely to be compromised. (See limitations section). Knowledge of the species, its basic physiology and understanding of how injury and disease affect the individual is important in making this judgement. Table 2.4.1 classifies some physical and behavioural changes according to whether they are likely to be indicative of severe disease, moderate disease or merely a suspicion of disease that might require confirming by other means (physical examination, blood sampling, radiography etc). The more severe the disease, the greater the degree to which the animals welfare is likely to be adversely effected.

The action required is dependant on the extent of the problem. Clearly animals showing signs of severe disease need urgent treatment or euthanasia on humane grounds. For animal's showing moderate disease or signs suspicious of disease the welfare cost/benefit of treatment/further investigation must be considered. (See limitations)

It is important that the pattern as well as the severity of disease be determined (i.e. how many individuals are affected, to what degree and how frequently). Disease and ultimately death is inevitable during an animal's lifetime even under optimal husbandry conditions. Disease in a single animal, whilst regrettable, does not necessarily require a review of how this species is kept. Disease in a multiple animals in the group however, especially over a prolonged period, is likely to be a reliable indicator a chronic welfare problem and that the husbandry standards are insufficient for the animals' needs. (See also Inspection of health and husbandry records as a tool for assessing welfare).

Why is it useful for assessing animal welfare?

The basis for this tool for assessing animal welfare is to use those observational techniques developed for assessing health and to equate signs of poor health with poor welfare.

As discussed in the introduction to this chapter, key components of an animal's welfare are how it feels and functions. Disease and injury are often associated with pain or discomfort, and can lead to temporary or permanent loss of function (e.g. inability to feed or move freely) with associated additional impacts on welfare.

Thus techniques developed for identifying disease states, such as visual inspection, are also useful for identifying cases of poor welfare.

Furthermore the severity and chronicity of the disease process and the number of animals and frequency that they are affected is likely to relate directly to the extent of the welfare problem.

Animals can be predisposed to some diseases as a result of exposure to some psychological stressors. Hence this tool can also play a subsidiary role in identifying cases of poor welfare other than those pertaining directly to an animal's physical health (see also sections 2.3 and 2.3)

What are the limitations?

a. Can this tool be used to consistently identify and quantify compromised animal welfare in all species?

- This tool is very useful for identifying signs of ill health. Information gained from its use can provide clues as to the extent of the animal's problem and, with appropriate training, inferences can be made as to the cause of the problem and what might be the best course of action.

- The tool is a crude instrument and visual manifestations of disease are not always consistent even within individuals, let alone between them, different species or taxa. The tool is most effective when used on demonstrative species where their behaviour, physiology and response to disease are well understood (e.g. social primates vs. undemonstrative reptiles). Other tools such as examination of health and husbandry records may be more effective at picking up health problems in the less demonstrative species.

- Even in those species we understand well, the signs picked up by visual inspection alone may only lead to suspicion of a disease/welfare problem. In those cases further investigation is required. Again examination of records may help, however other techniques are often required such as restraint for physical examination, blood collection, radiography etc. These diagnostic procedures may in themselves be highly stressful and in some circumstances the welfare cost of reaching a diagnosis and delivering treatment may outweigh the benefits of doing so.

- Visual inspection is designed to pick up signs of physical ill health. Signs of mental ill health and other chronic stressors might be better identified using other techniques such as those described under Behavioural Tools (2.2) and Physiological Tools (2.3).

b. What are the pitfalls in applying this technique?

- Successful application of this tool requires extensive training and experience in the biology (behaviour, ecology, physiology and pathology) of the species observed. Without this level of training it is easy either to misinterpret the signs seen or to miss cases of

poor welfare altogether. Keepers must be aware of their limitations and, whilst all should be able to recognise severe disease and if their animals are 'not right', they must also know when to ask for a second opinion from more experienced personnel or their vet. Regular review and continued development of the animal staff's skill at using this tool should be encouraged.

Table 2.4.1: Examples of parameters that might be assessed by visual inspection/physical examination, examples of observation that might be made for each parameter and their interpretation.

Suggested Interpretation / Parameter Observed	Suspicion of Disease:	Moderate disease:	Severe disease:
	Consider in conjunction with other parameters. Further investigation required.	May require intervention (consider whether the stress of handling and treatment might out way the welfare benefits of treatment)	Urgent intervention required to alleviate suffering.
Demeanor			
	Change in response to humans or conspecifics.	Herd/social animals: isolation from conspecifics. Failure to feed.	Distress vocalizations. Severe depression / unresponsive.
Body Condition			
	Under or overweight	Obesity leading to reduced activity/fitness	Emaciation Obesity leading to inability to locomote
Integument			
General condition	Poor sloughing reptiles Areas of hair or feather loss (NB may be associated with normal moult)	Dystrophic/malformed feathers. Lack of normal hair/feather regrowth. Failure to slough – retained spectacles, areas underlying necrosis. Poor growth/deformities	
Wounds	Multiple excoriations – may be due to cage mate aggression or inappropriate substrate.	Penetrating wounds. Slow rate of healing Pressure sores Self mutilation (including skin irritation – itching due to parasitism)	Wounds penetrating a body cavity. Skin loss coving large areas. Obviously infected wounds.
Hoof/nail growth	Excessive wear or mild overgrowth– is the substrate and diet appropriate?	Overgrown or deformed hooves/nails leading to abnormal gait/prehension.	Obvious infection or pain – unwilling to use limb. Inability to walk. Sloughing of one or more hooves.
Horn growth	Excessive wear or mild overgrowth– appropriate cage furniture?		Penetrating injury due to abnormal growth. Obvious infection/discomfort.
Skeletal system/neurological			
	Abnormal gait but not effecting speed or	Able but unwilling to use limb (acute phase)	In ability to maintain itself in an upright

	willingness to move. (e.g. reduced range of movement due to healed fracture / congenital deformity)	Abnormalities leading to difficulty in acquiring / prehending food, keeping up with conspecifics, mating etc.	position (e.g. fish swimming upside down, snake stuck on its back, extreme vertigo in mammals) Limb fractures. Limb loss (may not be applicable in invertebrates or cause major welfare problems in some smaller vertebrates). Inability to use limb – either physical or due to pain. Chronic unwillingness to use limb.
Eyes	Mild ocular discharge	Persistent discharge, Obvious discomfort Visual impairment leading to inability to negotiate obstacles, find food or interact with cage mates.	Gross swelling and behavioural evidence of pain. Eye protruding from socket. Inability of eyelids to close over eyes (in species with eye lids)
Respiratory			
Nasal discharges/ breathing	Mild clear or blood tinged discharge, animal bright. Normal breathing pattern for activity level.	Pus or prolonged, repeated bloody discharge from nose or mouth. Increase breathing rate and effort.	Marked increase in respiratory effort. Open mouth breathing (where not part of normal behaviour), Cyanosis (blue tinge) of mucous membranes or skin in animals that don't have pigmented skin.
Digestive			
	Abnormally texture and colour of faeces	Diarrhoea – without depression Constipation, frequent unproductive straining Mild to moderate colic of short duration	Severe diarrhea – associated with depression Profuse and or Bloody diarrhoea Severe colic

2.4.2 Inspection of Health and Husbandry Records as a tool for assessing animal welfare.

Description (history, description and practical use)

All zoos must keep basic health and husbandry records under the SSSMZP. These include animal inventories, births, deaths, movements, results of post mortem examinations, clinical findings etc. Simple analysis of this data (looking for differences from the norm) can yield information that may indicate an underlying animal welfare problem.

The following table shows the some of the types of data that can be derived from health and husbandry records.

Table 2.4.2: Examples of data that can be derived from health and husbandry records.

Demographic data: These give a numerical description of the population. There are many different parameters that can be used to help identify potential welfare problems. Explanation of their use and derivation is beyond the scope of this document however some examples are given below. Note: There are many different definitions of the various parameters. It is unimportant which is chosen as long as consistency is maintained. The definitions below are consistent with those used by the SPARKS and DEMOG computer programs (Wilken & Lees, 1998; www.isis.org)	
Birth rate	Annual Number of births/100 animals in the population
Inter-birth interval	Length of time between birth/hatching of successive offspring (individuals, litters, groups or clutches depending on species).
Mortality rates	Annual Death rate = % population dying per year Annual Neonatal death rate = % Animals born per year dying as neonates
Survivorship	Probability of surviving from birth to age x. This is done for each age class and a graph plotted for the population. This graph highlights ages when animals are most likely to die. It also shows maximum lifespan for the group being analysed.
Longevity	Average age at death

Health data: These describe the types of health problems seen and their frequency. Parameters of particular use for assessing animal welfare are:	
Categories of diseases seen	e.g. nutritional, environmental, infectious, degenerative, trauma.
Incidence	Number of new cases of each class of disease/yr

Ideally these data should be collected every year for each species held (see limitations section re practicality of doing this). Any difference from normal should be investigated further as it might be indicative of underlying welfare problem.

The most difficult part of this using this tool is knowing what is 'normal'. There are two approaches to this:

- The first is to collate data from as many institutions as possible that hold the species (and get information on the species in the wild). These sorts of data may well already have been collated for species that are part of managed programmes (e.g. EEPs). In these cases the information is often to be found in the species studbook or it can be obtained directly from the studbook/programme manager. The later is the preferred route as the studbook keeper/manager will have detailed knowledge of the study population and of mitigating circumstances that might have impact on the data (e.g. whether certain institutions have been advised to stop breeding because they had been too successful in the past etc.). Average values for the population might be taken as 'Normal' (but see below for caveats). Target values would be those from the institutions that have the lowest (non-cull) mortality rates, least disease and good breeding rates. These values are likely to change as husbandry practices improve hence regular review is required.

- Target values indicative of current best practice are not always available (e.g. when the species concerned is rarely held in captivity or data is not available from other collections). Institutions can still evaluate their own data however by plotting values over time and looking for any trends or abnormalities.

Why is it useful for assessing animal welfare?

a. Demographic data can be used to highlight possible cases of poor welfare.

- Many causes of poor welfare will lead to increased mortality and decreased life expectancy. Similarly, measures of reproductive success (e.g. birth rate, inter-birth interval) can also be negatively affected by causes of poor welfare. Unlike disease however, demographic parameters are not directly linked to animal welfare. Numerous other factors can affect demographic parameters whilst having little or no effect on welfare. For example a colony of harvest mice will have a higher reproductive rate than a single sex display group and yet their welfare status might be the same. Despite this lack of obvious cause and effect, deviations from 'normal' values should still be seen as indicators of potential welfare issues that might need further investigation using some of the other tools discussed in this chapter.

- Demographic data are particularly useful for assessing large groups of animals where individual identification is difficult and use of visual inspection, behavioural observations and physiological parameters is limited. Fish, amphibia and colonies of small birds and mammals might all fall into this category.

b. Health data can indicate welfare problems and their potential causes.

- As discussed previously in section 2.4.1, poor health typically has a direct impact on welfare because diseases and injuries often cause pain, discomfort or malaise. A high incidence of disease is likely to be indicative of some aspect of sub-optimal husbandry. Further analysis of the types of disease seen can suggest the causes of these welfare problems and hence allow rectification. For example a high incidence of bone fractures might indicate suboptimal nutrition (e.g. regarding calcium or vitamin D levels). Arthritis might indicate chronic pain which requires managing and, if the incidence is unusually high, that the substrate might be inappropriate.

- Examination of health records complements visual inspection as a tool for assessing welfare. Visual inspection provides a snapshot of current problems in living animals. Health records show how disease patterns change over time and they also include data from laboratory investigations and from animals that die. Laboratory and post mortem records might be the only way to determine the types of diseases affecting undemonstrative species thus allowing inferences to be made as to their welfare status and that of the remaining animals kept in the same conditions.

c. Analysis of records allows monitoring of potential welfare problems over time.

- A major strength of this tool is that it allows monitoring of the population over time. Zoo managers can evaluate the impact of husbandry changes on animal welfare and use this information to produce species recommendations. Zoo inspectors can use the data to audit welfare and see the effect of previous recommendation they have made.

What are the limitations?

a. Practical limitations of its use

- The value of this tool depends on the quality of the records kept. If the data are inaccurate or missing the inferences made will be at best of limited value and at worst wrong.

- When comparing data it is vital that the parameters of interest have been calculated in the same way. (e.g. is birth rate defined as births/100 animals or births/female of reproductive age? What definition is being used for 'birth' in marsupials?)

- Small population sizes will also limit the power of this tool. As a rule of thumb when populations are less than 20 individuals demographic data become difficult to analyse.

- Time consuming – For zoos holding large number of species it is likely to be impractical to plot and do a full analysis of data for each. Judgement will be needed as to which species to prioritise. Targeting species where problems are suspected or where other methods of assessment are difficult might be one way of overcoming this problem.

- Insufficient base line data – from the wild/other collections to be able to determine 'normal' values.

b. Limitations of the tool itself (i.e. limitations even if data quality is optimal)

- Historical: Visual inspection/ (+ other tools) may give you an idea or the welfare of an animal today. Inspection of records is an audit of welfare over varying periods of history (may be lifetime or just previous week). If analysis of records in the only tool used, timely intervention to correct severe welfare problems might not occur.

- Difficulty of interpretation. As stated previously, factors that affect welfare are likely often to have an impact on demographic data also. However demographics are influenced by many other factors also which are of no relevance to welfare (have no direct bearing on an animal's feelings or function). Detailed knowledge of the collection, species management and the other welfare assessment tools is needed if demographic data are to be used in drawing inferences about welfare.

- Difficulty in comparing data if the study population is different in age or sex composition from the managed population. For example, if the zoo studied holds a bachelor group of macaques, birth rate is obviously going to be lower than for a breeding group. Data analysis and interpretation should only be done by personnel who have a good understanding of the collection.

- Similarly this tool is difficult to use when there is regular immigration and emigration to and from the study population. For example, if the zoo doing the analysis is a holding institution for young adult stock prior to export for release. Deaths due to degenerative disease might be expected to be lower than average for the population as a whole.

- This tool is not useful for assessing welfare of an individual. (c.f. other tools for this) It is more useful for indicating potential problems in groups of animals.

Areas for future development

The advent and development of computerised record keeping and data analysis programmes has vastly increased the scope and accuracy of information that can be obtained from animal records. An international

record keeping and data analysis system is already in operation (International Species Information System) and allows some comparisons to be made between institutions. The second generation of programmes is currently under development (Zoo Information Management System – first phase integrating animal records, health records and studbook management due for completion in 2005). The greater the uptake and use of this system world wide the more powerful this tool will become.

Institutions are not limited to collecting demographic and health records. Data more specific to animal welfare might also be collected (for example, those data generated through the use of other tools suggested in this chapter). (See also appendices with examples of animal welfare audit forms.)

3   The roles of zoo staff in the management of animal welfare

Animal welfare assessment in the zoo environment is a process working on more than one timescale and involves;

- Ongoing daily assessment as part of keeper duties
- Regular welfare audit and review of the housing and husbandry of the collection (See Appendix 2 which includes outlines of the ZSL and Chester audit systems)
- Species specific appraisal in relation to social/housing changes
- Zoo inspections made in accordance with ZLA (See Section 5)

These different levels of welfare appraisal are complementary to each other. Each participant, from junior keeper to senior management, is part of this process and over the course of a year each has individual obligations to the animals in the collection. Individual zoos will differ in their organisational structure and the roles of keeper, senior keeper and curator are defined as follows;

Keeper – member of staff responsible directly for care of animals through the provision of diet and maintenance of exhibit. This person may be very junior and relatively inexperienced or may have considerable knowledge of the particular species.

Senior keeper – member of staff who still carries out practical husbandry but in addition has responsibility for staff and their conduct.

Curator – member of staff responsible for planning of the collection, who has an overview of the staff and who has responsibility for the systems (husbandry, reporting etc) that are in place.

These roles may be more fluid at smaller zoos with a less rigid structure. For example, keeping staff may report directly to curators or senior keepers to directors. What is important is that set procedures are in place, regardless of the size of institution, that allow for effective communication to resolve welfare issues.

3.1 The Keeper's role

The keeper is the front-line in ensuring the highest standards of welfare for zoo animals and therefore must have a good understanding of the behaviour and physical 'norms' for each species they care for. In particular the following apply to all keeping staff;

- all animals must be clearly seen and inspected daily. An initial inspection should be carried out first thing in the morning. Additional observations of animals must be carried out whenever possible throughout the day,

- keepers must look for signs of injury (see section 2),

- keepers must look for signs of disease (in both animals and their enclosures) (see section 2),

- keepers must look for signs of behavioural abnormality in relation to the individual animal and its relation to the group (if applicable) (see section 2),

- keepers must look for signs of an overall *change* in welfare status,

- keepers must also respond to reports of abnormal welfare, or situations, which may affect welfare, from visiting public,

- keepers must maintain enclosures that meet high standards of appropriate hygiene,

- keepers must provide the appropriate diet both in presentation, appropriateness and condition.

- keepers must monitor use of specific enrichment devices, materials or systems

Experienced keepers should continually refer to previous experience with the species or individual(s). Trainee keepers and junior staff must be

trained to identify possible welfare problems as part of their initial training – this is an obligation of senior staff. In particular, consistent, longitudinal care is important in the detection of changes in individuals and/or groups.

If any deviations from normal physical appearance or behaviour are observed a keeper has an obligation to report this to their line manager. This may be through, or directly to, a senior keeper, curator or vet. In practice in many zoos junior keepers would verbally report welfare concerns to a more senior keeper and this may then be additionally recorded in both section and zoo records. Written and verbal reporting and recording procedures should therefore be in place. The system in place should be inclusive so that all keepers have an ability to report concerns regardless of rank.

3.2   The senior keeper / curator's role

Senior keepers/curators must pay due attention to any animal welfare matter reported to them. They have an obligation of care to all species within their remit and are obliged;

- to respond by either inspecting the individual(s) themselves or by reporting the matter to more senior staff (if appropriate),

- in the event of a welfare problem being identified, find solutions, in conjunction with other staff, to alleviate the problem,

- in the event of injury and/or disease report this to the vet and, in conjunction with the vet, provide the most appropriate treatment/solutions,

- to put systems in place that allow the efficient reporting of welfare matters,

- be responsible for the organisation of keeper training to identify welfare problems.

- in the longer term, plan appropriate enclosures that provide for good welfare and/or select species that can be housed in existing enclosures whilst maintaining good welfare standards. All other staff may be involved in the planning of enclosures.

3.3   The vet's role

A vet may have a welfare matter reported to them directly by a keeper, senior keeper or curator and is obliged to provide appropriate, professional care in such circumstances. In addition vets;

- have an obligation to keep up to date with advances in knowledge of the methods of prevention and treatment of diseases relevant to the health and welfare of the animals in the collection.

3.4   Annual welfare audits and management review process

In addition, all individuals responsible for animal care, either directly or indirectly, may be involved in the development of appropriate welfare audit methods (Appendix 2). Zoos will find it helpful, for maintaining high standards of welfare, to carry out such an audit. Best practice would make this a biannual or annual event. Different zoos may choose to carry out this process at different levels, however, for all, the maintenance of good records of both veterinary and husbandry matters will be essential. During this audit process the records should be reviewed by senior management to highlight priority actions to address more urgent welfare concerns. Larger scale historical reviews of records may also provide interesting research projects, which may pay dividends in pinpointing 'hidden' welfare problems.

In addition to this, the yearly zoo inspection, carried out in accordance with the 1981 Zoo Licensing Act (SSSZMP) allows for an independent evaluation of the standards of the zoo. This will be discussed in Section 5.

3.5   Staff roles in zoo animal welfare illustrated by an example problem scenario

- A junior keeper notes during their morning inspection that there is blood present in the ring-tailed lemur enclosure. Further close inspection of all individuals in the group leads to a wound being identified on an adult male.

- The keeper alerts a more senior keeper to come and inspect the individual. This senior/head keeper makes the decision to isolate the male and inform the Curator that veterinary assistance is required.

- The keepers also note the injury in their daily report sheet, which goes to the Curators office and will be entered in animal records (ARKS). In addition this event is also noted in the section diary.

- The animal is examined by the vet and appropriate treatment administered. Keepers are given instructions for appropriate follow-up care. The vets keep medical records (results of examination, diagnostic tests, drugs administered etc.) preferably on a dedicated zoo animal medical record system such as MedARKS. A summary of

the medical record should also be placed on ARKS so that they are available to the zoo staff at all times.

- The keepers inspect the enclosure/cage mates to attempt to identify the cause of the injury. Females are observed being aggressive to other males. The females are coming out of oestrus and are responding aggressively to any approaches by males.

- Appropriate action is taken to attempt to lessen the likelihood of further attacks on males by females e.g. provide extra visual barriers to lessen tension in exhibit, prepare a contingency to separate males entirely for a short period of time if required, provide more scatter-feeds or puzzles to increase other behaviours. Also,

  - The injured animal is monitored closely throughout the period of treatment and the vet makes follow-up assessments.

  - After assessment of the situation in which the welfare problem was identified long-term changes may be made to husbandry regime.

  - Planned future housing (keepers, curators, vets, site development staff) to alleviate such situations

This example demonstrates that welfare problems may in many circumstances be a combination of physical, behavioural and psychological difficulties and appropriate solutions might require a holistic approach. **Fig. 3.1** summarises the different timescales and processes that overlap to effectively monitor the welfare of individuals in zoos.
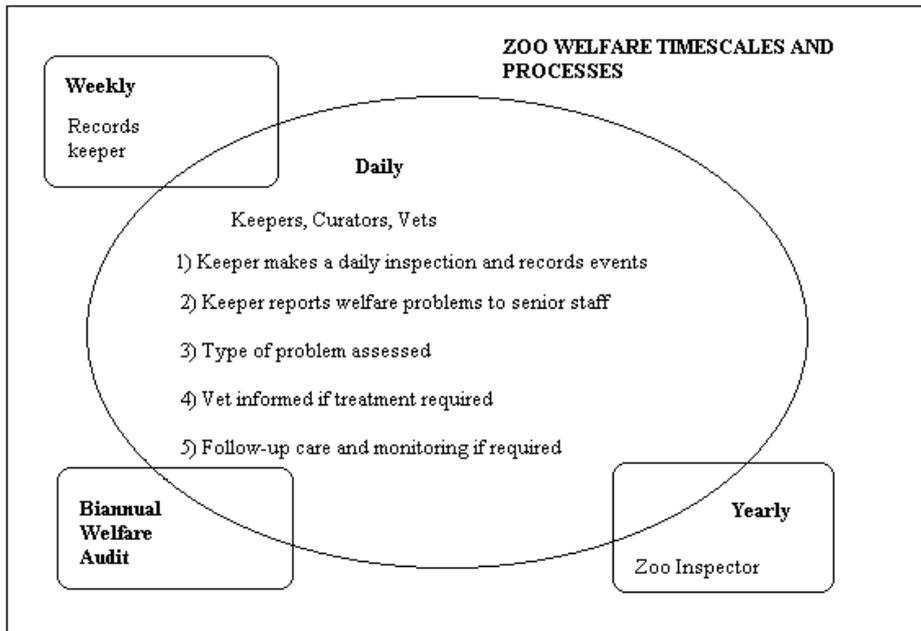
Fig. 3.1   Diagram to illustrate the differing timescales in the assessment of welfare by staff in zoos

4.   The role of the zoo inspectorate in animal welfare

The Zoo Licensing Act 1981, as amended, provides a requirement for licensing by Local Authorities, following a process of formal inspections of zoos, which includes the health, welfare and safety of the animals present. Standards for animal welfare are furthered in the Secretary of States Standards for Modern Zoo Practice. Both are fundamental in ensuring that satisfactory conditions and standards are achieved in zoos, and should be referred to by any person from the inspectorate.

The Act requires that a Local Authority arrange for an inspection to be carried out at differing times: prior to issuing, refusing, renewing or significantly altering a zoo licence, and during the period of a licence. There are also provisions for special and informal inspections, as defined.

For an inspection other than a special or informal, or where a dispensation is in force, a team of inspectors comprising not more than three appointed by the Local Authority, and two nominated by the Secretary of State, will assess the standards of animal welfare. One nominated inspector from the Secretary of State's lists will be a competent veterinary surgeon, and it is usual for the Local Authority to appoint similarly.

The toolkits within this chapter may serve to assist directly in the assessment of animal welfare during the inspection process but most are more relevant for use by zoo staff in the management of their animals.

Whilst some may be of value for direct use by inspectors, we suggest that the role of the inspector will more usually be one of auditing operating procedures to check that zoos have appropriate systems for the routine assessment and regular review of their animal's welfare. Any actions considered necessary by the inspectors as a result of their own assessments of animal welfare or of their findings concerning the zoo's systems for routine assessments and regular reviews, may be reported to the Local Authority for tackling either by setting conditions or making recommendations on a licence or amended licence. A local authority officer with concerns for animal welfare at any other time, having failed to receive adequate reassurance from the operator, is advised to discuss them with the Local Authority's veterinarian or Secretary of State's inspector, and under certain circumstances a special inspection may be deemed appropriate.

A special inspection will usually include a veterinarian in the inspection team and, in the case of an inspection where a dispensation exists, a veterinarian may again be nominated or appointed (as appropriate to the dispensation), to demonstrate that animal welfare issues are addressed.

Informal inspections are to be carried out by a Local Authority in any calendar year when no other inspection has been undertaken, and will usually take place towards the end of the year so as to avoid the possibility of more than one inspection in that year. The inspection will be carried out by a person appointed and deemed competent from within the Local Authority, or may be carried out by a suitable person on its behalf.

Further guidance on inspections may be found in DEFRA circular 02/2003.

5.   Education and Staff training

The efficacy of detection, recognition and reliability of welfare assessments and the effectiveness of measures taken to address problems that exist will greatly depend on the standards of knowledge, education and training of the relevant staff. The interpretation and significance of behavioural characteristics in relation to the welfare state of an animal is often far from straightforward. In recent years much progress has been made in understanding the causal factors and signs of poor welfare particularly in relation to behaviour. It is important that staff responsible for the care of zoo animals should be knowledgeable of these areas and as far as possible keep up to date with recent developments

Assessment of welfare should be an integral part of any course relating to the education and training of zoo keeping. Animal behaviour and welfare is already included in a number of courses that cover zoo management, both vocational and academic in nature. (*Information on relevant*

educational courses can in be found in Appendix 3). 'On the job' training also forms an important part of education on recognising and dealing with welfare problems.

6.   Recommendations for Research

During the last 100 years there have been great advances in the sciences and technology that underpin zoo animal welfare. Nutrition, for example, has been placed on a much firmer footing through advances in understanding of the general principles that have come about largely through research into human and farm animal nutrient requirements and feeding. There have been great advances also in knowledge about infectious diseases and their treatment and control. Here again zoo animals have often been the beneficiaries of the results of research into basic principles carried out on laboratory and farm animals.

However, whilst we know much more about the basic principles of nutrition, disease control and other aspects of biology relevant to the welfare of animals of whatever species, knowledge of general principles is not enough. Whilst these principles are crucial, there is a great deal of work still to be done to elucidate in detail the many variations in specific requirements among the species kept in zoos, e.g. for nutrients, housing, social and thermal environment. Likewise, at present, in many cases, when antibiotics, analgesics and other drugs are given to zoo animals, dose rates are based on those that have been determined to be safe and effective for the common domesticated animals and for humans – there is a need for much more work on species-specific regimes for zoo animals.

In prioritising research for welfare improvements, it is necessary to have a clear view of what the major problems are. These are likely to vary from species to species and to be dependent also on housing and husbandry regimes. The welfare assessment methods outlined above will help in identification of where the major problems lie. Disease can have a major impact on welfare and sub-optimal husbandry is often a factor leading to disease. Research aimed at preventing or controlling the common causes of disease of each species is likely to be very significant in reducing threats to welfare.

During the last twenty years, there has been increasing scientific interest in methods of exploring animal welfare and, here again, as a result of economic factors, the main focus of efforts has been on farm and laboratory animals. Many of the methods for welfare assessment mentioned above were first developed for use in these contexts or as spin offs of developments in human medicine.

One approach that has proved to be very informative in making improvements in animal husbandry has been to seek the animals' own opinions about what type of environment they favour. In these preference tests, animals are given the choice of selecting, or working to gain access to, one of several environments that may differ in size, shape, colour, or social or other content. Observations about what the animals choose can be very helpful in informing judgements about how they should best be kept. In this way, for example, chickens have been 'asked' about their preferences for cage sizes, perch diameters, floor substrates and many other aspects of their environments. There is a great deal of potential for this approach in exploring the welfare requirements of zoo animals.

Some of the physiological welfare assessment methods outlined above may prove to be helpful for a wider range in the future. There is a need for the development and evaluation of these (e.g. cortisol assays, especially those based on faecal or urine samples that collected without causing stress) for use in further species. The value of these methods depends upon thorough knowledge of the all the factors (e.g. sex, season, age) that can influence results.

A very wide, and increasing, range of species are maintained in captivity these days as companion animals, for conservation or education in zoos, and for other reasons and zoos can make important contributions to knowledge about the welfare requirements of some of these species.

Research in the some of the areas outlined above is challenging, time consuming, technically demanding and expensive. Obtaining funds for studies in these areas is not easy. However, there are increasing opportunities because of the growth in interest in animal welfare research. Quite a number of universities in the UK have animal welfare research groups so there are new opportunities for collaboration between zoos and universities in this field, and various organisations accept applications for funding for animal welfare research.

7.   Recommendations for the development of specific welfare codes

Codes of recommendations for welfare are valuable tools for helping to set standards and encourage good practice in farm animal husbandry. In many cases, it is possible to give much greater individual attention to zoo animals than is typical for farm stock so approaches found helpful in promoting welfare in production animals will not necessarily be relevant in the zoo context. However, it seems likely that the development of further codes of recommendations for the welfare of zoo would be helpful. Ideally, since species are finely adapted to their natural environments and have specific requirements related to this, such codes should be at the species

level. However, the development of species specific such codes by the zoo and other wild animal keeping communities for the very wide range of species kept would be a major undertaking and it is appropriate that, where resources are available for this, efforts should be carefully prioritised. Whilst species-specific codes may be the ultimate aim, codes dealing with taxa at higher levels (e.g. at the level of genera or families) may be a more realistic goal for some groups, at least in the shorter term.

There are a variety of sources of information and guidance on husbandry of zoo animals including The International Zoos Yearbook, and publications produced by the Association of British Wild Animal Keepers (ABWAK), the Britain and Ireland Association of Zoos and Aquariums (BIAZA, formerly the Zoo Federation), The European Association of Zoos and Aquariums (EAZA) and the American Zoo Association. A number of guidelines and standards for keeping zoo animals are listed in Appendix 13 of the Secretary of States Standards of Modern Zoo Practice (Defra, 2004).

8.   References

Bahr, N.I., Pryce, C.R., Dobelli, M. & Martin, R.D. (1998) Evidence from urinary cortisol that maternal behaviour is related to stress in gorillas. **Physiology & Behaviour** 64, 429-437.

Bildsøe, M., Heller, K.E. & Jeppeson, L.L. (1991) Effects of immobility stress and food restriction on stereotypies in high and low stereptyping female ranch mink. **Behavioural Processes** 25, 179-189.

Bonacic C. MacDonald D.W. and Villouta G. (2003) Adrenocorticotropin-induced stress response in Captive vicunas in the Andes of Chile. **Animal Welfare** 12, 369-385.

Boyd Group (2002) **The Boyd Group Papers on the use of Non-Human Primates in Research and testing**. Edited by Smith, J.A. and Boyd, K.M. The British Psychological Society Scientific Affairs Board Standing Advisory Committee on The Welfare of Animals in Psychology.

Braasted, B.O. & Bakken, M. (1993) Maternal infanticide and periparturient behaviour in farmed silver foxes *Vulpes vulpes*. **Applied Animal Behaviour Science** 36, 347-361.

Brown J.L. Wasser S.K. Wildt D.E. and Grahm L.H (1994) Comparative aspects of steroid hormone metabolism and ovarian activity in fleids measured non invasively using faeces. **Biology of Reproduction** 51, 776 – 786

Cabanac, M. (1971) Physiological role of pleasure. **Science** 173, 1103-1107.

Cabanac, M. (1979) Sensory pleasure. **Quarterly Review of Biology** 54, 1-29.

Companion Animal Welfare Council (2003) **The welfare of non-domesticated animals kept for companionship.** CAWC. Available at: www.cawc.org.uk.

Clubb, R. & Mason, G. (2002) **A review of the welfare of zoo elephants in Europe**. RSPCA, Horsham, UK.

DEFRA (2004) **Secretary of State's Standards of Modern Zoo Practice**. Department of the Environment, Food and Rural Affairs. Available from Defra Publications, Admail 6000, London SW1A 2XX and at www.defra.gov.uk/wildlife-countryside/gwd/index.htm.

EC Regulation (2005) on the protection of animals during transport and related operations. http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2005/l_003/l_00320050105en00010044.pdf

Feil, D., Razani, J., Boone, K. & Lesser, I. (2003) Apathy and cognitive performance in older adults with depression. **International Journal of Geriatric Psychology** 18, 479-485.

Fraser, A.F. & Broom, D.M. (1990) **Farm animal behaviour and welfare**. 3rd Edition. Bailiere Tindall, London.

Fraser, D., Weary, D.M., Pajor, E.A. & Milligan, B.N. (1997) A scientific conception of animal welfare that reflects ethical concerns. **Animal Welfare** 6, 187-205.

Galindo F. Brousset DM Benitez MA Catano A and King L (1999) Behaviour and faecal cortisol as non-invasive indicators to assess environmental manipulation   of a group of chimpanzees. In **Proc.4th international conference on Environmental Enrichment, Edinburgh** (1999).

Gambarana, C., Tolu, P.L., Masi, F., Rinaldi, M., Giachetti, D., Mrazzoni, P. & De Montis, M.G. (2001) A study of the antidepressant activity of Hypericum perforatum on animal models. **Pharmacopsychiatry** 34, S42-S44.

Garner, J.P., Wayne, C.M., Würbel, H. & Mench, J.A. (2003) Barbering (whisker trimming) in laboratory mice involves the same brain systems as compulsive behaviours in trichotillomania, autism and other obsessive-compulsive spectrum disorders. In Ferrante, V. (Ed) **Proceedings of the 37th International Congress of the International Society for**

Applied Ethology. Fondazione Iniziative Zooprofilattiche e Zootechniche, Abano Terme, Italy. Pp 75.

Garner, J.P., Weisker, S.M., Dufour, B. & Mench, J.A. (2004) Barbering (fur and whisker trimming) by laboratory mice as a model of human trichotillomania and obsessive compulsive spectrum disorders. **Comparative Medicine** 54, 216-224.

Hawkins, P., Morton, D.B., Bevan, R., Heath, K., Kirkwood, J.K., Pearce, P., Scott, L., Whelan, G. & Webb, A. (2003) Husbandry refinements for rats, mice, dogs and non-human primates used in telemetry procedures. Seventh Report of the BVAAWF/FRAME/RSPCA/UFAW Joint Working Group on Refinement, Part B. **Laboratory Animals** 38, 1 - 10.

Harding, E.J., Paul, E. & Mendl, M. (2004) Cognitive bias and affective state. **Nature** 427, 312.

IATA (2004) **IATA Live animal regulations**. International Air Transport Association. (http://www.iata.org/publications/9105.htm).

Joergensen, G. (Ed) (1985) Mink production. Scientifur, Hilleroed, Denmark.

Kirkwood, J.K. (1999) Accommodation for wild animals in captivity: How do we know when we've got it right? In Plowman, A.B. & Stevens, P.M.C. (Eds) **Conservation Centres for the New Millenium**: Proceedings of the 5th International Sympoisum on Zoo Design. Whitley Wildlife Conservation Trust, Paignton, Devon. p51-62.

Kirkwood, J.K. (2003) Welfare, husbandry and veterinary care of wild animals in captivity: changes in attitudes, progress in knowledge and techniques. **International Zoo Yearbook** 38: 124-130.

Kirkwood, J.K. (2004) The importance of animal welfare. In G.C. Perry (Ed) **The welfare of the laying hen**. CAB International, Oxford. Pp 1-7.

Kirkwood JK and Hubrecht R (2001) Consciousness, cognition and animal welfare. **Animal Welfare 10s**, 5-17.

Kirkwood, J.K. & Stathatos, K. (1992) **Biology, rearing and care of young primates**. Oxford University Press, Oxford.

Landon, V.I., Grenfell, J.L., Netelovski, E.I.L. & King, J.E. (1999) Determinants of chimpanzee longevity in zoos. **Laboratory Primate Newsletter** 38, 17-18.

Leonard, B.E. (2002) Stress, norepinephrine and depression. **Acta Neuropsychiatrica** 14, 173-180.

Marchant-Forde, J.N. (2002) Piglet- and stockperson-directed sow aggression after farrowing and the relationship with a pre-farrowing, human approach test. **Applied Animal Behaviour Science** 75, 115-132.

Mason, G.J. (1995) Tail biting in mink (*Mustela vison*) is influenced by age at removal from the mother. **Animal Welfare** 3, 305-311.

Mason, G.J., Cooper, J & Clareborough, C. (2001) Frustrations of fur-farmed mink. **Nature** 410, 35-36.

Mason, G.J., Cooper, J & Clareborough, C. (2002) The use of techniques from human economics to measure what animals value, illustrated by experimental work on the American mink (*Mustela vison*). In: Hare, V.J., Worley, K.E. & Myers, K. (Eds) **Proceedings of the 4th International Conference on Environmental Enrichment, Edinburgh 1999.** Pp 111-117. The Shape of Enrichment, San Diego, USA.

Mason, G.J. & Latham, N.R. (2004) Can't stop, won't stop: is stereotypy a reliable animal welfare indicator? **Animal Welfare** 13, S57-S70.

Meehan, C.L., Millam, J.R. & Mench, J.A. (2003) Foraging opportunity and increased physical complexity both prevent and reduce psychogenic feather picking by young Amazon parrots. **Applied Animal Behaviour Science** 80, 71-85.

Meehan, C.L., Garner, J.P. & Mench, J.A. (2004) Isosexual housing improves the welfare of young Amazon parrots. **Applied Animal Behaviour Science** 81, 73-89.

Montane J. Marco I. Lopez-Olvera J. Manteca X. and Lavin S. (2002) Transport Stress in Roe Deer: Effect of a short lived antipsychotic. **Animal Welfare** 11,   405-417.

Owen, D., Gomm, M., Davies, M., Pickersgill, M. & Brunt, A. (2004) Non-invasive measurement of stress in captive white rhinoceros (*Ceratotherium simum*). Poster available from Central Science Laboratory, Sand Hutton, York YO41 1LZ.

Pruessner, M., Hellhammer, D.H., Pruessner, J.C. & Lupien, S.J. (2003) Self- Reported depressive symptoms and stress levels in healthy young men: associations with the cortisol response to awakening. **Psychosomatic Medicine** 65, 92-99.

Radford, M. (2001) **Animal welfare law in Britain: regulation and responsibility**. Oxford University Press, Oxford.

Rolls, E.T. (1999) **The brain and emotion**. Oxford University Press: Oxford.

Rushen, J., Lawrence, A.B. & Terlouw, E.M.C. (1993) The motivational basis of stereotypies. In Lawrence, A.B. & Rushen, J. (Eds) **Stereotypic animal behaviour: fundamentals and application to animal welfare**. CAB International, Wallingford. Pp 41-64.

Ryan, S., Thompson, S.D., Roth, A.M. & Gold, K.C. (2002) Effects of hand-rearing on the reproductive success of western lowland gorillas in North America. **Zoo Biology** 21, 389-401.

Shepherdson DJ, Carlstead KC and Wielebnowski N (2004) Cross institutional assessment of stress responses in zoo animals using longitudinal monitoring of faecal corticoids and behaviour. **Animal Welfare** 13. 105-115

Sherwin, C (2001) Can invertebrates suffer? Or, how robust is argument-by-analogy? **Animal Welfare** 10, S103-S118.

Suleman, M.A., Wango, E., Sapolsky, R.M., Odongo, H. & Hau, J. (2004) Physiologic manifestations of stress from capture and restraint of free-ranging male African green monkeys (*Cercopithecus aethiops*). **Journal of Zoo and Wildlife Medicine** 35, 20-24.

Small, D.M., Zatorre, R.J., Dagher, A. et al (2001) Changes in brain activity related to chocolate: from pleasure to aversion. **Brain** 124, 1720-1733.

Smith, T. (2004) Zoo Research Guidelines: Monitoring Stress in Zoo Animals. BIAZA, The British and Irish Association of Zoos and Aquariums (available at http://www.zoofederation.org.uk/uploads/Zoo%20Research%20Guidelines%20-%20Monitoring%20Stress%20in%20Zoo%20Animals.pdf).

Talling, J.C., Robson, M., Owen, D. & Lane, J. (2004) Seasonal differences in behaviour and physiology or performing and exhibit macaws in a zoo. Poster available from Central Science Laboratory, Sand Hutton, York YO41 1LZ.

Tartabini, A (1991) Moth-infant cannibalism in thick-tailed bush-babies (*Galago crassicaudatus-umbrosus*). **Primates** 32, 379-383.

Von Borell, E. & Hurnick, F. (1991) Stereotypic behaviour, adrenocortical function, and open-field behaviour of individually confined gestating sows. **Physiology and Behaviour** 49, 709-713.

Wass, J.A., Pollard, J.C. & Littlejohn, R.P. (2003) A comparison of the calving behaviour of farmed adult and yearling red deer. **Applied Animal Behaviour Science** 30, 337-345.

Webster, A.J.F. & Main, D.C.J. (Eds) (2003) Proceedings of the 2nd International Workshop on the Assessment of Animal Welfare at Farm and Group Level. **Animal Welfare** 12, 1-712.

Wells, A., Terio, K.A., Ziccardi, M.H. & Munson, L. (2004) The stress response to environmental change in captive cheetahs (*Acinonyx jubatus*). **Journal of Zoo and Wildlife Medicine** 35, 8-14.

Williamson, S.M., Bordvin, C.M. & Howe, B.A. (1991) The ecology of adolescent maltreatment – a multilevel examination of adolescent physical abuse, sexual abuse and neglect. **Journal of Consultancy in Clinical Psychology** 59, 449-457.

Wielebnowski, N.C., Fletchall, N., Carlstead, K., Busso, J.M. & Brown, J.L. (2002) Non-invasive assessment of adrenal activity associated with husbandry and behavioural factors in the North American clouded leopard population. **Zoo Biology** 21, 77-98.

Wielebnowski, N. (2003) Stress and distress: evaluating their impact for the well-being of zoo animals. **Journal of the Veterinary Medical Association** 223, 973-976.

Wilcken, J., & Lees, C. (eds) (1998) **Managing Zoo Populations: compiling and analysing studbook data***. Australasian Regional Association of Zoological Parks and Aquaria: Sydney, Australia.

World Association of Zoos and Aquariums (2004) **Ramifications of the reproductive management of animals in zoos**. Proceedings of the World Association of Zoos and Aquariums Symposium Organised jointly by ZooSchweiz, OZO and Zoos in Bavaria, at Goldau-Rigi, 27th February – 1st March 2003. WAZA , POB 23, CH-3097 Liebefeld-Berne, Switzerland.

Zoos Forum (2003) The ethical review process. In the **Zoos Forum Handbook**. Available at:
www.defra.gov.uk/wildlife-countryside/gwd/zoosforum/handbook/index.htm.

9.   Further Reading

Appleby, M.C. 1999. **What Should We Do About Animal Welfare?** Blackwell Science, Oxford.

Appleby, M.C. & Hughes, B.O. (Eds) 1997. **Animal Welfare**. CAB International, Oxon.

Armstrong, S.J. & Botzler, R.G. (Eds) (2003) **The animal ethics reader**. Routledge, Taylor and Francis, London.

Broom, D.M. and Johnson, K. 1993 **Stress and Animal Welfare**. Chapman & Hall Animal Behaviour Series, London, UK.

FSBI (2002). Fish welfare. Briefing Paper 2, Fisheries Society of the British Isles, Granta Informations Systems, 82A High Street, Sawston, Cambridge CB2 4H, Tel/Fax: +44(0)1223 830665. Email: FSBI@grantais.demon.co.uk

Fowler, M. E. & Miller R. E - eds, (1986-2003). **Zoo and Wild Animal Medicine.** Editions 2-5. W.B. Saunders Co, Philadelphia.

Gregory, N. (2004) **Physiology and Behaviour of Animal Suffering**. Blackwell Publishing, Oxford.

Griffin, D.R. 2001. **Animal Minds: Beyond Cognition to Consciousness**. Chicago University Press, Chicago.

Harrison, G. J., & Ritchie, B. W.,(1994) Making Distinctions in the physical examination. In Ritchie, B. W., Harrison, G. J. & Harrison, L. R. (eds), **Avian Medicine Principles and Application**. Winger Publishing, Inc, Florida

Kleiman, D.G.,Allen, M.E., Thompson, K.V. & Lumpkin, S. 1996 **Wild Animals in Captivity**. University of Chicago Press, Chicago.

Moberg, G. & Mench J. A. (eds). 2000. **The biology of animal stress: Basic principles and implications for animal welfare**. CABI Publishing, Oxford.

Norton, B.G., Hutchins, M., Stevens, E., & Maple, T.L. (eds). 1995. **Ethics on the ark: zoos, animal welfare, and wildlife conservation**. Smithsonian Institute, Washington DC.

Radford, M. 2001. **Animal welfare law in Britain: Regulation and responsibility**. Oxford University Press.

Smith, B. P., (2002) **Large Animal Internal Medicine**. Third Edition Mosby

Smith, T. (2004) **Zoo Research Guidelines: Monitoring Stress in Zoo Animals**.   BIAZA, The British and Irish Association of Zoos and Aquariums London (available at

http://www.zoofederation.org.uk/uploads/Zoo%20Research%20Guideline s%20-%20Monitoring%20Stress%20in%20Zoo%20Animals.pdf).

Stamp Dawkins, M. 1998. **Through our eyes only?: The search for animal consciousness.** Oxford University Press.

Terlouw, EM, Schouten WGP and Ladewig J, (1997) Physiology. In: **Animal Welfare** eds Appleby M and Hughes B. CAB international.

Webster, J. 2005. **Animal Welfare: limping towards Eden**. Blackwell Publishing, Oxford.

Young, R.J. (2003) **Environmental enrichment for captive animals**. UFAW Animal Welfare Series (Series Editors Kirkwood, J.K., Hubrecht, R.C. & Roberts E.A.). Blackwell Publishing, Oxford. 228 pages.

Wilcken, J., & Lees, C. (eds) (1998) **Managing Zoo Populations: compiling and analysing studbook data**. Australasian Regional Association of Zoological Parks and Aquaria: Sydney, Australia.

10. Useful Websites

DEFRA website (http://www.defra.gov.uk/animalh/welfare)
RSPCA website (http://www.rspca.org.uk – see especially the Science section)

The Shape of Enrichment (http://www.enrichment.org)