Evaluation of enclosure design, with focus on wild and domesticated herbivores in Swedish zoos

Utvärdering av hägn, med fokus på vilda och domesticerade herbivorer i svenska djurparker

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Abstract

What is the meaning of zoos today? Some states that they are used for conservation and education, while other believes it’s a place for entertainment. When evaluating factors such as animal welfare and ability to perform natural behaviours, enclosure design is an important factor. Lack of natural settings and unsuitable diets may cause stereotypic behaviours and aggression towards other individuals. No recent study has been made regarding enclosure design in Swedish zoos. This study focused on wild and domesticated herbivores from the order Perissodactyla, Artiodactyla and Proboscidea. Questionnaires and direct observation were used to evaluate enclosure design and fulfilment of the regulation set by the Swedish Board of Agriculture concerning keeping animals at zoo (SJVFS 2009:92, Dnr L 108). Seven zoos located in the middle and south of Sweden were included in the study and a total of 76 enclosures were assessed. Major part of the enclosures had natural settings and species-specific diets. Almost all of the enclosures had great ability for species-specific foraging and social contact. All zoos suffered from health problems, but had management plans to reduce current health problems. Feed enrichments were used in the major part of the enclosures and stereotypic behaviours were not present in any of the enclosures. Overall, Swedish zoos have enclosures with great possibility for both wild and domesticated herbivores to perform social and species-specific foraging behaviours. However, there should be an increased focus on animals held in temporary enclosures in order to improve their welfare and reduce the risk of developing stereotypic behaviours.

Sammanfattning

Djurparkens betydelse är ett väl diskuterat ämne. Vissa menar på att djurparker är plats för underhållning, medan andra menar att djurparker används för att bevara utrotningshotade arter och utbilda besökare. Hägnets utformning är viktigt att ha i åtanke när man utvärderar djurvälfärd och möjligheten att utföra naturliga beteenden. Finns det brister i deras miljö (såsom reducerad möjlighet att utföra naturliga beteenden) eller felkonstruerade dieter kan detta påverka djurens välfärd och leda till stereotypiska beteenden och aggressivitet. Det finns ingen tidigare studie gjord med avseende på hägnutformning på zoon i Sverige. Denna studie fokuserar på vilda och domesticerade herbivorer från ordningen Perissodactyla, Artiodactyla och Proboscidea. Frågeformulär och direkt observation användes för att utvärdera utformningen av hägnen och om hägnen uppfyllde kraven som ställs i statens jordbruksverks föreskrifter om djurhållning i djurparker m.m; (SJVFS 2009:92 Dnr L 108). Sju djurparker i mellersta och södra Sverige ingick i studien och 76 hägn blev bedömda. De flesta hägn innehöll naturliga miljöer och hade tillgång till art-specifika dieter. Nästan alla hägn hade stor förmåga att utföra art-specifika födosöks beteenden och hade social kontakt med andra individer. Det fanns enstaka hälsoproblem i alla djurparker, men alla djurparker hade rutiner för att minska nuvarande hälsoproblem. Foderberikning användes i nästan alla hägn och stereotypa beteenden uppvisades inte i någon av hägnen. Sammanfattningsvis så har vilda och domesticerade herbivorer i Svenska djurparkshägn stor möjlighet att utföra sociala och artspecifika födosöks beteenden. Djur i temporära hägn skulle behöva läggas mer fokus på då dessa hägn hade reducerad möjlighet för sociala och artspecifika födosöksbeteenden.

Preface

When I write papers, I either want to discuss complex questions or bring up provocative issues to create discussions. This thesis enabled me to deal with the issue of keeping wild animals in zoos. What is right or wrong may come from either personal experience or hard facts. In this thesis, I wanted to combine animal behaviour, welfare and housing in order to establish if wild animals could be kept in captivity without reducing their welfare and ability to perform natural behaviours.

I would like to thank my supervisor Maria Andersson for the chance to combine my favourite issues in this thesis.

I would also like to express my gratitude to participating zoos for their hospitality. Without them, this thesis would not have been written.

My family has been my biggest support and I´m so grateful; you guys are amazing in every single way.

Fredrika Lindgren
Västerås, January

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1. Introduction

Non-territorial grazers with the ability to live in large herds and on limited areas could be said to be pre-adapted to a life in captivity and was most common candidates for domestication. The effort to domesticate species with less desirable traits, such as the moose and fallow deer was abandoned due to the difficulties maintaining them in captivity. Some species from the herbivore family was ignored completely because of complex mating systems, large home areas and territorial behaviour (Tennessen & Hudson, 1981). Domesticated animals were and are used in the agriculture society, while some wild animals started to be captured and kept in captivity for other purposes. Over 200 years ago, zoos were established to house wild animals for entertainment and amusement of the public. Today, the focus has shifted from using wild animals only as attractions to instead be used for education and conservation. Since many wild animals are almost extinct, the use of zoos to conserve endangered species and inform the public could be one tool to avoid extinction. One benefit of this shift has been improvement of the environment for wild animals kept in zoos, by focusing on natural behaviour, veterinary care and appropriate diets. One other benefit is the pooling and analysis of data, which enable the zoos to maintain genetically healthy populations of endangered species (Rabb, 2004). However, animals not selected for captivity or husbandry may have difficulties coping in captivity due to the different needs and preference compared to ”pre-adapted” domesticated animals (Moberg & Mench, 2000, p. 338)

Regulations from the Swedish Board of Agriculture concerning keeping animals at zoo (SJVFS 2009:92 Dnr L 108) are used to regulate how wild and domesticated animals should be housed and managed in Swedish zoos. No recent study could be found regarding enclosure design and if Swedish zoos fulfil the regulations set by the Swedish board of agriculture. Therefore, the purpose with this study is to compare the current design and environment of enclosures in Swedish zoos with the Swedish regulations regarding keeping animals in zoos. Furthermore, the enclosures will be evaluated to see if the environment is suitable for wild and domesticated herbivores. The focus will be on wild and domesticated herbivores from the order Perissodactyla, Artiodactyla and Proboscidea. Recommendations for improvement of enclosure design and environmental enrichments will be given if needed.

Questions need to be answered:

1. How do the environments for herbivores look like in Swedish zoos?
2. Does the enclosures for herbivores fulfil the regulations from the Swedish Board of Agriculture concerning keeping animals at zoo (SJVFS 2009:92 Dnr L 108)
3. Are herbivores at Swedish zoos able to perform species-specific behaviours?

2. Literature review

2.1. Foregut fermenters vs. hindgut fermenters

Classification of mammals into herbivores, omnivores and carnivore groups are based mainly on diet selection and history. Herbivores are the group of animals that are adapted, both physically and anatomically, to a plant-based diet (Cheeke & Dierenfeld, 2010). Almost 80 % of the remaining mammals are herbivores divided into two major groups: Foregut fermenters and hindgut fermenters (Ley *et al.,* 2008). Ruminants are classified as foregut fermenters and

have four compartments named abomasum, omasum, reticulum and last and most important, the rumen. Rumen is a large compartment were microbial fermentation of nutrients occur. The environment in the rumen is anaerobic, leading to anaerobic fermentation of glucose into volatile fatty acids (VFA), which is the major end product of rumen fermentation and energy source for the animal. Hindgut fermenters (non-ruminants) have, instead of a rumen, large hindguts where microbial fermentation occurs. The capacity to digest nutrients, especially fibre, is greater in ruminants compared to non-ruminants due to the ability to retain nutrients longer in the rumen and therefore enable further breakdown of nutrients with help of microbes (Cheeke & Dierenfeld, 2010). Elephant, rhinoceros and horse are examples of non-ruminants, whereas sheep, okapi, giraffe, sheep and cattle are examples of ruminants (Ley *et al.,* 2008). Steuer *et al.* (2011) investigated the correlation between dry matter intake (DMI) and body mass of both wild and domesticated herbivores. A comparison between non-ruminants and ruminants regarding mean retention time (MRT) and feed intake were also conducted. Results showed that body weight influenced the DMI and non-ruminants had significantly higher DMI compared to ruminants. MRT also differed between non-ruminants and ruminants. Non-ruminants had an MRT ranging between 20 hours (domestic pony) and 47 hours (white rhinoceros), whereas ruminants had a MRT ranging between 23 hours (forest buffalo) and 75 hours (domestic cattle). The benefit of having higher DMI and short MRT intake when quality of the forage is low, gives non-ruminants the ability to absorb digestible nutrients and dispose of indigestible nutrients faster than ruminants. The negative aspect is the reduced ability to digest fibre and other nutrients that need longer time to break down in the gastrointestinal tract (Soest, 1994).

2.1.1. Feeding strategy & social structure

Herbivores can be divided into groups according to their feeding strategy. The three major groups are grazers, browsers and mixed feeders. Cattle, zebra and sable antelope are grazers and equipped with either a large rumen or ability to consume feed at a high rate, enabling ingestion of plants with high fibre and low energy content. Browsers have instead a gastrointestinal tract developed for low fibre forage and therefore select low fibre parts such as fruit, leaves and soft plant parts. Examples of browsers are giraffe, moose and roe deer. Mixed feeders, such as goats, sheep and elephant, are adaptable to different environments and can shift between browsing and grazing depending on the availability of nutrients (Cheeke & Dierenfeld, 2010; McNaughton & Georgiadis, 1986).

It is commonly known that herbivores spend most of their time foraging and socializing, however time spent foraging within the herbivore family differ depending on social structure, feeding strategy, size and gastrointestinal function (Okello *et al.,* 2002). The Przewalski's horse is a large grazer with hindgut fermentation and spends up to 45 % of their daytime grazing in the wild (King, 2002; Souris *et al.,* 2007). Goats and sheep, which are small mixed feeders with foregut fermentation, spend instead up to 61 % of their time grazing or browsing and 10 % ruminating (Pokorná & Hejcmanová, 2013). Common zebra and Impala feed on similar vegetation but have different anatomically features and feeding behaviour. Impala are a small sized selective mixed feeder, whereas the zebra is a large non-selective grazer. Due to the small size of the impala, the energy requirement and need to find highly nutritious plants are greater compared to the common zebra. The foraging efficiency is therefore higher in the impala as an adaption to find suitable forage, while the zebra generally has a higher feed intake of a broader variety of forage (Okello *et al.,* 2002). Another aspect that needs to be considered is the seasonal difference in feeding behaviour and selectivity. Similar to the elephant (Owen-Smith & Chafota, 2012), Moose are a selective in their choice of forage and

shift their foraging strategy depending on season, selecting for certain browse-species during winter when availability of high-nutritional plant-species is low (Wam & Hjeljord, 2010). Dromedary camels on the other hand do not shift their feeding strategy between seasons, and select for perennial woody plants, herbaceous plants, grasses and weeds independent on season and availability of other nutrient-rich plants (Dereje & Udén, 2005).

Social structure and organisation varies within the herbivore family and influence the selection of animals during early domestication. Social organisation can be divided into two groups: Dominance hierarchy and territoriality. Dominance hierarchy is based on dominance/submission between individuals in a group and where a "pecking-order" is established and maintained through social interactions between individuals. This type of social organization is common in domesticated herbivores, enabling them to share space and live in large groups. Territorial animals have larger home range and defend it from other species or individuals. Increased need of space and aggressive behaviour towards intruders created difficulties when keeping territorial animals in captivity (Price, 2008). Animals with dominance hierarchy, such as goats (Barroso *et al.*, 2000), cattle (Šárová *et al.*, 2013) and horses (Krueger & Heinze, 2008) may be easier to keep in captivity were there is limited space and larger groups, compared to the more territorial animals that need larger areas and smaller groups, or even needs to be kept individually.

2.2. The meaning of zoos

The shift from using zoos for entertainment to education and conservation could be explained by the pressure from the general public's demand for more animal welfare friendly environments in the zoos, but also because of the greater need to handle the increasing number of endangered species (West & Dicke, 2007). The meaning of zoos can be discussed and options might vary. Some may say that keeping animals in captivity is cruel and unnecessary, while others stress its importance for conservation and relocation of endangered species. In order to improve the status of zoos as a place for education and conservation, focus on the visitors opinions toward the zoos are important (Woods, 2002). Zoos with enclosures with wild settings and are well managed often get positive feedback from visitors, whereas zoos with bare enclosures with more "captive" feeling and poor management often get negative feedback (ibid.).

2.2.1. Enclosure design

Figur 1. Mesh fence- horizontal

When designing an enclosure, the need of the animals, visitors and animal keepers should be taken into account. The ability for the animal to hide from visitors and perform natural behaviours are important, but also the ability for the visitor to see the animal needs to be considered, creating a compromise between the visitors and the animal's needs (Fernandez *et al.*, 2009). In order to keep the animal inside the enclosure and the visitor out, suitable barriers need to be in place. Depending on what type of species is kept in the enclosure, the barriers can look different, from fences to wet moat and ha-ha wall (wall with vertical slope). Mesh fence is steel wires woven to a fence supported by either timber, steel or concrete posts (see figure 1) and can be both vertical and horizontal. Mesh fence is suitable for herbivores and it is cheap and easy to build, compared to other barriers. High walls and pits made of concrete or stone are common in older zoos and are used for a variety of species (see figure 2). Wood fences are often used in petting zoos and enclosures where domestic animals are kept. This fence can either be entirely made of wood planks or in combination with electrical wire, similar to fences seen on agricultural farms (see figure 3) (Rees, 2011).

Figure 2. High wall made of concrete

Figure 3. Wood fence

The nature of the substrate can also vary depending on type of enclosure and species held there. Grass, sand, concrete, bark chipping and gravel are common substrates in zoos today. In order to prevent claw/hoof/foot problems, it is important to consider type of substrate best suited for the specific specie. According to Haspelagh *et al.* (2013), elephants are more likely to suffer from foot problems when concrete used as floor substrate in the enclosure. Sand also contributes to foot problems, but the frequency of foot problems is depending on the quality of the sand, grain size and layer thickness. Suitable substrate for elephants is not yet scientifically established and no current study has been found. Different to the elephant, sand stalls has shown improvement in hoof and leg injuries in dairy cattle (Norring *et al.*, 2008). Keeping cattle on pastures also improves the recovery of hoof and leg injuries (Hernandez-Mendo *et al.*, 2008).

Keeping animals in groups or individually depends on different factors such as species, sex, social structure and season. Most of the herbivore species are social individuals and lives in groups; accept for males that lives separated from the group during larger part of the year. Social animals are often kept in groups of similar species in captivity, mimicking the social order in the wild. The interest for multi-species groups in zoos has increased and there are both advantages and disadvantages with this type of housing. The advantage is increased interaction between species, which is a form of social enrichment and increased educational value for visitors. The disadvantages may be competition for food, aggression between individuals and risk for parasite transmission between species (Rees, 2011).

2.2.2. The use of enrichments to reduce stereotypic behaviours in zoos

Stereotypic behaviour can be described as a repetitive behaviour induced by frustration and repeated attempts to cope with its environment (Mason *et al.*, 2007). Foraging behaviour is highly motivated in both wild and domesticated herbivores and frustration caused by reduced ability to forage may lead to stereotypic behaviours. Stereotypic behaviours that resemble feeding behaviours, such as repetitive oral and oro-nasal activities, are the most common types of stereotypic behaviours in both domesticated and wild herbivores kept in zoos (Bergeron *et al.*, 2008). Tongue-rolling in cows and crib-biting in stabled horses are two examples of common stereotypic behaviours in domestic herbivores and are related to insufficient feeding (ibid.). Bashaw *et al.* (2001) conducted a survey of 71 zoos in America regarding stereotypic behaviours in giraffes and Okapi (from the family *Giraffidae*). Approximately 80 % of the study animals showed stereotypic behaviour and repetitive licking and pacing were the two major stereotypic behaviours performed. Licking was related to feeding motivation whereas pacing was related to the physical environment. However, licking was also associated with number of hours kept indoors and pacing with feeding concentrate, indicating that oral and locomotor stereotypic behaviours could affected by both environment and feeding. In elephants, weaving, nodding and pacing are common stereotypes and are associated with diet, enclosure area and ability to exercise. Additionally, foot problems may also be a contributing factor to stereotypic behaviours in elephants (Haspeslagh *et al.*, 2013).

According to Mason *et al.* (2007) it is difficult to establish the cause of stereotypic behaviour in wild animals kept in zoos due to diversity between individuals/species and lack of knowledge about behavioural need in captive animals. However, the use of enrichments could reduce the risk of developing stereotypic behaviours by encourage natural and species-specific behaviours. Enrichments create a more complex environment and type of enrichments is depending on the specific need of the animal and the behaviour/behaviours that is most important for the animal to perform. For example, barriers and natural areas promote territorial behaviour, escape routes & reduce stress during social interactions by creating privacy if needed. Climbing structures also creates hiding places and promotes climbing behaviour for certain species. Novel objects encourage play and provide the ability to explore. Substrates such as litter, dirt, vegetation and trees increase the ability to forage and investigatory behaviour when feed is concealed in the substrate. Feeding practices and devices stimulate natural feeding strategies when the animals need to acquire and process the feed in different ways and during different times of the day (Swaisgood & Sheperdson, 2005).

3. Material & Method

A questionnaire and direct observations were used at seven anonymous zoos located in the middle and south of Sweden and the study took place in May and June, year 2015. A questionnaire was sent out to all the seven zoos, containing four questions regarding over-all management of herbivores (Table 1). Protocol was used for direct observations and contained enclosure design, covering enclosure areas and barriers, ground substrate, housing, feeding routine, hygiene and social grouping. Collection of information was made by visual inspection of the enclosures and with the help from zoo personnel. Ability to perform social and species-specific behaviours was evaluated with the use of the whole protocol and scientific literature relevant for the behaviours and species in question. Before the start of the study, the protocol was tested on a random zoo in Sweden and modifications were made to

improve the assessment of the enclosures. There was one protocol used for each enclosure, independent on mixed-species group or species-specific groups.

Table 1. *Questionnaire with response choices*

1. Are there a zoologist and veterinarian linked to the zoo?	Yes/no
2. Is there enclosures for sick animals or animals in need of special care within the park area?	Yes/no
3. Have the herbivores any health or/and behavioural problem?	Open-ended
4. Are the enclosures cleaned regularly? Is there any measure to reduce parasite pressure?	Open-ended

The species studied were: 1. Domesticated species: African pygmy goat (*Capra hircus*), Allmoge goat (*Capra hircus*) (including göinge-, jämt- & lapp goat), Allmoge cows (*Bos taurus taurus*) (including Bohuskulla-, ringamåla- and vänecow), Alpaca (*Vicugna pacos*), American miniature horse (*Equus ferus caballus*), Ankole-Watusi (*Bos taurus africanus),* Angora goat (*Capra aegagrus*), Aurochs (*Hybrid of Bos primigenius*), Camel (*Camelus bactrianus domesticus*), Donkey (*Equus africanus asinus*), Dwarf zebu (*Bos taurus indicus*), Fjord horse (*Equus ferus caballus*), Gotland pony (*Equus ferus caballus*), Llama (*Lama glama*), Miniature shetland pony (*Equus ferus caballus*), North Swedish horse (*Equus ferus caballus*), Semi-domesticated Northern reindeer (*Rangifer tarandus tarandus*), Shetlands pony (*Equus ferus caballus*), Swedish Holstein (*Bos taurus taurus*), Swedish hornless cattle (*Bos taurus taurus*) (including Swedish red hornless cattle and Swedish mountain cattle), Swedish sheep breeds (*Ovis aries domesticus*) (including Dala-fursheep, Åsen-, Värmland-, Gestrike-, Rosenslag- and klövsjö sheep) and Yak (*Bos grunniens*).

2. Wild species: African buffalo (*Syncerus caffer*), African bush elephant (*Loxodonta africana*), Barbary sheep (*Ammotragus lervia),* Bison (*Bison bison*), Blackbuck (*Antilope cevicapra*), Blesbuck (*Damaliscus pygargus phillipsi*), Bukhara urial (*Ovis vignei bochariensis*), Capybara (*Hydrochoerus hydrochaeris*), Common eland (*Taurotragus oryx*), Eastern bongo (*Tragelaphus eurycerus*), European Bison (*Bison bonasus*), Fallow deer (*Dama dama*), Forest reindeer (*Rangifer tarandus fennicus*), Lowland tapir (*Tapirus terrestris*), Markhor (*Capra falconeri*), Moose (*Alces alces*), Muntjac (*Muntiacus*), Muskox (*Ovibos moschatus*), Plains zebra (*Equus quagga*), Przewalski's horse (*Equus ferus przewalskii*), Red deer (*Cervus elaphus*), Rhinoceros (*Rhinocerotidae),* Rothschild's giraffe (*Giraffa camelopardalis rothschildi*) and Southern pudú (*Pudu puda*).

The results are compared with the regulations from the Swedish Board of Agriculture concerning keeping animals at zoo (SJVFS 2009:92 Dnr L 108).

4. Results

4.1. Overall management of herbivores

Six of seven zoos responded to the provided questionnaire. Five of the six responding zoos reported having a veterinarian and a zoologist linked to the zoo and one zoo had only a

veterinarian. According to the regulations set by the Swedish Board of Agriculture, a veterinarian and zoologist must be linked to the zoo. All the responding zoos had additional enclosures for sick animals or animals in need of special care.

Health problems were reported in all the responding zoos: 50 % had problems with claw health in goats, 16,7 % had reduced foot health in elephants, 16,7 % had laminitis in horses and 16,7 % had recent problems with calf mortality in moose. One zoo that reported problems with reduced claw health also reported problems with babesiosis (parasitic disease) in moose and cattle. Four of six zoos reported using special diets and claw/foot care to reduce current health problems.

Enclosures were cleaned regularly in all the responding zoos but there was a difference in size and site of the area cleaned. Two zoos cleaned only around the feeding areas and four zoos cleaned the whole enclosure on regular basis. Faecal sample were used in all responding zoos to detect parasite infection. If positive, anthelmintic were used. One zoo reported using bark chipping as ground substrate to avoid parasite infection in moose and removed water sources for goats and reindeers in order to avoid bacterial infections. One of the zoos also reported using deworming pellets for moose during the summer months.

4.2. Evaluation of group specific regulation

Results from the protocols, comprising of display enclosures only (69 enclosures), was used to evaluate group specific regulations and was compared with SJVFS (2009:92 Dnr L 108). Enclosures were divided into three groups according to the regulation: 1. Elephant 2. Perrisodactyla & artiodactyla (except for domesticated forms) and 3. Domesticated forms of perrisodactyla & artiodactyla. The three main groups were further divided into smaller groups (subgroups) containing both single species and mixed species.

4.2.1 Elephants

Two elephant enclosures (group 1) were assessed and compared with the regulation. Enclosure number 1 fulfilled two of four regulations and enclosure number 2 fulfilled three of four regulations (Table 2). 3 § regarding height and floor heating could not be answered for both elephant enclosures due to lack of response from the zoo in question.

Table 2. *Comparison between regulations and results for elephant enclosures*

General	1. African elephants	2. African elephants
1 § Animals should have access to shower or pool with a depth of at least 1 m.	Not fulfilled	Not fulfilled
2 § Rear enclosure should be available.	Fulfilled	Fulfilled
3 § Requirements for enclosure area as follows:		
- Indoor enclosure area with display: 50 m²/animal, but at least 200 m², height 6 m. The floor shall be equipped with floor heating.	Fulfilled for area	Fulfilled for area
- Enclosure design: Separation facilities with minimum space of 50m²/animal. Scrub Spot.	Not fulfilled for two of three facilities	Fulfilled

4.2.2. Perrisodactyla & artiodactyla (except for domesticated forms)

Group 2 (perrisodactyla & artiodactyla (except for domesticated forms)), included regulations for ten subgroups of different species (appendix 1) and 32 enclosures were assessed. Seven of ten subgroups fulfilled their specific regulations (two subgroups had no indoor display for Przewalski´s horse, plains zebra and Blesbuck and two subgroups housed Przewalski´s horse, blackbuck and muntjac outdoor all year round, therefore regulations regarding indoor housing and display was not applied to these species). Fulfilment of regulations regarding enclosure area for three subgroups could not be answered due to lack of response from the zoos in question (Table 3).

Table 3. Group 2 assessment regarding subgroup-specific regulations. Presented in percentage of total number of regulations fulfilled per subgroup.

Animals	Fulfilled	Not fulfilled	Can not be answered	No indoor display	Outdoor all year round
Wild equines	50%	0%	19%	19%	13%
Lowlan d tapir	100%	0%	0%	0%	0%
Rhinoceros	100%	0%	0%	0%	0%
Rothschild´s giraffe	100%	0%	0%	0%	0%
Tropical ruminants >300 kg	83%	0%	17%	0%	0%

Tropical ruminants 150–300 kg	100%	0%	0%	0%	0%
Tropical ruminants 50-150 kg	75%	0%	0%	25%	0%
Tropical ruminants 20-50 kg	33%	0%	0%	0%	67%
Northern & mountain living ruminants >50 kg	71%	0%	29%	0%	0%
Northern & mountain living ruminants <50 kg	100%	0%	0%	0%	0%

4.2.3 Domesticated forms of perrisodactyla & artiodactyla

Group 3 (Domesticated forms of perrisodactyla & artiodactyla) included regulations for six subgroups of different species (appendix 2) and 46 enclosures were assessed. According to the regulation, this group must have access to pasture or fresh cut grass during the summer period. Two enclosures (housing American miniature horse, fjord horse and Gotland pony) did not fulfil this general regulation. One of six subgroups fulfilled their specific regulations (Watussi, zebu, dwarf zebu and other domesticated forms of buffaloes and oxes were housed outdoor all year round. Therefore, regulations regarding indoor housing and display were not applied to these species and regulations relevant to these species were fulfilled).

Regulations regarding enclosure area (indoors and outdoors) could not be answered for all six subgroups due to lack of response from the zoos in question. The subgroup for domesticated forms of goats had three enclosures that did not fulfil the regulations regarding climbing abilities indoors (one enclosure) and outdoor enclosure area (two enclosures). All subgroups had several enclosures with no indoor display (Table 4).

Table 4. Group 3 assessment regarding subgroup-specific regulations. Presented in percentage of total number of regulations fulfilled per subgroup.

Animals	Fulfilled	Not fulfilled	Can not be answered	No indoor display	Outdoor all year round
Domesticated forms of equines	33%	0%	52%	15%	0%
Domesticated forms of camelids	60%	0%	10%	30%	0%
Domesticated forms of sheep	43%	0%	32%	20,5%	4,5%

Domesticated forms of goats	36%	6%	28%	28%	2%
Domesticated forms of cattle except Watussi, zebu and dwarf zebu	12,5%	0%	62,5%	25%	0%
Watussi, zebu, dwarf zebu and other domesticated forms of Buffaloes and oxes	36%	0%	0%	64%	0%

4.3. Evaluation of enclosure design

Results from the protocols, covering both display enclosures and temporary enclosures without display housing animals at the time of the study (total of 76 enclosures), was used to evaluate the enclosure design.

4.3.1. Display enclosures

69 display enclosures were assessed (60 species-specific and 9 mixed species) and a total number of 618 animals were present in the enclosures. 67 of 69 enclosures held animals in groups. Two enclosures held mature males individually. Six enclosures had seasonal storage indoors with display and domesticated goat, cattle and sheep was the most common animals in the enclosures. Various types of barriers/walls and combinations were used for the display enclosures and major part (79 %) of the enclosure barriers/walls comprised of mesh fence (both vertical and horizontal) and wood fence (Figure 6). Visitor access to barrier/walls varied between no access (0%) to full access (100%) and a total of 66 enclosures were assessed (three enclosures could not be assessed due to rotation between species) (Figure 7). There was no difference between wild and domesticated species regarding visitor access to barriers/walls. Major part of the enclosures had 100% enclosure visibility for visitors (Figure 7) and there was no difference in visitor visibility between wild and domesticated species.

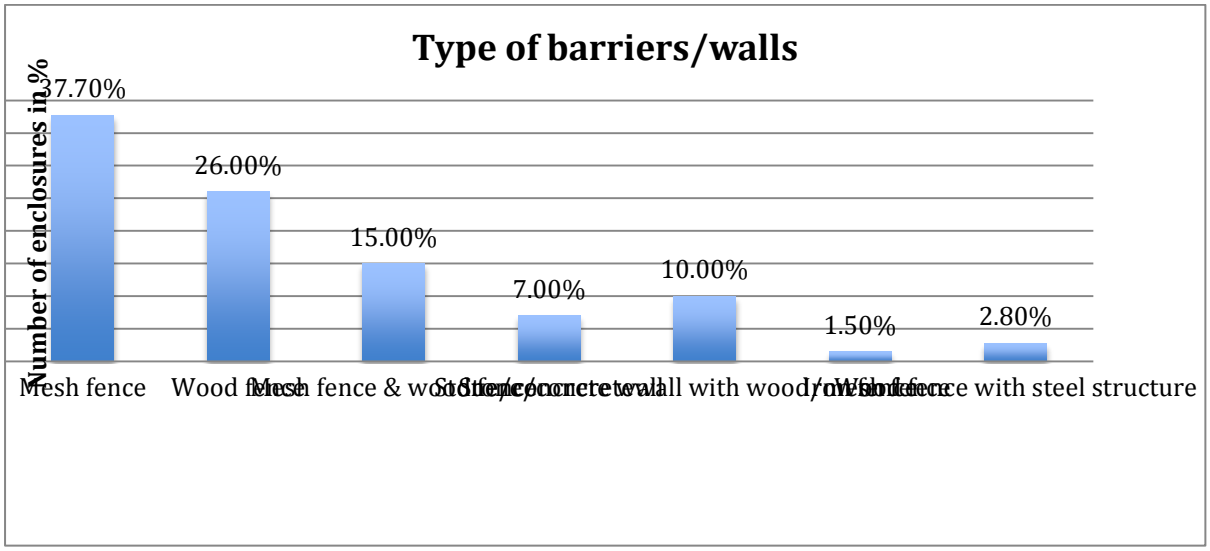

Figure 6. Types of barriers/walls for display enclosures. Presented in percentage of total number of enclosures

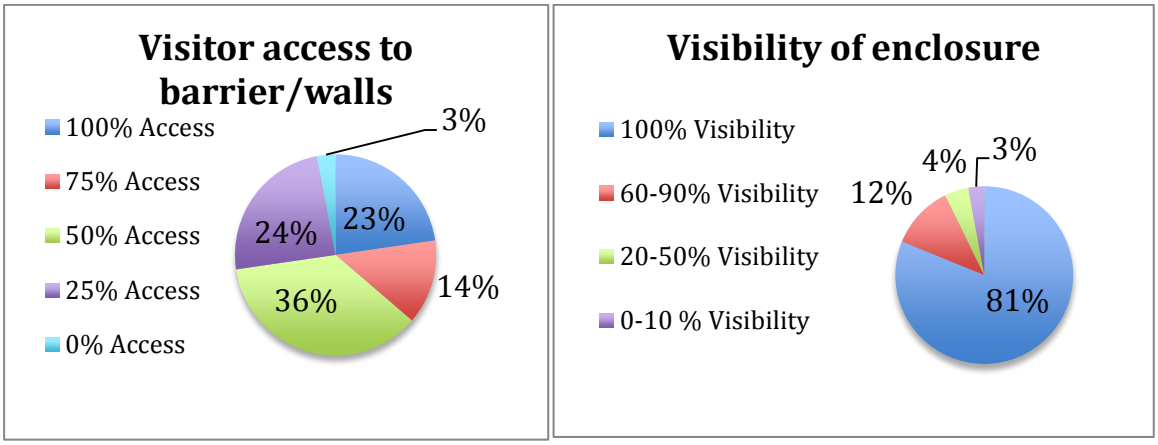

Figure 7. Visitor access to enclosure barriers/walls (left) and visibility of enclosure for visitors (right).

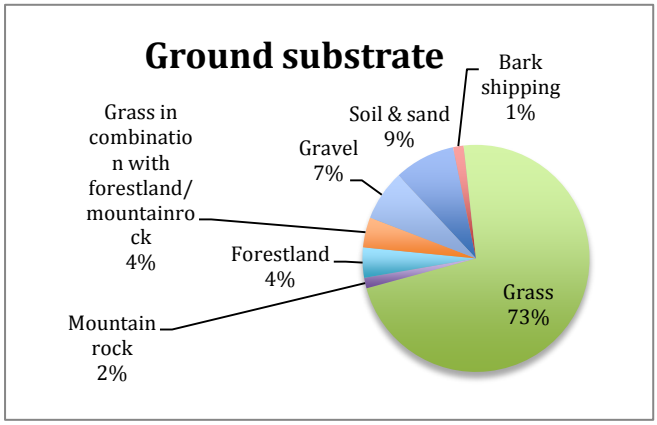

Figure 8. Major ground substrates in display enclosures. Presented in percentage of total number of enclosures.

Ground substrate was assessed by the major substrate (>50%) in each enclosure. Grass was most common and was present in 73 % of the enclosures. Grass was present in enclosures for both wild and domesticated herbivores. Bark shipping was only present in enclosures for forestland reindeer and gravel was present in enclosures for horse and European bison. Mountain rock och forestland was present in enclosures for moose, markhor, reindeer and Bukhara urial (Figure 8).

Feeding routines was divided into number of feedings/day and type of feed. Feeding was performed one, two or three times per day. A total of 61 enclosures were assessed regarding number of feedings/day (eight enclosures could not be answered due to lack of response from zoos in question). 73,8 % of the enclosures fed one time/day, 18 % fed two times/day and 8,2 % fed three times/day. Ten different feeds were used and the diet for the animals held in the display enclosures contained one to several feeds. The most common feeds used was hay (29 %), pellets (27 %) and shrubs (23%) (Figure 9). Deworming pellets was used in one enclosure for moose. Shrubs, hay, species-specific pellets were used for both wild and domesticated herbivores. Fruit/vegetable and bread was used mostly for wild herbivores and silage and straw was mostly used for domesticated herbivores. Access to grazing or fresh cut grass was assessed in 68 enclosures (one enclosure could not be answered due to lack of response from zoo in question). 97 % of the responding zoos had access to grazing/fresh cut grass during the summer period and 3 % had no access. Enclosures with no access to pasture housed domesticated horses of different sizes.

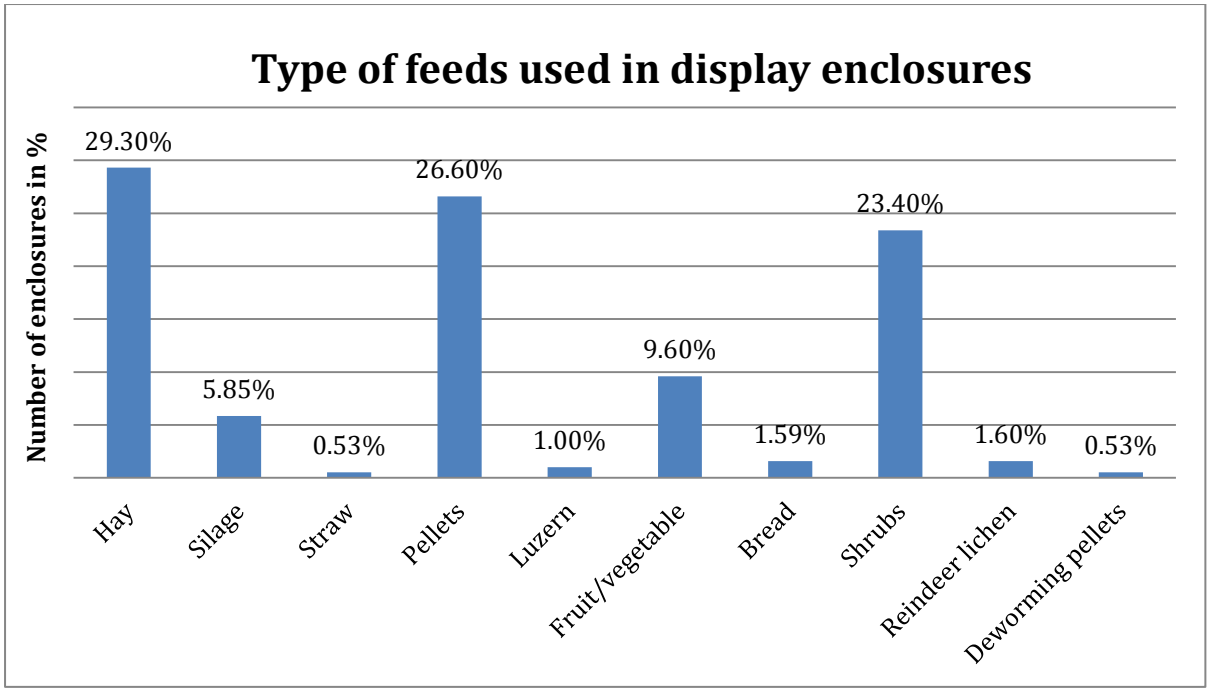

Figure 9. Type of feeds used in display enclosures. Showed in percentage of total number of enclosures. Several feeds are used in the same enclosures.

The use of feed as an enrichment was assessed in 67 enclosures (two enclosures could not be assessed due to lack of response from zoo in question). 87 % of the enclosures used feed as an enrichment and 13 % did not use feed enrichments. Type of enrichments varied and a total of six feed enrichment was used (Figure 10). Shrubs were the dominant enrichment used for both wild and domesticated herbivores. Feed in trees was only used for giraffe and training with food was only used for elephants. Scatter feeding was most common in enclosures for wild herbivores and slow-feeding-net with hay or straw was most common in enclosures for domesticated herbivores.

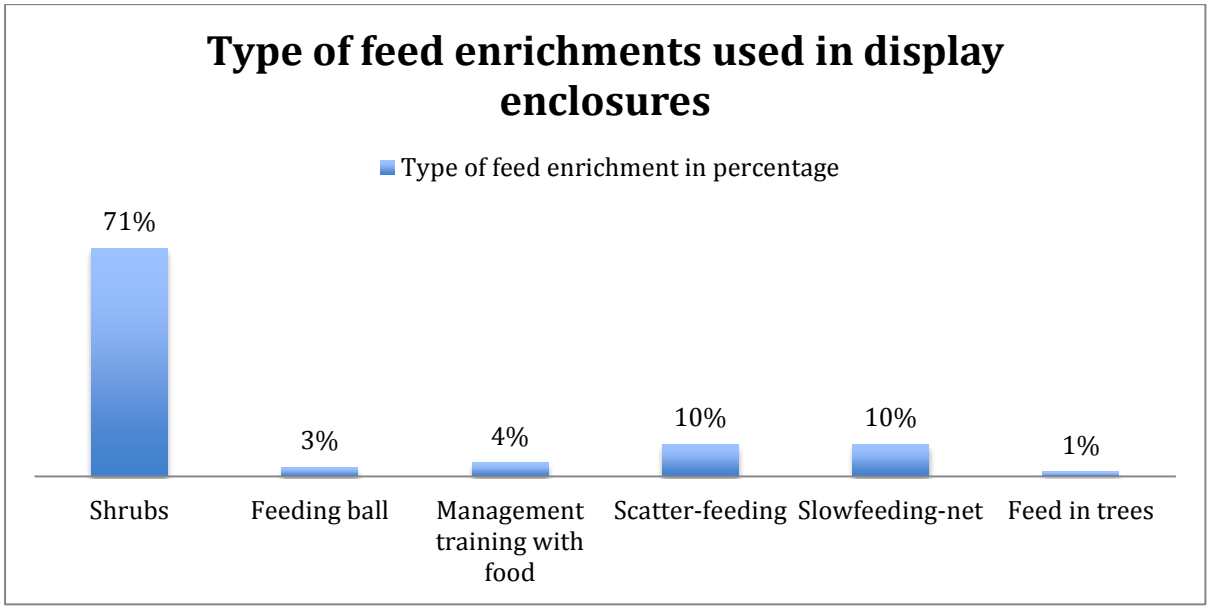

Figure 10. Type of feed enrichments used in display enclosures. Showed in percentage of total number of enclosures using feed enrichments.

Major part of the enclosures held animals in groups (97 %), both species-specific and mixed species (Figure 11). Two enclosures (3 %) held the animals individually and consisted of one male elephant and one domesticated male sheep.

Ability to perform species-specific behavioural need was divided into 1. Species-specific foraging and 2. Social contact. Evaluation of these behavioural needs was assessed with the help of the results from the protocols and scientific literature relevant for the behaviours and species in question. Species-specific foraging was assessed in 68 enclosures (one enclosure could not be assessed due to lack of response regarding feeding routines from zoo in question). Social contact was assessed in 69 enclosures. Scale between great possibility to no possibility was used (Figure 11). Great possibility was dominant for both species-specific foraging behaviour and social contact (57 % and 67%) for both wild and domesticated herbivores. Small possibility to perform species-specific foraging behaviour was found in both wild and domesticated species. One enclosure containing American miniature horse had no possibility to perform species-specific foraging behaviour. Small possibility for social contact was found in enclosures containing individually held male animals (elephant and sheep). Both animals had some social contact with other individuals' trough the barriers/walls.

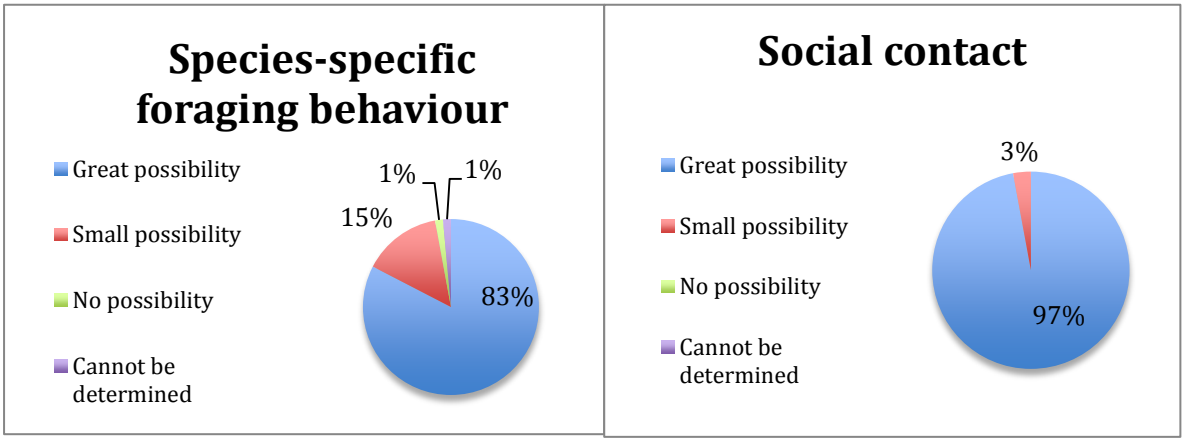

Figure 11. Assessment of specie-specific behavioural need for display enclosures. Presented in percentage of total number of enclosures.

4.3.2. Temporary enclosures without display

A total of seven temporary enclosures holding animals at the time of the study were assessed (five species-specific and two mixed-specie enclosures). Only domesticated herbivores were present in the enclosures. The major reason using temporary enclosures was separation of males and females with young offspring.

Barriers/walls used for six of seven temporary enclosures were mesh fence (83,3 %) & mesh fence in combination with wood fence (16,7 %) (One temporary enclosure was indoors with no access to outdoor enclosure).

Visitor access to enclosure barrier/walls and visibility of enclosure were assessed in seven enclosures (Table 4). Enclosures with 100 % access to barrier/walls had also 100% visibility, whereas enclosures with 0 % access had 0-10 % visibility for visitors. Enclosures with full visitor visibility consisted of one indoor enclosure with camel and alpaca, two outdoor enclosures with African pygmy goat (species-specific) and alpaca, goat and American miniature horse (mixed species).

Table 4. *Visitor access to barriers/walls and visibility of enclosure. Results in percentage of total number of temporary enclosures*

Visitor access to barrier/walls	*100 % access*	*0 % access*
Number of temporary enclosures (%)	42,8	57,2
Visibility of enclosures for visitors	*100% visibility*	*0-10% visibility*
Number of temporary enclosures (%)	42,8	57,2

Ground substrate was assessed by the major substrate (>50%) in each enclosure and consisted of soil and sand (42,9 %), grass (42,9 %) and straw (14,2 %). Straw was used for one indoor enclosure.

Feeding routines was divided into feeding times/day and type of feed. Feeding was performed one to two times per day. A total of 6 enclosures were assessed regarding feeding routines (one enclosure could not be answered due to lack of response regarding feeding from zoo in question). 83 % of the enclosures were fed one time per day and 17 % were fed two times per day. Six different feeds were used and the diet for the animals held in the temporary enclosures contained one to several feeds (Figure 12). Pellets were the dominant feed used and was fed in all the assessed enclosures. Vegetable/fruit and bread was given to one enclosure housing African pygmy goats.

Access to pasture/fresh cut grass was assessed in all temporary enclosures. 57 % of the enclosures had access to either pasture or fresh cut grass. 43 % did not have access to either pasture or fresh cut grass.

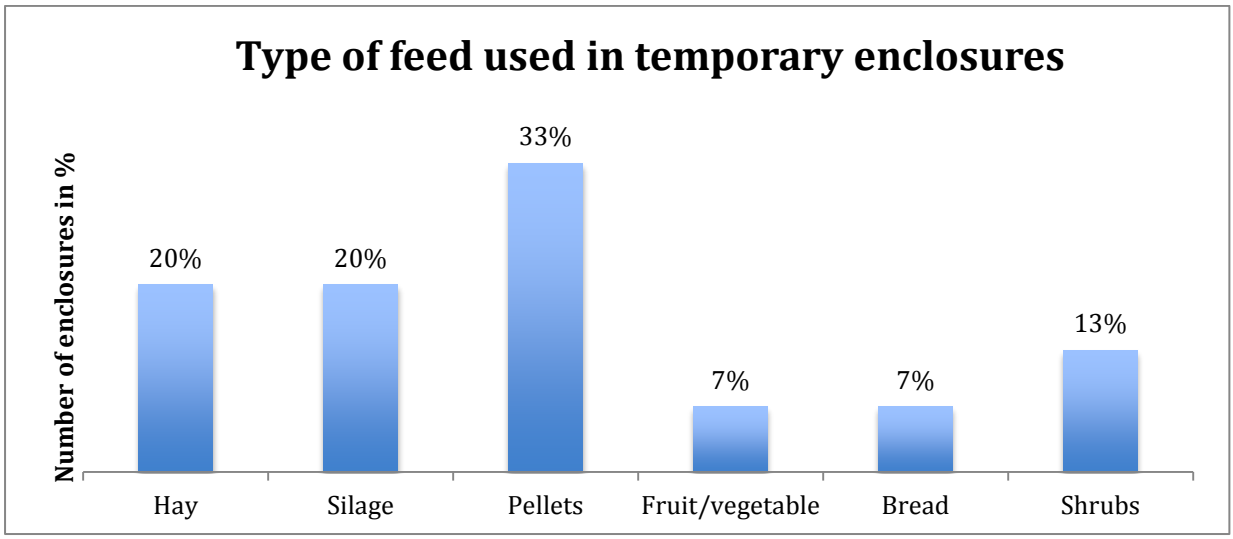

Figure 12. Type of feeds used in temporary enclosures. Showed in percentage of total number of enclosures. Several feeds are used in the same enclosures.

Feed enrichments were assessed in five enclosures (two enclosures could not be assessed due to lack of response regarding feeding from zoo in question). 40 % of the enclosures used feed enrichments and 60 % did not use feed enrichments. Shrubs were the only feed enrichment used.

Major part of the enclosures held animals in groups (71 %), both species-specific and mixed species. Two enclosures (29 %) held the animals individually and consisted of one male goat and one male donkey.

Ability to perform species-specific behavioural need was divided into 1. Species-specific foraging and 2. Social contact. Species-specific foraging was assessed in seven enclosures. Scale between great possibility- no possibility was used. 14 % of the enclosures had great possibility to perform species-specific foraging, 43 % had small possibility and 43 % had no possibility. No possibility to perform foraging behaviour was found in enclosures not using feed enrichment and with straw and soil as ground substrate. Great possibility to perform foraging behaviour was found in enclosures using feed enrichments and with grass as ground substrate. Major part of the enclosures had great possibility for social contact (71 %) and the remaining enclosure had small possibility for social contact (29 %). Small possibility for social contact was found in enclosures with individually held animals (males).

5. Discussion

The purpose with this study was to assess enclosure design for wild and domesticated species from the order Perissodactyla, Artiodactyla and Proboscidea. This was made by investigate if Swedish zoos follow the regulation set by the Swedish board of agriculture and if the enclosures enabled species-specific behaviours. There were some difficulties assessing enclosures with the use of the regulation because of lack of response from the zoos, either by not responding to email or not having answer for specific areas. This may cause a bias when evaluating if Swedish zoos fulfil the regulation. Overall, the results from this study shows that display enclosures in Swedish zoos were well managed and had large enclosures and with proper setting suitable for individual species. Well-designed enclosures enable natural behaviours for the animals and give the visitor a positive feeling when visiting these types of zoos (Woods, 2002). Temporary enclosures on the other hand had less ability to perform natural behaviours due to smaller areas, less natural settings and reduced use of feed enrichments (only 40 % used feed enrichments). Because most of the temporary enclosures held males over a long period of time and not sick animals, focus on improving the enclosure should be taken into consideration.

All zoos had health problems, for example reduced claw/hoof health and parasite infection in moose and cattle, but were working towards reducing and removing the current health problems with the use claw treatment, faecal sample in combination with anthelmintic and regularly cleaning of enclosures. Swedish zoos had different kinds of enclosures, from small enclosures with sandy soil to large grass enclosures. Goossens *et al.* (2005) studied the prevalence of gastrointestinal nematodes by assessing patterns of faecal egg counts and clinical signs in exotic ungulates kept in zoos. Similar to the current study of Swedish zoos, small enclosures with sandy soil was clean daily while large grass enclosures only were cleaned around feeding areas. The results from Goossens *et al.* (2005) showed low parasite infection in animals held in enclosures that were cleaned regularly, despite the high stocking rate, and high parasite infection (with no clinical sign) in animals held in large grass enclosures that was not cleaned regularly. The recommendations were similar to what the studied zoos are using today; anthelmintic programs and cleaning. However, late turnout and frequent cleaning of whole enclosures (even large grass enclosures) was recommended to reduce parasite infection. This should be considered for zoos having animals kept on pasture where cleaning is not frequent.

5.1. Social grouping

Results showed that almost all enclosures held animals in groups (67 of 69 display enclosures and 5 of 7 temporary enclosures). Knowledge about social structure and need of wild animals kept in captivity is necessary to create well-functioned groups. Price & Stoinski (2007) states that optimal group size for wild animals in captivity is not depended on the same factors as in the wild, for example competition for food or the risk for predation, which leads to more flexible group sizes and constellations. The authors further describe the effect of improper group constellation and small enclosures. Problems that could occur are reduced ability to alleviate social tension, causing stereotypic behaviours and aggression. This could not be found in enclosures holding wild and domesticated herbivores in this study, indicating that group constellation and enclosure area are sufficient.

5.2. Enclosure design

In this study, visitor visibility was used to evaluate the ability for animals to hide from visitors by estimate how much of the enclosures the visitors was able to see and how much access they had to the fence surrounding the enclosures. Mesh fence and wood fence was most common (79 %), which gives good visibility for both animals and visitors. However, visibility of the animals depended both on access to barriers/walls, forest and shelters disguising the animals. Visitor had access to larger part (50-100%) of the enclosures, expect from some enclosures were access to barriers/walls was lower (0-25 %). Visibility was almost 100 % for the enclosures (81 % of the enclosures had 100 % visibility). The impact of visitor visibility may vary between species depending on how sensitive they are. Kalioujny *et al.* (2013) investigated the effect of visitors on activity budget of large wild herbivores kept in zoos. Giraffes, Grant's zebra, Thomson's gazelle and common eland are commonly known to co-habit in the wild and is therefore often kept in the same enclosures in zoos. Results show that the daily activity budget varied between species: Giraffes and zebras daily activity pattern was not affected by visitors, whereas the eland shifted from feeding to standing and gazelle increased the time spent feeding and reduced the time resting. Furthermore, aggressive behaviour was not affected for any of the study individuals. These results may be important to consider for Swedish zoos and should be investigated further in order to reduce unnecessary stress for the animals held in zoos.

Regulations from the Swedish Board of Agriculture concerning keeping animals at zoo (SJVFS 2009:92 Dnr L 108) includes regulations regarding substrates for only a few species. For example, elephants should have access to either sand or dirt whereas the major part of the wild and domesticated ungulate has no regulations regarding substrates. Furthermore, domesticated ungulate should have the ability to graze during the vegetation period, meaning that they should have access to either fresh cut grass or pasture, but it is not included for wild ungulates. Despite what the regulation states regarding substrate, results showed that grass was most common (73%). Forestland, and mountain rock was the second most common substrate in the enclosures. Almost all the animals in the enclosures had great possibility to perform species-specific foraging behaviour (83 %) with the use of suitable feed and ground substrate. Elephants had either sand or dirt as ground substrate, but less ability to forage compared to other species, despite the effort from the staff to create foraging abilities (feeding balls, shrubs and management training with feed). This may be due to the elephant's size and highly complex feeding selection (Pretorius *et al.*, 2012).

Herbivores are well adapted to shift their feeding strategy depending on availability of feed and therefore demand a more complex environment to fulfil their feeding behaviour (Cheeke & Dierenfeld, 2010; McNaughton & Georgiadis, 1986). Furthermore, nutritional need and feeding behaviour may not be fulfilled due to only few diets available for wild herbivores kept in captivity (Soest, 1994). Diets used for domestic herbivores are often modified and used for wild herbivores, which may not be suitable due to different feed preference, selection behaviour and need (ibid.). According to the results from this current study, this type of modified diet is also common in Swedish zoos, where hay and pellets are common feeds used for both wild and domesticated herbivores (30 and 25 % respectively). However, Swedish zoos are also using shrubs, fruit/vegetable and reindeer lichen to create a more varied diet that includes more fibrous feeds that take longer time to manipulate, creating a more complex environment.

Creating a diet for wild herbivores may be difficult because of their different need and preferences. Kowalczyk *et al.* (2011) investigated the feeding strategy of the European bison and the effect of supplement feeding. Results showed a preference for grazing, but when feed was scarce and no supplement feed was available there was a shift towards browsing, indicating that bison could be a mixed feeder adapting their feeding strategy depending on availability and season. Mendoza & Palmqvist (2008) on the other hand classifies bison as a grazer due to the muzzle morphology. The difference in classification may cause difficulties to establish a diet suited for bison kept in zoos, where the ability to forage and select their own diet may be reduced. Moose have historically been difficult to keep in captivity due to its low resistance to parasite infections and diseases caused by inappropriate diets (Mendoza & Palmqvist, 2008). In the wild, the diet consist mostly of browse and only 2 % grass, while in captivity it has been common to feed moose diets similar to cattle and horses (ibid.). Some zoos may have difficulties creating enclosure with enough trees and browse to fulfil the dietary requirement and may instead keep them on pastures with access to hand-cut browse, which may lead to chronic diarrhea, inflammatory bowel disease and early death (ibid.). In order to reduce the risk of these diseases, high-fibre and low-starch diets are recommended, either in pellet form or forest-enclosures with reduced pasture access (Shochat *et al.*, 1997). According to the results this scenario is also common in Swedish zoos, were half of the moose enclosures contain forest and the rest contained wetlands with grass. Half of the enclosures holding moose also gave hay, which is not suitable because of the low inclusion in wild moose diets (Mendoza & Palmqvist, 2008). Shrubs were however used for all moose enclosures and were distributed above ground to reduce parasite pressure.

5.3. Feed enrichments and stereotypic behaviours

According to the results from the questionnaire, no herbivores in the studied zoos suffered from stereotypic behaviours, which could be explained by the use of feed enrichments in almost all the enclosures (87%). Shrubs were most common, but also slow-feeding-nets and feeding balls was used to increase feeding time without increase feed intake. This approach is further supported by (Mueller *et al.*, 2013: Posta *et al.*, 2013) that states that in order to increase the foraging time and reduce obesity, browse and other enrichments that encourage walking and manipulation are recommended. Another aspect that has not been mention is stereotypic behaviours in young herbivores. Bergeron *et al.* (2008) do not take infant ungulates that show stereotypies into account because it is more related to frustrated suckling than foraging behaviours in adult ungulates and the relationship between these two is unclear. This could be discussed due to the fact that the frustration the infant ungulate show may be due to unfulfilled suckling behaviour, and therefore could be categorised as a stereotypic behaviour if it is showed as a repetitive movement. If stereotypic behaviours are correlated

with previous experience, this may also be a contributor to oral stereotypies when the infant gets older, despite improvement of its environment. This may be important to consider when working to reduce/remove stereotypic behaviours in older animals, by focusing on providing a complex environment for young animals also.

6. Conclusion

It is difficult to establish if Swedish zoos totally fulfil the regulations regarding enclosure design when not all the regulations could be evaluated. However, direct observations could be used to assess the general status of the enclosures. Results showed that major part of the herbivores had great ability to perform species-specific foraging behaviour and social contact with other animals. This may be explained by the use of feed enrichments, wild settings in the enclosures and good management. However, there should be an increased focus on animals held in temporary enclosures in order to improve their welfare and reduce the risk of developing stereotypic behaviours.

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8. Appendix

Appendix 1.

9 KAP. perrisodactyla & artiodactyla (except for domesticated forms)
General
1 § Rear enclosure should be available.
2 § Equines that naturally live in cold climates may be held outdoors only with access to wind and rain shelters.

Wild equines (Przewalski´s horse, Plains zebra)
3 § Requirements for enclosure area as follows:
Stable/night quarters: 6 m²/animal, but at least 12 m².
Indoor enclosure area with display: 6 m²/animal, but at least 12 m² for zebra. Other species shall not be displayed indoors.
Outdoor enclosure area with display: 2500 m².
Enclosure design: Well-drained and firm surface. Scrub Places.

Lowland tapir
4 § Species can be seasonally kept in indoor enclosures with display.
5 § Requirements for enclosure area as follows:
Indoor enclosure area with display: 50 m². Stable/night quarter: 12 m² / animal, but at least 24 m². The space should be able to be shared.
Enclosure design: floor must be equipped with floor heating. Access to bathing or self-controlled shower.
Outdoor enclosure area with display: 500 m².
Enclosure design: Dense undergrowth or equivalent and shelters.

Rhinoceros
6 § Requirements for enclosure area as follows:
Indoor enclosure area with display: 50 m²/animal.
Enclosure design: Scrub opportunity.
Outdoor enclosure area with display: 4000 m².
Enclosure design: Mud bath, scrub opportunity.

Rothschild´s giraffe
12 § Requirements for enclosure area as follows:
Indoor enclosure area with display: 25 m²/animal, but at least 50 m², height 6 m.
Enclosure design: Access to deep litter or floor fitted with floor heating.. Highly placed feeding areas.
Outdoor enclosure area with display: 4000 m².
Enclosure design: Highly placed feeding areas.

Tropical ruminants> 300 kg (African buffalo, common eland)
13 § Requirements for enclosure area as follows:
Indoor enclosure area with display: 8 m² / animal, but at least 12 m².
Outdoor enclosure area with display: 3000 m².
Enclosure design: Possibility to isolate male and females with calves should be available.

Tropical ruminants 150 – 300 kg (Eastern bongo)
14 § Requirements for enclosure area as follows:
Indoor enclosure area with display: 6 m²/animal, but at least 12 m².
Outdoor enclosure area with display: 3000 m².
Enclosure design: Possibility to isolate male and females with calves should be available.

Tropical ruminants 50-150 kg (Blesbuck)
§ 15 Requirements for enclosure area as follows:
Stable/night quarter: 4 m/animals, but at least 6 m.
Indoor enclosure area with display: 6 m/animals, but at least 12 meters for blesbuck. 4 m/animal, minimum of 24 m for other species.
Outdoor Enclosure area with display: 2500 m.
Enclosure design: Ability to isolate males and females with calves should be available. Sight barrier indoors in groupbox.

Tropical ruminants 20 - 50 kg (blackbuck, muntjac)
16 § Species can be seasonally kept in indoor enclosures with display.
17 § Requirements for enclosure area as follows:
Stable/night quarters: 2 m²/animals, but at least 12 m².
Enclosure design: Sight barrier, If more than one male animal there should be a separate male area.
Outdoor enclosure area with display: 1 000 m².

Northern and mountain living ruminants> 50 kg
(Barbary sheep, bison, European bison, Fallow deer, forest reindeer, Bukhara urial, moose, muskox, red deer, semi-domesticated northern reindeer, markhor)
§ 22 Requirements for enclosure area as follows:
Outdoor Enclosure area with display: 3000 m².
Enclosure design: Several wind and rain shelters. Rain and wind protection is not required for deer from Cervus and odocoileus family and moose.
Muskox should have protection from rain and protection from the sun during the warm season.
Firm, mountainous and well-drained ground that permits climbing facility for mountain species.
Possibility to remove skin from the antlers: Mud holes for deer from the Cervus family.
Only a sexually mature male during the mating period at the specified dimensions.

Northern and mountain living ruminants < 50 kg (southern pudú)
23 § Requirements for enclosure area as follows:
Outdoor enclosure area with display: 1 000 m².
Enclosure design: Several wind and rain shelters. Firm mountainous and well-drained ground that permits climbing facility for mountain species. Possibility to remove skin from the antlers and sight barriers. Only a sexually mature male animal per space.

Appendix 2.

10 chap. Domesticated forms of Perrisodactyla and Artiodactyla

General

1 § The animals' hooves alternative claws should be inspected regularly and trimmed if needed.

2 § The animals should be given the opportunity to graze daily during the grazing season. For goats and camelids, shrubs or fresh chopped sly should be provided for browsing. For other animals, grass should be given.

Domesticated forms of equines (Shetland Pony, American miniature horse, fjord horse, gotland pony, miniature shetland pony, north swedish horse, donkey)

3 § Between stalls or boxes, there should be a separation device that prevents the animals to hurt each other.

4 § If foaling takes place in the stables, a Foaling box must be provided.

5 § IF the equine is tied up in stall or box, a halter or neck strap and leash should be used. A halter or neck strap shall not consist of materials that can harm the animal.

6 § Requirements for enclosure area as follows:

Stable/night quarter: Wither height of <0.85 m (3 m^2), 0.86-1.07 m (4 m^2), 1.08-1.30 (5 m^2), 1.31-1.40 m (6 m^2), 1.41-1.48 m (7 m^2), 1.49-1.60 m (8 m^2) - DFS (2007:6) table 1.

Indoor enclosure area with display: Wither height of <0.85 m (3 m^2), 0.86-1.07 m (4 m^2), 1.08-1.30 (5 m^2), 1.31-1.40 m (6 m^2), 1.41-1.48 m (7 m^2), 1.49-1.60 m (8 m^2) - DFS (2007:6) table 1.

Outdoor enclosure area with display: 250 m^2/animals, the area can be allocated to several paddocks. The minimum area shall however be 500 m^2.

Domesticated forms of camelids (camel, llama, alpaca)

10 § It should be possible to keep sexually mature camel stallion in a separate paddock.

11 § camel, llama and alpaca can be kept outdoors with access only to the wind and rain shelter.

12 § Requirements for enclosure area as follows:

Indoor enclosure area with display: Dromedaries should have indoor area of 10 m^2/animal, but at least 15 m^2.

Outdoor enclosure area with display 2500 m^2.

Domesticated forms of cattle except Watussi, zebu and dwarf zebu (Allmoge cows, aurochs, Swedish Holstein, Swedish hornless cattle)

13 § Basic provisions contained in Chapter 2. SJVFS (2010:15)

14 § Requirements for enclosure area as follows:

Stable/night quarter: Table 1-6 in SJVFS (2010:15)

Indoor enclosure area with display: Table 1-6 in SJVFS (2010:15). The animals must have retreat opportunities.

Outdoor enclosure area with display: 250 m^2/animals, the area can be allocated to several paddocks. The minimum area shall however be 500 m^2.

Watussi, zebu, dwarf zebu and other domesticated forms of Buffaloes and oxes (Ankole-Watusi, dward zebu, yak)

15 § Requirements for enclosure area as follows:

Indoor enclosure area with display: 12 m^2/animals. Dwarf zebu: 6 m^2/animals, however, a minimum of 12 m^2.

Outdoor enclosure area with display: 2500 m^2.

Enclosure design: Yak and water buffalo should have daily access during summer to bathing opportunities or individual controlled shower.

Domesticated forms of sheep (Swedish sheep breeds)

16 § Sheep shall be kept in loosed housed systems.

17 § Must be coat trimmed at least once a year.

18 § At lambing, a separate space should be available.

§ 19 Requirements for enclosure area as follows:

Indoor enclosure area with display: Table 13 in SJVFS (2010:15) The animals must also have retreat opportunities.

Outdoor Enclosure area with display: 125 m^2/animals, but at least 250 m^2.

Domesticated forms of goats (African Pygmy goat, allmoge goat, angora goat)

20 § goats of wool breed should be trimmed at least once a year.

§ 21 Requirements for enclosure area as follows:

Stable/night quarter: Table 15 in SJVFS (2010:15)

Indoor enclosure area with display: Table 15 in SJVFS (2010:15). The animals must also have retreat opportunities.

Enclosure designed: climbing facility.

Outdoor Enclosure area with display: 50 m^2/animal, but at least 250 m^2.

Enclosure Design: climbing facility, fodder hedges.

Regulations regarding Equines, cattle, sheep and goat DFS (2007:5) has been replaced by SJVFS (2010:15)

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