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Welfare in captive carnivores: what can studies tell us about captive wolf management?

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Abstract

Welfare in animals is currently an area of great scientific attention. If wild animals are to be kept in captivity, environments must be made available that satisfy their specific biological and behavioral needs. This provides help towards eliminating abnormal behaviour in captive animals. Because the wolf (*Canis lupus*) is an adaptable species it is hard to generalize about them and therefore they are greatly misunderstood. This leads to problems when managing wolves in captivity. Until recently no studies addressed the effect of enclosure size, I have found that to effectively manage wolves a balance of correct size and content as well as familiar co specifics will greatly aid in the well being of wolves in captivity.

Introduction

The welfare of animals in the context of their management has increasingly become the centre of scientific interest (Mallapur 1999). Like their wild con specifics, captive animals need to engage in a variety of behaviors such as seeking shelter, nest sites, mates and food resources; defending territories and exploring new spaces. Most captive animals are, to a large extent, denied the opportunity to engage in species specific behaviors. This denial may be severely detrimental to animal well-being (Laidlaw 2000).

Many studies have been carried out on captive wolves because of their ease of access (White, 2001). Some have focused on health care and early socialisation of captive wolves (Klinghammer & Goodmann 1987) while others look at vocalisations (Harrington & Mech 1978; Tooze *et al* 1990) and scent marking (Peters & Mech 1987). Despite the number of articles that have been written about wolves, and even though there is enough information to produce general

guidelines for their management, there are many aspects of wolf biology that remain to be thoroughly described (Mech & Boitani 2003).
Until a recent report by Frezard & Le Pape (2003), no studies have specifically addressed the effect of enclosure size or pack social dynamics in captive populations.

The aim of this review is to address i) how welfare in captivity is assessed, ii) examine enclosure utilisation of captive animals and to iii) ultimately focus on studies that relate to wolf activity patterns and behaviour. This leads to the overall goal of producing a solution of what the best enclosure design would be for housing captive wolves. Through reviewing literature around my topic I will highlight gaps in research and justify the need for my study, avoiding any replication.
In this introduction however, I need to firstly address the wolf itself so that a better understanding is gained when considering pack composition in captivity.

Wolf behaviour

A study by Mech (1999) concludes that the typical wolf pack is a family, with the adult parents guiding the activities of the group. Packs typically consist of related individuals (Mech 1970) and this is therefore a problem in captivity because if pack members are missing this is hard to replicate.
Even with the range of morphology and ecology in the Canidae family, social behaviour remains similar throughout its members. Some specialisations have occurred in group living species to maintain group cohesion and to reduce intra specific aggression. In comparison to the bat eared fox which developed contact behaviours such as social grooming; the wolf has evolved more specialised agnostic postures that serve to maintain social hierarchy (Kleiman 1967) (Table 1).

Table 1: Expressive characteristics of visual features used during social interactions in wolves (Adapted from Mech & Boitani 2003)

Feature	Aggressive expression	Fearful expression
Eyes	Direct stare Open wide	Looking away Closed to slits
Ears	Erect and forward	Flattened and turned to the side
Lips	Horizontal contraction (agnostic pucker)	Vertical retraction (submissive grin)
Mouth	Opened	Closed
Teeth	Canines bared	Canines covered
Tongue	Retracted	Extended (lick intention)
Nose	Shortened (skin folded)	Lengthened (skin smoothed)
Forehead	Contracted (bulging over eyes)	Stretched (smoothed)
Head	Held high	Lowered
Neck	Arched	Extended
Hair	Erect (bristled)	Sleeked
Body	Erect/tall	Crouched/low
Tail	Held high Quivering	Tucked under body Wagging

Measuring welfare in captivity

Animal welfare assessment commonly involves behavioural and physiological measurements (Rutherford *et al* 2004). This section aims to address the problems of captive carnivores, focusing on the two key ways in which welfare is assessed in captive animals (Mason 1991).

Stereotypy and stress in captive animals

Stereotypic behavior is a phrase that is too easily used and, even in its correct usage, a matter of debate (Laidlaw, 2000). They are frequent in captive animals, currently displayed in an estimated 85 million captive animals globally (Mason & Latham 2004). It can be defined as repetitive, invariant behaviour patterns with no obvious goal (Mason 1991). However the underlying processes are poorly understood (Mason & Vickery 2005). Stereotypies are thought to indicate that an animal's environment is sub optimal and that the animal is suffering from a welfare problem such as stress (Mason 1991). A study by Mason & Latham

(2004) found that approximately 68% of situations that increase stereotypies also decrease welfare. However there are exceptions and it has been suggested that they are not a reliable indicator of stress in animals (see Mason 1991 for review). Stereotypic behaviour needs to also be distinguished from displacement behaviours which could help relieve frustration and conflict (Laidlaw, 2000). Animals may perform displacement activities when an ongoing action is stopped before it is completed (Goodmann *et al* 2002).

A study by Clubb & Mason (2003) investigated the previously unexplained variation in captive animals' welfare by focusing on caged carnivores. They show that it originates from constraints forced on the natural behaviour of susceptible animals, with extensive lifestyles in the wild predicting stereotypy and the extent of infant mortality in captivity (figure 1).

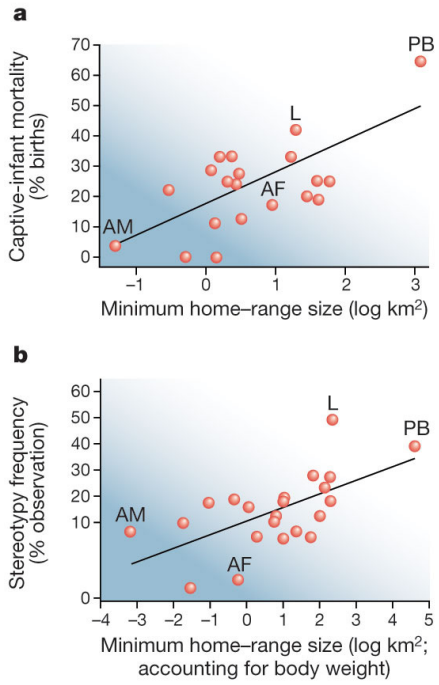

Figure 1: Natural ranging behaviour and welfare of species from the order Carnivora in captivity. The cross species plot (a) shows that carnivores' minimum home-range sizes in the wild predict captive infant mortality. (b) shows that together with body weight, minimum home-range size also predicts stereotypic pacing in captivity. On these cross-species plots, a few species from a range of families and with varying relation to the regression line are highlighted: AF, Arctic fox (Alopex lagopus); PB, polar bear (Ursus maritimus); AM, American mink (Mustela vison); L, lion (Panthera leo). (From Clubb & Mason 2003).

Husbandry of these species in captivity is therefore in need of improvement, such as provision of extra space (for example, a polar bear's standard enclosure size is about one-millionth of its minimum home-range size). Alternatively, zoos could stop housing wide-ranging carnivores and concentrate instead on species that respond better to being kept in captivity.

Morgan & Tromborg (2007) suggest that perhaps the greatest stressors in populations of captive animals are those over which the animal has no control and from which they cannot escape. The importance of controllability in animal welfare is a complex subject, and one that is problematic for study. Even so many investigators have argued that control is essential for animal well-being. Another aspect of captivity that may be stressful to animals is its predictability. It may be essential however to introduce animals to a certain amount of unpredictability, in the case if the aim of maintaining animals in captivity is conservation and reintroduction.

When considering stress in wolves, enclosure size directly links to this as if there is not a large enough enclosure; the omega wolf has nowhere to seek refuge (White 2001).

Captive behaviour

This section aims to provide an overall insight into captive behaviour, focusing on wolf activity patterns and interactions.

Space utilisation by captive animals

Many studies have been carried out on the effects of enclosure and spatial associations. For example, in female ring-tailed coatis (*Nasu nasu)* (Romero & Aureli 2007), and adult and juvenile groups of captive chimpanzees (*Pan troglodytes)* (Taylor-Holzer & Fritz 1985). Both these studies have application;

however a study by McCreery (2000) on African wild dogs has particular relevance as it has an applied value to conservation as well as spatial considerations.

The development of the spread of participation index (SPI) was first applied to describe the extent of enclosure utilisation by captive animals. It is particularly functional in assessing the effects of enclosure use by the animals in relation to management actions such as using environmental enrichment to challenge stereotypic behaviour (Plowman, 2003).

One approach regarding spacing behaviour is to consider the ideal free distribution (Milinski & Parker 1991). This is one of a series of terms which describe the possible allocation of animals in a patchy habitat. If all animals were free to move to alternative patches without any constraint then ideally each individual goes to the place where its gains will be highest. In this approach however, it needs to be determined what represents gain; for example food supply, water, or in the case of group behaviour in laying hens, the presence of familiar co specifics (Lindberg & Nicol 1996). While it may not be a critical factor in the housing of wolves, elevated vantage points may provide a previously unavailable behavioural opportunity and could be considered a gain (Laidlaw 2000).

Carnivores in captivity spend more than 75% of their time in less than half of their enclosure space (Mallapur 1999). The study by Frezard and Le Pape (2003) further supports this as they found that in a comparison of enclosures for six packs of wolves, in each park the animals used only a part of the available space. The proportion was found to be lower in the larger enclosures. The authors also emphasise the importance of spatial choice and social group management. This was through the behavioural diversity being little affected by the enclosure, instead being highly related to the composition of the pack.

Activity patterns in captive wolves

Wolves are flexible enough to learn new patterns and to adjust their activity accordingly. The activity patterns of wolves in the wild can shift to adjust to changes in predictable patterns in temperature and prey activity for example. Activity patterns also vary in captive packs. In most captive packs daylight activity peaks in the morning and evening. Morning activity could however be related to the cleaning routine in zoo enclosures. It was found that the overall activity did not differ between wolves housed in outdoor chain link kennels and in large enclosure with natural vegetation (Mech & Boitani, 2003).

The seasonality of courtship and reproduction may also influence wolf activity patterns. In several captive packs the frequency of overall interactions and aggression peaked during winter months in the lead up to the breeding season. Sleep takes up to about one third of an animal's time. It involves periods of inactivity organised on a rhythmic daily basis. The animal usually seeks out a typical sleep site and adopts a typical sleep posture (McFarland 1989). In wolves this could be side or curl rests (Goodmann *et al* 2002). In the study by Frezard and Le Pape (2003) the proportion of time resting was found to be higher in large, comfortable enclosures.

Social interactions in captive canids

Among carnivores, group living is atypical, only 10 – 15% of the species form stable social groups outside the reproductive period. The application of primate socio ecological models to social carnivores requires detailed behavioural and ecological data (Romero & Aureli 2007). However no model is comparable to wolf social organisation because wolves are cultural animals with learned, therefore variable, social organisation (Sharp 1978).

Captive wolves typically maintain a stricter hierarchy within the pack than their wild co specifics. It is enforced with more frequent intraspecific aggression and dominance displays. This distinction has been associated with the difference in social bonds between related and unrelated wolves. The majority of captive wolf

packs consist of unrelated individuals that did not mature with their present co specifics.
In captive wolves, average aggression levels towards pack mates are found to be four times higher than a wild pack (White, 2001). This could be detrimental to the animals' health and to human safety. Whites' study points towards the importance of social factors such as relatedness, age, resource competition and stability of the pack in particular reference to the causes of higher levels of aggression in captive packs. With further research, these results could be applied to planning enclosure design, resource allocation and reintroduction and captive breeding efforts for wolves and possibly other socially hierarchical species.

Socialisation

This section is particularly relevant for my study as I will be comparing between socialised and non-socialised wolves.

Socialised versus non-socialised

In the example of Wolf Park in America, the animals have purposely been socialised to humans with the aim of providing education for the public and to be a research facility. This is also found in the UK Wolf Conservation Trust in Beenham, (Reading) where the wolves are more likely to carry on uninterrupted interactions in the presence of visitors. This is thought to be because humans are acceptable social companions, allowing researchers to observe film and handle, manipulate and move wolves to experimental locations with a minimal amount of stress to the individuals and little disruption to the pack social order. When wolves are not socialised and require medical care for example, the first obstacle is catching them. These methods might aggravate the animals' condition or make it appear vulnerable and more likely to be harassed after treatment by its pack members. Socialised wolves however, are more easily approached, routine maintenance is effectively achieved and the wolves may receive routine medical care and some emergency treatments without traumatic methods of capture and

restraint. Overall the stress and disruption caused by human presence and activity are therefore significantly decreased (Klinghammer & Goodmann, 1985).

Socialisation creates additional opportunities to enrich the wolf's environment, this is because socialised individuals can be leash trained and allowed to explore the world beyond the enclosure and this perhaps could allow some limited hunting behaviour (Klinghammer & Goodmann 1987). The same authors in an earlier paper however, identify problems associated with maintaining exotic species socialised to humans (Klinghammer & Goodmann 1985*)*. These include preference for humans over co specifics which could result in failure to breed successfully and in excessive orientation to humans. In cases where staff personal is high, handlers may be subject to attacks due to dominance challenges. For example, this could be from the frequent introductions and departure of experienced caretakers familiar to the wolves. These problems do however have solutions. In response to being subject to attack, handlers can learn to detect an animals readiness to challenge and avoid being caught up in escalating threat displays that could lead to an assault. Hand rearing wolf pups with litter mates as well as with human foster parents ensures they can interact normally with canids. In a study by Topal *et al* (2005), the pups were socialised to humans as well as other wolves daily when the pups were four months old. Through this, the hand reared wolf puppies after the study finished, were then able to be successfully integrated into a pack of wolves by the age of two.

Socialisation also increases the range of behavioural management practices that can be applied. For instance, teaching wolves cut off signals gives the handlers judgment in restricting or finishing wolf-human interactions. In wolf behaviour, calming signals are used which decrease the intensity of an interaction that may be becoming too vigorous or aggressive. This is seen in wolf behaviour with averting gaze which handlers can use as well. This is because it is part of both the canine and human selection of expressive behaviours which are innate in

wolves and are correctly interpreted by those that are socialised to humans, as well as their pack mates (Goodmann *et al* 2002).

Handlers and keepers must be aware that any interaction with the animal may cause behavioural shaping, intended or not. Therefore they must train themselves to be aware of behavioural sequences the animals show in their presence and practice searching for any behaviours of their own which may inadvertently shape the animals. A thorough knowledge of the animals' perceptual surround is valuable for the array of positive reinforcers it can suggest. Where the opportunities for handlers exist, this system has much to offer in improving management, research and general husbandry of captive wolves in our care (Klinghammer and Goodmann 1985).

Solutions

Enclosure design and content

Laidlaw (2000) provides a comparison between housing practices and gives a general guideline to good enclosure design being rooted in consideration of the biological and behavioral needs of captive wolves. The design should incorporate sufficient space to facilitate normal movements and a range of natural behaviors, as well as adequate space for members of the public who come to view them. The provision of an appropriate amount of space, along with factors impacting on animal well-being, at the design stage will help ensure an acceptable quality of life for the captive and prevent animals from constantly searching for escape routes. Quality of space, accomplished in part through enclosure furnishings, is a core requirement for animal well-being. Natural items such as small trees, shrubs, logs with intact bark and leaves, stumps, hillocks, rock piles, earth mounds, deep litter, sand boxes, streams, ponds and pools, and other features can be incorporated into many exhibits increasing their complexity and making them more interesting for the animals. Artificial items can supplement natural features.

In addition to increasing activity, furnishings may also provide other benefits such as the provision of shade, and hiding spots for animals that wish to remove themselves from the view of the public or each other.

Building the enclosure is the most expensive and labour intensive element in any captive wolf project, it is also the least open to to later change (Frank 1987). Enclosures housing potentially dangerous animals should be designed and constructed so that the animals can be moved to a secure secondary containment area prior to staff entering the enclosure. Entry points should be through a set of double gates, so that the first gate can be opened and locked before the second gate into the actual animal enclosure is opened. Laidlaw (2000) suggests that night quarters may be required to secure potentially dangerous animals at times when staff supervision is minimal. These also should be carefully designed with the biological and behavioral needs of the animals considered.

Size of enclosures

The Dangerous Wild Animals (Northern Ireland) Order (2004) provides guidance to the requirements of keeping wolves and wolf-dog hybrids. In this document it gives the minimum recommended floor space per animal in an outdoor enclosure to be 200 square foot. For each additional animal this should be increased by 100 square foot. This differs slightly from the minimum husbandry standards for medium and large canids contained in the American Association of Zoos and Aquariums (AZA) (Grisham *et al* 2000). In response to the AZA minimum enclosure size of 150 square foot for one large cursorial canid, it seems very small. When considering the social aspects of canids, in which case it would better to have at least two animals housed together, increasing the enclosure by 50% as required in the guidelines gives 225 square foot of space. Again this is incredibly small and the AZA guideline does not compare favourably with the institutions that participated in the comparison of housing practices by Laidlaw (2000). In which these facilitate the two key areas of space and social groupings.

Wolf Park for example suggests that no permanent wolf enclosure for non-socialised wolves should be less than one acre in size.
Most establishments have spatial restrictions which limit the sizes of enclosures, but I would urge those institutions wanting to house large canids to make the space available for the animals, or make the decision not to house them. This is emphasised by the study of Clubb & Mason (2003) where their findings indicate that keeping naturally wide ranging carnivores should either be fundamentally improved or phased out.

Implications:

Welfare

Multi species data, from the many taxa held in zoos, hold enormous potential for increasing the fundamental understanding of animal welfare (Clubb & Mason 2004). In relation to stress, the challenge is to determine the optimal balance of variability and routine that is ideal for each species, and probably for each individual.

Conservation

Despite the inspiring research developments in animal behaviour over the last two decades, Sutherland (1998) highlights 20 subject areas in which behavioural studies can make a substantial contribution to solving present conservation problems. One example is captive breeding, where the success of release programmes depends largely upon the animals behavioural skills.

It may be possible to apply these findings and future findings to several different fields related to wolf ethology. Zoos and other institutions could put to use a guideline for the number of wolves and area needed per wolf in enclosure design for the future.
At the moment, it appears that limited resources should be applied to building more separate enclosures to facilitate smaller packs rather than into enlarging

present pens when considering the aggression level in resident wolves as an example.

As mentioned, conservation biology could also benefit. Wolf reintroduction efforts are often more successful when a 'soft release' method is employed to introduce the animals to the new surroundings. With lower aggression and stress level, the translocated wolves stand a better chance of forming strong social bonds with each other and becoming a viable wild wolf pack once released.
Such knowledge can also be put into use in captive breeding efforts for the most endangered canids in the world, the Red wolf (*Canis rufus*) (Busch 1995) and the African wild dog (McCreery 2000). Other ethologists and facilities around the world may be able to generalise this trend to other social pack animals that incorporate a strict social hierarchy such as golden jackals, dingoes and mongoose (White 2001).

Conclusion

From reviewing the above I hope to further add to the literature with studying the effect of enclosure use in socialised and non socialised wolves. Perhaps only endangered wolves should be housed in captivity with the aim of reintroduction as wolves are wide-ranging carnivores and the highly socialised pack is extremely hard to manage when members in captivity go missing.
Through my study, I hope to further add to guidelines for enclosure size and needs.

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