Optimal Housing of Horses (*Equus caballus*)
Based on their Natural Behaviour

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Companion Animals

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Summary

During the course of evolution the horse (*Equus caballus*) developed specific behaviours to be able to live and survive in a for prey animals harsh environment. Natural behaviours are referred to as behaviours which have evolved in nature and are strongly manifested in the animals genes to serve a certain purpose, namely to stay healthy, survive and reproductive fitness. Natural behaviours of horses have manifested themselves to such an extent that nowadays they still can be observed in feral as well as captive held horses when giving them the chance. Some of this behaviours are essential to perform for the horse to prevent stress and reduce welfare. Natural behaviours of the horse can be classified under the following major behaviour classes: social, comfort, locomotive, ingestive, eliminative and reproductive.

- At least being accompanied by one conspecific, four being the most commonly observed group size
- Male and female together or only males together
- Up to 16 hours eating per day
- Low energy, high fibre diet –mainly grasses and sedges, but also twigs, leaves and bushes
- Between 15-30km movement per day
- Different areas to show comfort behaviour, such as sheltering, sand and water bathing

*In an optimal housing system horses need to be able to express above mentioned key features of their natural behaviours*

<table>
<thead>
<tr>
<th>Space</th>
<th>6 hectares: 500mx120m</th>
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<tbody>
<tr>
<td>Summer area</td>
<td>3.5 hectares</td>
</tr>
<tr>
<td>Winter area</td>
<td>2.5 hectares</td>
</tr>
<tr>
<td>Amount of horses</td>
<td>4</td>
</tr>
<tr>
<td>Items available</td>
<td>Gravel path (500m), Water hole, Sand patches, Shelter areas (trees) on the summer area, Shelter area (stable) on the winter area, Bushes and trees, Mineral spot, Hay racks (3x) on the winter area, Human area</td>
</tr>
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Summarizing the above investigated natural behaviours it can be concluded that for adult horses the ones being most essential for both mental and physical health and wellbeing are social, ingestive, locomotive and comfort behaviour. Reproductive behaviour of course plays a vital role for survival in the nature, but with regards to welfare and wellbeing it is less vital than the above mentioned ones, the same counts for eliminative behaviour. When taking foals into consideration as well, of course maternal care and education play a key role, especially in the early stages of the foals’ life.
**Introduction**

The aim of this report is to investigate natural equine behaviour and based on this to develop an optimal housing system which allows horses to express their natural behaviours. For this a naturalistic approach will be applied to ensure that the essential behaviours can be expressed to maintain health and welfare of the horse, but still allowing management and handling, thus taking into account the role the human plays in keeping horses as companion animals. The paper does not focus on the feasibility of this system, but exclusively looks at what horses would need in a captive environment, no matter which breed, status or usage. The main method used to establish this is by reviewing relevant literature.

The ‘naturalistic’ approach implies that when creating a housing system for horses their natural behaviours are the starting point and based on scientific knowledge it is decided which behaviours and behaviour parts are essential and vital for the horses’ health, welfare and survival. The natural complexity is reduced to such an extent that at least an environment is present which allows horses to meet their basic needs.

**Background information**

During the last 60 million years the equids have evolved to what we nowadays know as the domesticated horse (*Equus caballus*). During the course of evolution the horse developed specific behaviours to be able to live and survive in a for prey animals harsh environment. In this paper natural behaviours are referred to as behaviours which have evolved in nature and are strongly manifested in the animals genes to serve a certain purpose, namely to stay healthy and survive. Natural behaviours of horses have manifested themselves to such an extent that nowadays they still can be observed in feral as well as captive held horses when giving them the chance.

These classes include different sub-beaviours which are explained in the following chapters in more detail. The listed classes have been mainly identified and summarized with the help of McGreevy (2004) and Waring (2003).

This paper focuses on several main, summarized natural behaviour classes:

- Social behaviour
- Comfort behaviour
- Locomotive behaviour
- Ingestive behaviour
- Eliminative behaviour
- Reproductive behaviour

**Social behaviour**

**Herd structure**

Herd of horses may be up to 600, the band sizes within tend to vary according to population density and pattern of distribution of resources (McGreevy, 2004). The social structure made up by different groups that follow similar movement patterns within a common home range is called a herd (McCort, 1984).

Three major types of social groups can be described: harem groups, multiple male and female groups and bachelor groups. Harem groups are most common and consist of one stallion and four to five mares and their offspring (McCort, 1984). However, observations with regards to group size differ a lot. Waring summarized in 2003 that the most commonly observed number of group members is 4 horses (Waring, 2003). The foals stay in the maternal herd for 2 years. Multiple male and female groups consist of more than one stallion and several mares and their offspring. These groups are on average larger than the harem groups. The groups also differ in mating behaviour and dominance structure. Bachelor groups are completely composed of stallions. These stallions are young males that are forced out or their family groups or older males that lost their membership in a
harem or multiple male and female group. These different groups do interact with each other. (McCort, 1984).

**Hierarchy & roles**

The need for a defined social status per individual within any horse grouping is to promote stability, so that the amount of injuries and distress decreases. Aggressive behaviours such as biting, kicking, circling and displacement then merely become threats to bite and kick. If this were not the case, social flux would lead to decreased conception rate, increased foal and fetal mortality. Moreover, an organized social structure with one being dominant over another and with occasionally social triangles in the middle based on affiliate relationships permits the leader to quickly elicit a fight or flight (defend or herd away in escape) response to a predator approach (McGreevy, 2004; Minero & Canali, 2008).

Determination of rank can be explained in terms of age because it reflects experience in dealing with challenges and knowledge about how to exploit resources. The length of residency within a band also predicts rank. Females can also become the dominant one thanks to their stronger bonds with their peers than stallions since the latter spend more time patrolling or only enter the band during the breeding season. Dominance or avoidance order is not purely genetic since foals of a high-ranking mother do not always become high-ranking themselves; the status is a learned relationship among individuals. Birth order status is disrupted at the time of weaning (McGreevy, 2004).

Rank determines priority access to maintenance resources like resting sites and watering holes. It dictates the order in which bachelors eliminate on one other’s excrement and scent marking by rolling as last if dominant. It also influences selection of grooming partners and neighbours (McGreevy, 2004).

Bachelor male groups have a strong dominance hierarchy. It is always the dominant male that interacts with the other groups and this male is most likely to obtain females (McCort, 1984).

**Play and investigative tendencies**

Play fighting is of vital importance in colts because it serves as a way to learn defence mechanisms which will someday help them protect their own bands from predators or bachelor competitors. It has also been proven that play behaviour enhances learning. Moreover it is way to establish pair bonds (McGreevy, 2004).

**Home range**

Home ranges include grazing sites, watering holes, shade, windbreaks and refuges from insects. Observations have shown that home ranges of individual groups vary a lot depending on the availability of food and water. From research is shown that home ranges of a band might differ from 0.8km² to almost 80km² (Waring 2003). The exploitation of these sites depends on climate, season, predation risk and prevalence of biting insects. Then again, not all parts are used equally since grazing is not uniform (McGreevy, 2004).

**Communication**

Horses are primary visual communicators; they are also extremely sensitive for changes in the body language of their conspecifics. Vocal communication and communication through odours is also possible (Goodwin, 2007). Whenever this behaviour is not facilitated or not possible as is in the case under stabled conditions then certain behaviours develop like weaving and box-walking (McGreevy, 2004). This again shows the need of being surrounded by conspecifics to naturally reduce stress levels and increase safety.
Agonistic

When groups encounter the dominant males interact. These interactions vary from distant posturing and threats to physical contact. The stallions approach each other with their head held high and tail partially outstretched. Sometimes this results in biting and kicking or chasing each other (McCort, 1984). Usually, agonistic behaviours are kept to a minimum (threats) since it costs energy and it depends on what there is to gain or lose.

To sum up the key points of social behaviour, what we must remember at all times is that they are social animals and need at least on other conspecific for social interaction and safety. Horses live in groups/bands of an average size of four animals. The composition of these bands varies from one stallion with a few mares (called a harem), to bachelor groups composed of only males. The structure within the band is based on bonds and dominant status. Horses are not territorial and only present agonistic behaviour to maintain the integrity of the group. Play behaviour is of great importance for the development of fighting skills and to learn their social position in the band. The home range of horses has been shown to differ considerably and strongly depend on the availability of food and water.

Comfort behaviour

Comfort behaviour increases the physical comfort of the animal. Licking, nibbling, scratching, rubbing and rolling are comfort behaviours. These activities are frequently repeated throughout the day (Goodwin, 2007). Furthermore, seeking shelter to avoid bad weather circumstances and insect harassment are examples of comfort behaviour.

Licking is occasionally seen in horse populations. It is normally used to groom in and around the mouth, but it is also done to groom accessible parts of the forelegs and shoulder. Licking is used to remove dirt from the body surface (Waring, 2003).

Nibbling is a common form of grooming. Nibbling is done with the teeth and varies from mild scraping of the skin to a rapid nipping activity, where the skin is pinched repeatedly. This is done to relieve itching sensations or to remove dried material from the pelage. Like licking, not all parts of the body are accessible to this behaviour, thus nibbling can be seen primarily on the forelegs and sides of the body (Waring, 2003).

Scratching can be done by rubbing the hind hoof against the head or neck. This behaviour is commonly seen in foals but rarely occurs in adults (Waring, 2003).

Rubbing is massaging the skin against another surface of the body or against an object in the environment. Horses often rub their muzzle against their forelegs or barrel, this is done in response to an itching sensation. Horses commonly rub their head, neck, base of tail and buttocks against specific fixed objects in their environment. Fences, door frames, posts, trees, and shrubs can be used as fixed objects. The horse stands with its body touching the object and rocks back and forth rubbing a localized area of skin against the object. Sometimes a horse walks under low branches and let them rub the back. On other occasions, the animal may straddle a small tree or scrub and walk forward allowing the plant to rub its belly (Waring, 2003).

Rolling is a specialized way of rubbing the back by utilizing the ground as a fixed object. Rolling can be done for dusting the coat for thermo regulative reasons and insect defence. Immediately after rolling the horse usually shakes his whole body, this generally releases a cloud of dust. Rolling is also associated to social dominance. Some horses tend to roll at certain locations within their environment. The preferred sites are generally places with dry fine soil, sand, or in some cases mud (Waring, 2003).

Interactive nibbling between two horses is a common form of mutual grooming (allogrooming). The two partners usually face each other, standing so that one shoulder is close to the shoulder of the other horse. The horses nibble each other especially on areas of the body that cannot easily be reached during self-grooming. The neck and the withers are usual sites for nibbling. Grooming at the ‘preferred grooming site’ reduces the heart rate of the recipient horse (Feh & de Mazières, 1993). Horses tend to have one or a few regular grooming partners. Yet some horses never
seem to allogroom. Mutual grooming usually happens between horses of the same social status. The most dominant will almost always end a grooming bout (Waring, 2003).

Moving to other places can be done to increase comfort. Under cold, rainy and windy weather conditions horses will seek shelter (Heleski & Murtazashvili, 2010). In strong winds horses stand with their hindquarters positioned into the wind. When the night has been cold, in the morning horses will seek sunny places to rest in the warmth of direct sun rays. Each horse orients its body broadlyside to the sun to gain maximum exposure.

In hot weather horses often rest in the shady areas during the hottest period of the day. To avoid the heat horses also spent prolonged periods in and around water (Waring, 2003).

When flying insects are present, horses have their tail in nearly constant motion. Striking the body with the tail is a way to remove insects from the hindquarters without the need for further actions with the head or legs. Shaking of the head and neck also happens in response to insects and other irritations around the face and ears. Another way to avoid flies is moving to high, bare places where unfortunately no forage is found, to escape the flies (King & Gurnell, 2010). Horses also spent time in the water to reduce the effects of insects.

When grouped, the tail switching of horses serves a mutual function to fend off insects. Even pairs of horse occasionally stand side by side facing opposite directions while mutually switching the forequarters of their partner. Horses have significantly fewer horsefly bites when housed in large groups (Duncan & Vigne, 1979).

The daily sleep cycle of horses is polyphasic, meaning they sleep more than one period a day. Horses rest periodically and sleep occurs in some of these periods. They frequently rest in standing position. When resting, horses distribute their weight on only three legs and have their neck lower than when they are awake. The standing posture demands the least energy. Recumbency in contrast causes some cardiac, respiratory and other internal stress due to compression of organs and pressure against the substrate. Nevertheless, recumbency occurs in most horses at least once a day. Foals rest more often in recumbency than adults (Waring, 2003). Horses tend to show resting and sleeping behaviour more frequently and extensively when being surrounded by conspecifics, since through the group horses feel more safe and comfortable. It is common that at least one horse is staying alert to protect the rest of the group.

Similar to other mammals horses exhibit different stages of wakefulness and sleep e.g. alert wakefulness, drowsiness, slow-wave sleep and paradoxical sleep. Drowsiness is intermediate between alert wakefulness and slow-wave sleep. Slow-wave sleep is the initial and more frequent form of sleep and can occur in a standing or recumbent position. Paradoxical sleep is a very deep sleep occurring in lateral or occasionally sternal recumbency. During slow-wave sleeping, the heart and respiratory rates decrease, but in paradoxical sleep heart rates elevate again. The ECG in paradoxical sleep is similar to the ECG in alert wakefulness. During paradoxical sleep, bursts of rapid eye movement (REM) and sometimes movement of limbs, ears, and facial musculature occur. Although an animal is difficult to arouse during this stage of sleep it seems like the horse is still awake. This is why this stage of sleep is called paradoxical sleep (Waring, 2003).

Comfort behaviour increases the comfort of the animal. What is most important is the need for contact with conspecifics to perform comfort behaviour. Known is that grooming at the 'preferred grooming site', mostly only accessible during allogrooming, reduces the heart rate. This is one of the grooming functions. Horses that are kept in groups also have significantly fewer horsefly bites. This is because they can keep the horseflies away by mutual tail switching. These are a few out of several reasons why horses need to be with conspecifics. Other ways to avoid insects are spending time in and around water or move to high, bare areas. In the summer horses will spend more time in shady areas or in water and during cold, windy and rainy weather conditions horses will seek shelter. To perform these types of comfort behaviour horses need to have access to different areas.
Locomotive behaviour

Locomotive behaviour, in this case (forward) movement, is one of the most important natural behaviours of horses and it is strongly integrated in social and especially ingestive behaviour. However, it also plays a role in reproductive behaviour, equine communication and is also an integral part of the anti-predator strategy (McGreevy, 2004). This strategy indicates that a horse is a constant mover, when given the opportunities and right circumstances it walks from 15-30km (about 60,000 hoof movements) up to 65-80km per day (McGreevy, 2004). Locomotion across different terrains strongly depends on the availability of food, water and other environmental influences, such as seasonal effects (Waring, 2003). Walking such distances on a daily basis also implies the large amount of time spend walking (and eating) per day. The most energy effective gait during daily movement is the four-beated walk, followed by trot and canter or gallop (Waring, 2003), but these faster gaits are mostly related to either play or fight.

Locomotive behaviour has several vital functions for the horses’ survival and health. Generally speaking, a constant moving animal is more difficult to hunt for a predator than an animal which is standing and resting at a certain spots for long periods (anti-predator strategy). Besides, movement is strongly related to proper digestion, since movement is vital for gut motility and thus food passage. Horses being confined in free movement show a higher occurrence of colics and other impaired (digestive) health conditions (Feige et al., 2002).

Blood circulation and with that stimulation of general metabolism and supply of nutrients to for example muscles and connective tissue is strongly dependent on movement. As the lower limbs in horses do not have any musculature, the hoof mechanism becomes the only moving power for the venous blood to be carried back to the heart and thus allows proper blood circulation (Strasser, 2000). With every step, the hoof capsule expands and with that blood is sucked in and pumped out of the hoof. This hoof mechanism, does not only supply the hoof and other tissues in the lower limb with blood and thus nutrients, but also supports the heart and general blood circulation. This having said, implies the importance of movement for tissue built-up and strengthening, especially during the growing phase (McGreevy, 2004). It has been found that young horse having received inappropriate possibilities to move show increased occurrence of osteochondrosis (Wilke, 2003).

Generally speaking, movement ensures proper digestion and promotes peristalsis, blood circulation and nutrient supply (in the lower leg). Locomotive behaviour is strongly interrelated with other equine specific behaviours and thus represents the importance of appropriate access to movement to ensure the horses’ health and well-being. Although it is very difficult and not yet defined what the optimum amount of movement for a horse is, it appears to be that the horses’ metabolism has adapted to move about 15-30 km per day. This amount should be kept as a reference for the amount of movement needed for horses to become and stay healthy.

Ingestive behaviour

Ingestive behaviour consists of all the behaviours performed to consume substances. It includes feeding and drinking behaviour. Horses spent most of their time on ingestive behaviour, up to 16 hours per day (Goodwin, 2007). Around 10 hours during daylight hours are spend on foraging (Salter 1979) but also at night horses spent time grazing (Keiper, 1980). Horses often graze in cycles with three or more prolonged periods of grazing. Whether these periods are during the daytime or nighttime depends on the season and weather (Waring, 2003). For example, horses on very dry and hot days reduce their food intake during the day and start showing increased ingestive behaviour during the night. It has also been shown that horses do not withhold themselves from feeding for more than four hours (Waran, 2007).

The horses’ digestive system has evolved to a highly efficient digesting rough and low energy fiber intake that spreads over the whole day. The horses’ stomach continuously produces gastric acids throughout the day and night, even if there is no feeding material in the stomach (Andrews, 1999). When eating food with a high fiber content a horse chews a lot (about 40,000 chewing movements per day) and that produces saliva which has a buffering effect on the gastric acid. If a
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horse does not produce enough saliva the pH in the stomach can go down which increases risk of gastric ulcerations (McGreevy 2004).

Social conditions also influence time spend on grazing. The size of the group has an influence. Since a horse is a prey animal looking-up and walking are important anti-predator strategies. If horses are alone they spend more time on locomotion and less on feeding than if they are in a group. In addition, while grazing horses tend to distance themselves from others, social spacing. With increased group size the distances between horses increase.

While feeding horses walk large distances because they seldom take more than two mouthfuls in one spot before moving on to the next, this is called trickle feeding. The lack of walking while eating in captive conditions may be a contributory factor in the emergence of Laminitis. Before and while feeding there is a significant elevation in heart rate and an increase in blood flow to the feet (McGreevey 2004).

As primary forage horses choose grasses and sedges which together constitute 50% up to 90% of the annual diets of feral horses in the western United States, but relative importance varies with local availability and season (Salter, 1979). Although horses rely on grasses as their major food source, a certain percentage constitutes bushes, leaves, twigs, fruits and buds (Waring, 2003). This percentage may differ considerably throughout the seasons. It has been shown that horses can select very effectively certain herbs, but also mineral spots such as clay and salt. With this effective selection horses avoid mineral deficiencies and health problems (Waring, 2003).

Since grass is the horses’ primary food source, this indicates that the horse eats with its neck low for most of the time. Through this posture the horses avoids dust and other fine particles getting into the deeper airways and the swallowing reflex is allowed by the extended and relaxed position of the neck.

Horses have a few criteria when selecting grazing patches, for example, they have the tendency to create and maintain patches of short grasses where they concentrate their feeding. Another criteria horses select on is how near the patch of grass is to a feces pile, this has to do with the risk of parasite infection. In a radius of one meter near a feces pile, the amount of parasites on the grass is much larger than outside this range. Despite regular de-worming by humans, horses will keep up this precaution (Fleurance, 2006).

The amount of water a horse needs varies with its condition and the climate. For an adult horse this is between 40 to 50 liters per day (Vos, 2006). Trips to water may vary in frequency according to the location of the forage and the environmental temperature. Movement towards water is mostly made by the entire group. Usually they visit the water source at least once a day, but if forage is farther away from their water source the visits can be 72 hours apart (McGreevy, 2004). In feral horses the major water source, especially during summertime are water pools, where they do not only drink, but also express comfort behaviour e.g. water bathing (McGreevy, 2004). Horses tend to stand within such pools with either the front or all four feet, giving them the possibility to absorb water and thus becoming flexible. This has become an important indirect effect of drinking behaviour for the elasticity and thus functionality of the hooves (Strasser, 2000). In stabled conditions horse show a preference for drinking water out of buckets. With Pressure valve bowls more horses fall to maintain their fluid balance (McGreevy, 2004).

For natural ingestive behaviour horses need to have the opportunity to forage in such a manner that it is spread over the whole day and mounts up to 16 hours a day. Horses need as a large part of their diet roughages. In particular grasses and sedges will be ingested, but also other kinds of plants need to be available. Horses are trickle feeders which means that they only take small bites of forage every few steps and thus walk constantly. Horses drink around 40 to 50 liters of water on a daily basis and naturally prefer to drink from waterholes, standing with at least their front legs in the water.
**Eliminative behaviour**

Eliminative behaviour is the behaviour performed when excreting feces and urine. Feral horses do not select where they defecate or urinate because most of the time it is on the spot where they are grazing (Lamoot, 2004). Horses in pastures tend to show considerable more care when selecting defecation sites. They return repeatedly to areas that are not used for grazing to prevent grazing areas to be infected by parasites (Fleurance, 2006). Explanations for this is that under wild conditions the risk of infection is lower because the density of horses, thus feces, is lower (Lamoor, 2004) and the grazing sites are considerably larger. Problems in pastured horses with this selection behaviour are that increasing parts of the pasture are not used for eating.

Horses do not show this eliminative behaviour only to lose their excess waste, but also for other purposes. Defecation and urination are also often shown in confrontations between horses. In confrontations between males fecal deposition and (or) sniffing of faeces are observed. During interactions between herds defecation is also observed (McCort, 1984). Horses pay a lot of attention to excretions of other herd’s members and also from horses that do not belong to their herd. Mainly adult males will smell defecation or urination and defecate or urinate on top of the excretion and then smell it again before going on. Adult females and young horses react less on excretions of others but have been observed to show the same behaviour. Researchers noted that only 4.3% of defecations and 11.2% of urinations were without any apparent stimulus (McCort, 1984).

Urination in mares increases when they are in estrous. They maintain the urination posture for longer periods than when in anestrous and often tilt their hind toes until the weight can no longer be borne and the tail is held to the side. This way of standing may act as an inviting visual signal for stallions. The clitoral winking that occurs normally after urination is far more frequent when in estrus.

*Wild horses do not discriminate on where they defecate. However, it has been observed that free roaming horses instinctively avoid feeding close to faeces to prevent parasite infections. Defecation and urination on top of the defecations and urine of other horses has also a social meaning and is mostly performed by stallions. This thus results in the need of sufficient space to avoid grazing near faeces.*

**Reproductive behaviour**

**Sexual behaviour of stallions**

When stallions are pastured or free ranging they exhibit more the behaviour of testing the mare’s receptivity (olfactory, visually and tactile cues) than erection, mounting, intromission, pelvic thrusting and ejaculation because only during standing oestrus does the mare allow this. The full behaviour pattern involves the attraction to the urination-like stance and raised tail of the mare followed up by the stallion prancing and trotting making sure she is separated from the group. Then he will sniff her head, flanks, genital areas and groin, possibly in synchrony with nipping the thighs and buttocks. When the mares still show receptive cues other pre-copulatory activities (eg. flehmen; licking the mare’s croup, hind legs neck and forelegs) will continue and encourage arousal for complete penis erection. Excitement will wane when the approaches are encountered with laid back ears, biting and kicking threats of the mare. In free-ranging pony stallions, it was found that the first mounting and intromission was successful in more than half of the cases and usually was achieved by the second attempt (Waring, 1983).

Logically, the sex drive of the stallion coincides with the breeding season of the mare even though libido occurs throughout the year. Interestingly, it has been verified that seasonal photoperiods has an influence on the stallion’s sexual cycle. Masturbation is normal for all age classes and can even occur while resting. In addition, adult stallions are less interested in retrieving young mares in oestrus. Colts are rarely allowed to copulate with mares older than four years, reasons for this probably have to do with them gaining sexual maturity after the age of two and then only start breeding at four years of age. Apart from the age, coat colour and dominance status of the
mare also plays a role in the stallion’s preference. They tend to ignore those whose oestrus is the first after foaling.

Importance of expressing this behaviour lies by the possibility of the onset of excessive aggression whenever stallions are subject of frustration due to incomplete sexual interactions and repeated non-ejaculatory copulations. This could lead to multiple attempts to mount and copulate with non-oestrous mares. Cases have been reported where foals were severely injured and young mares attacked (biting, kicking and striking). Novel environments and previous psychologically traumatic experiences contribute to impotence and fear of mares (Waring, 1983).

Sexual behaviour of mares

The free-ranging state of fillies can determine that due to poor nutrition puberty is reached not until her third Spring. During sexual activity they seek out contact with bachelor stallions or unfamiliar harem stallion, because they are usually ignored by the familiar ones when more mature mares are also receptive. Since reproductive success and biological fitness is enhanced when companionship of one stallion is maintained, mares usually remain loyal to this single-stallion bands. Consequently, they will interfere with the courtship and mating of other mares with their stallion in a degree according to her reproductive state and rank. Receptiveness towards stallions increases with age (McGreevy, 2004).

The following courtship behaviours define the oestrus: abrupt haltings during locomotion, approaching and following of the stallion, lifting the tail, clitoral winking, urinating, and tolerance of the stallion’s sexual behaviour. When they fail to attract the harem stallion they may disperse in search of other males. Oestrous mares also show certain facial expressions (open mouth and bared teeth). The length of courtship varies in relation to the rank. Matings occur up to six times per heat in single stallion groups, after dismounting takes place the couple remains close until other activities take priority. Hormonally induced oestrus may fail because of the lack of exogenous factors like odours, sounds, sight and touch that do arise under the tending of stallions (McGreevy, 2004).

Maternal behaviour

After a gestation of approximately eleven months, mares normally foal in mid to late spring which ensures sufficient feed is available for lactation. Sex of the foal contributes to the duration of the gestation and also to the condition of the mare prenatally, this being poorer when carrying a filly. It is suggested that non-reproductive sex encourages stallions to remain with the band. Social interactions increase among the mares. Peri-parturient behaviours include standing, sternal and lateral recumbency and walking along with being left behind by the rest of the group to avoid mis-mothering. Most mares foal at night presumably to avoid daytime predators. Vigorous rolling is thought to correctly position the foal and help discharge the placenta. Afterwards, the mare and the foal quickly rejoin the herd so as not attract unwanted predators with these membranes (McGreevy, 2004).

The strong bond with her foal, especially for male offspring, facilitates its survival and development but is at the expense of bonds with herd affiliates. This can take up to two weeks to consolidate and is initially stronger from the side of the mare. Grooming her foal clean helps to identify her offspring from others. The moving away or grazing of the mare only happens when the foal is not in a vulnerable position like when recumbent. Feral horses will sometimes suckle besides their own new born foal also older siblings. Przewalski horses may also when having lost their foal suckle orphaned foals (McGreevy, 2004).

Whenever mares do not tolerate their foals signs of rejection such as aggression are observed. These however can be induced by introducing a large dog to stimulate maternal defensiveness. Foal itself also has a role to work on this attachment (McGreevy, 2004).

The ability to show reproductive behaviour in stallions and mares is important from an ultimate point of view because it contributes to fitness and survival. The requirements for the stallion must be met otherwise frustration levels rise and he will become more aggressive. What the mares
need to behave sexually in a normal way is a good nutrition to prevent oestrus cycles disturbance or fetal mortalities. For maternal care to be effective the bond with her foal must consolidate through close contact so as to avoid foal rejection.

Summarising the above investigated natural behaviours it can be concluded that for adult horses the ones being most essential for both mental and physical health and wellbeing are social, ingestive, locomotive and comfort behaviour. Reproductive behaviour of course plays a vital role for survival in the nature, but with regards to welfare and wellbeing it is less vital than the above mentioned ones, the same counts for eliminative behaviour. When taking foals into consideration as well, of course maternal care and education play a key role, especially in the early stages of the foals’ life. This thus means that especially social, ingestive, locomotive and comfort behaviour (and maternal behaviour) need to be considered for an optimal naturalistic housing system for adult horses with still the human being able to handle and manage them.

**Optimal housing system based on natural behaviours**

Horses are very social flight animals and have developed specific natural behaviours which help them stay healthy and able to survive in their quite harsh natural environment, the steppe. Nowadays horses are predominantly kept as companion animals in a captive environment and used for pleasure purposes. Horses have become domesticated, but their natural behaviour has not changed and several key features are still vital for the horses’ health and well-being. In the following chapter therefore the above investigated natural behaviours will be brought into relation with housing systems of human-handled horses. Based on that, an optimal housing system, allowing horses to express vital key features of natural behaviours will be presented.

**Current housing systems and their limitations**

In the following paragraphs a brief overview of the commonly used current housing systems will be given. It is important to know to which extend the different housing systems allow natural behaviours to be expressed and where the limitations arise. This knowledge can be used as a supportive tool for designing an optimal housing system for the horses’ well-being. For more details and individual differences of the housing systems see annex 1.

**Individual housing in boxes**

The most common housings system used in the horse industry are individual housing in boxes. More than 80% of all horses in Europe are housed in such systems. It is payable and practical, since the horse can be kept under direct control and supervision of the human. In general the size of a box is recommended to be at least 3x3m, yet these are really only recommendations and the basis on which these recommendations are built are rather random as well. In general the size of the box depends on the size of the horse. Within this system there are rather big differences, with regards to turnout, size and the possibility for social contacts. Principally, box housing has been shown not to be an adequate housing system with regards to the ability to express natural behaviours and thus for the health and welfare of horses.

**Individual housing at stands**

The stands used as individual housing for horses is a relic from several decades ago and have officially been identified as animal unfriendly by the animal protection and even the government. Nevertheless, in several countries this form of housing is still seen. Often the agreement is made that no new stand are allowed to be built and the already existing ones should be used. The size of the stand can vary between 1x2m to 1,2x2m. Not a lot of space for a horse. When this system is used to keep horses the possibility to express natural behaviour is almost none, especially since the horse is normally tied to the wall and thus cannot move at all.
Group housing in closed stables

This system is most commonly used for breeding purposes, stabling several mares with their foals in a closed barn, so that they can move freely and make contact with other horses and foals. In this system the size, access to outside, bedding and group size can vary a lot. The most common used size is 7x4m, depending on the number of horses kept in a group stable, horses have relatively more space to move around, especially when compared to the first two systems.

Group housing in open stables

This system describes a housing system where several horses normally have access to shelter in form of an open barn where they can walk in and out whenever they like. Often such a system includes a reinforced paddock with sand or bricks. This system also differs in size, access to pasture, size of horses, availability of roughage and the number of horses. Horses which are kept in groups in open stables can have a lot of interaction with other horses in the stable. The opportunity to walk outside and the possibility of interaction between the horses makes this system special and friendly.

During the last decades two specific systems derived from that, namely the HIT system and the paddock paradise, both systems try to encourage the horse to move more. Especially the HIT system has gained much popularity in the equine industry during the last years, but especially this system faces several disadvantages such as the possibility of increased stress levels in lower ranked horses, often there are too many horses on a too little space. However, this paper does not go into further detail of such specific systems, but will take such points into consideration for the optimal housing system.

Horses kept exclusively on the pasture

Horses which are exclusively kept on pastures have normally more space to move, graze, play and run; of course this also depends on the size of the pasture and the availability of grass. Keeping the horses exclusively on pasture brings definitely huge advantages with regards to the expression of natural behaviours, but still proper management of such a pasture is necessary to keep the horses healthy.

In general it can be said that the majority of current horse housing systems are not primarily designed on the basis of natural behaviour of horses, but rather built on practicability on the humans’ side (anthropocentric approach). Open stabling and pasture housing are the two systems which allow horses to express natural behaviour the most, but still often miss essential features, strongly depending on the individual effort being made. As already stated the minority of horses live in such housing systems.

Recommended housing system using a ‘naturalistic’ approach

Based on the previously investigated natural behaviours of horses an optimal housing system will be designed using a ‘naturalistic’ or ‘top down’ approach which allows horses to express essential key features of their natural behaviours and thus guaranteeing high welfare and health of the horses. In annex II a table has been included where all the key features of natural behaviours are listed in relation to their importance to equine health and welfare. The system has been built up on the basis of this table and the result can be seen below (see Fig. 1 and Table 1).
Data for the optimal housing system:

Table 1. Characteristics of the optimal housing system.

<table>
<thead>
<tr>
<th>Space</th>
<th>6 hectares: 500mx120m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer area</td>
<td>3.5 hectares</td>
</tr>
<tr>
<td>Winter area</td>
<td>2.5 hectares</td>
</tr>
<tr>
<td>Amount of horses</td>
<td>4</td>
</tr>
<tr>
<td>Items available</td>
<td>Gravel path (500m), Water hole, Sand patches, Shelter areas (trees) on the summer area, Shelter area (stable) on the winter area, Bushes and trees, Mineral spot, Hay racks (3x) on the winter area, Human area</td>
</tr>
</tbody>
</table>

Figure 1. Design of the optimal housing system for horses.
Encouraging social behaviour:

The system is designed for a total of 4 horses, either a harem band with one stallion and 3 mares or a bachelor group. Through this natural social interaction and a most stable hierarchy and harmony is guaranteed. The reason for having chosen 4 horses is that it has most commonly been observed that a typical harem group consists of about three to four mares and one stallion, therefore this has been taken as optimum. However, a clear statement of how many horses really would be the optimum can hardly be given. As several studies have shown social interaction is crucial, thus at least two horses are needed for comfort and safety. This means that at least two horses should be kept together. It can be assumed that in free roaming horses there will be a maximum of how many mares a stallion can keep in his group and under control. However, this maximum is not known and probably varies per individual. More or less the same counts for bachelor bands, thus there also will be a maximum above which the harmony and stability in the band will be threatened.

A restriction using the top down approach is here that since it is only one band, no “territorial” behaviour will occur with rivalling bands or bachelor stallions. This however is not seen as a key feature of natural behaviour and might even decrease the welfare of the horses, in terms of stress and possible (serious) injuries. Another restriction having made is that it has been decided to keep the band without offspring, since this would mean that the offspring would stay about two years and this would mean that about 3-6 progenies would be present all times. Due to space restriction it therefore has been decided that the stallion gets vasectomized, so that he still can show stallion appropriate behaviour, but with no offspring resulting. A drawback is that maternal care and education can thus not be presented by the mares.

Encouraging comfort behaviour:

The system has been designed to strongly encourage comfort behaviour such as conspecific interaction, sand rolling, sheltering and water bathing. Such comfort behaviour has been identified as being crucial for a positive experience and physiologically necessary, since water and sand bathing is beneficial for thermoregulation and a parasitic defence. It therefore has been cared for that horses must have access to a water hole, several different types of trees and bushes and several rolling areas. Since they live together under a strong social bond, this bond ensures the possibility for horses to show mutual grooming and feel safety, which has been shown to considerably drop the heartbeat and stress levels. The summer area contains a little piece of forest for the horses to shelter especially against heat. To avoid insect harassment they can move to the more open areas or the water hole. During winter time it has been decided to give horses the possibility to shelter in a three sided stable, since the wind, rain or snow combined with cold are a bigger challenge for horses and trees alone might give inappropriate shelter. Optimally the area should also contain some kind of hills, since it has been shown that horses search for higher places in summer time to avoid insects. This however has due to feasibility not been considered.

Encouraging locomotive behaviour:

The system is a pasture system with the size of 6 hectares. Looking at the size of the horses’ natural territory even 6 hectares is rather small. The major reason for deciding on a certain size is strongly related to locomotive and ingestive behaviour. The space of 6 hectares is therefore derived from regular recommendations of how much space is generally needed for one horse over one year with regards to the amount of grass available. Those regulations normally advise half to three quarter of a hectare per horse. However, it has been decided that at least the double amount is needed per horses, since the developed system does not contain highly rich grasses, but contains species appropriate grasses, low in energy and high in fibre. Although free roaming horses inhabit huge territories this is not possible for captive conditions. Therefore it has been decided to focus on the space horses minimally would need with regards to food availability and movement. However,
this size is not a fixed number and can be altered depending on the group size and other factors which will be discussed in more detail in the following chapter.

Since horses walk about 15-30km per day and might even surpass this distance considerably, their body and metabolism have adapted to walking such distances. To be able to guarantee this movement, the system encourages the horses to walk a certain distance to the water hole. The length of the path towards the water hole is approximately 500m, assuming a horse walks about three times per day to get water this already results in walking three kilometres. Another encouraging factor is that especially the summer area has its shelter regions (trees) and comfort area in the upper corner, so that horses need to first walk down to the entry of the path and then to the water hole, resulting in even more movement. Being able to feed horses purely on grass they will constantly walk while eating, resulting in a considerable distance walking per day. Having a harem band the herding behaviour of the stallion will result in additional movement. Since the horses have to walk over the gravel path each time they want to drink, they walk a considerable amount of the total distance on hard, abrasive ground, guaranteeing equal and proper wearing of the hoof. Also the occasional wild herding games between stallion and mare allow proper kind of movement, not only walk, strengthening the horses’ body considerably.

Encouraging ingestive behaviour:

The possibility of having “unlimited” access to low energy grass even on 6 hectares strongly depends on for example weather circumstances. To be able to maintain the land properly and to ensure natural eating behaviour the area is divided into a summer area and a winter area. This stimulates the natural nomading behaviour of horses and guarantees a more natural diet during the seasons, thus fresh young grass in spring and summer and outgrown grasses during winter time. On both areas it has been taken care that different kinds of fast growing trees such as willows and bushes are present on which horses can browse. Especially on the winter pasture larger amounts of bushes are present. Another natural behaviour of horses is that during summer time they will feed also for winter reserves. During winter time it is natural that horses will lose weight considerably, which is a natural and healthy process. However, with installing three hayracks where easily big bales of hay can be placed are present in the winter area, it is guaranteed that there is a possibility to feed the horses hay in very harsh winters to prevent them from starving. It is still preferred to have them feed on grass exclusively, since this is their natural behaviour and involves a lot of locomotive behaviour, which will decrease considerably when being fed on hay racks. The grasses on the total area have been chosen to be very low in energy and diverse. It has also been taken into account that the grasses contain different kinds of herbs allowing the horse to selectively choose herbs needed to maintain their health.

As already mentioned, horses need to go to a waterhole when in need of a drink. The water hole ensures that the horses will moisture their hooves, so they stay elastic and healthy. To be able to give the horses the possibility to search for specific minerals, a mineral spot has been installed, where soil rich in minerals and spore elements are present. It could be argued whether this is really necessary or not, but since the horses are still living on a restricted area and cannot choose the grasses and other elements to such an extent as they might do in nature it has been decided to install such an area. The horses could of course also be supplemented with additional artificial minerals by the human, but such a supplementation always bears the risk of over or under supplementing the horse.

Discussion

There are several points which can be discussed with regards to the setup of the recommended system. Firstly, there is the size of the area, of course it can be more or less determined which home range size an individual horse has and based on this the system could be created. However, this home range is very specific and huge differences could be observed in relation to the availability of food. Moreover, certain areas within this home range may rarely be
visited by the horses, so that the actual home range might even be smaller. The size of six hectares has mainly been based on the amount of horses, the availability of food and the possibility of sufficient movement. However, since these factors could be altered in terms of minimizing the group number and offering preserved food for some time of the year it is likely that horses can express their natural behaviours on a smaller sized area, but in limited ways. The size of such an area is therefore not a strict size, but can be altered to a certain extent, but since the natural behaviour of horses is to “trickle feed” it is strongly recommended to try and offer the horses the possibility for that behaviour, especially since locomotive behaviour is strongly related to this.

As for sufficient movement also here it is not really known how much movement a horse exactly needs to properly support the blood circulation and nutrient supply. The major indication for this is the movement feral or free roaming horses show. Also there are strong indications showing health issues when horses receive too little movement, but also then there are no real quantitative measurements available of what is too little. The amount of movement the horses receive in such a system can however also not be quantified beforehand. Several studies have shown considerable differences in movement between different housing systems, but none really reaches the amount of movement made by horses in nature. Through the installation of a gravel path and with that forcing the horses to move, the herd constellation and the size of the area, it is assumed that the horses will meet their 15-30km quota on a daily basis. It has been shown that environmental enrichment in terms of offering different sources of food (grass, bushes, twigs), having a dynamic herd structure and spreading the whole place into different “areas” promotes movement considerably.

Also the group size is not really a fixed number and can be altered. Research has shown that since horses are highly social animals that they at least need one conspecific to feel safety and be able to express natural behaviours. The number of four horses has been chosen because it is known that the most common constellation in a harem group is normally one stallion and three to four mares (and/or offspring). The number of mares however can alter considerably. In nature this would depend on the strength and dominance of the stallion and his possibilities to defend his mares towards rivalling stallions and to capture new ones. In the designed system this does not play a role, but it can be assumed that even in such a constellation there is a maximum number of mares a stallion can handle. In general however, it is very complicated to determine the optimal number of horses needed.

With regards to reproduction it has been decided to vasectomize the stallion so that still reproductive behaviour can be expressed and the stallion still has its task in life, namely herding, protecting and mating with mares. It has been indicated that stallions not being able to fulfil their natural behaviour are more likely to show aggressive behaviour (towards human and other horses). However, also this decision could be altered and it could be decided to instead let the fertile stallion cover the mares and receiving offspring on a regular basis. This than would mean that the offspring would stay in the herd until about the age of two years until it would get kicked out of the group by the stallion. With that it would be naturally weaned as well, since it has been shown that (too early) artificial weaning might be a very stressful situation for the offspring. However, this would mean that in principle even more space and grazing area would be needed.

As already mentioned the feeding regime could be adapted as well. The horses could be fed with preserved grasses (hays) for some time of the year and also be supplemented with minerals and vitamins artificially. These adjustments would result in the need of a smaller sized area, but would especially compromise the amount of movement per day. However, since most horses are ridden or used in another way this loss of movement could eventually be compensated.

So in general it can be said that the above designed system is not a fixed set up, but can be altered in certain ways, especially in terms of area size and group size and constellation. It is still a very difficult task to determine the optimal group size and the optimal size needed per horse, especially since this might depend on external factors and type of individual horses.
The feasibility of such a system replacing the current housing systems has not been considered in this paper, but it would certainly need several adjustments, since especially the role of the human is not considered at all.

Conclusion

In conclusion it can be said that for horses to stay health and to guarantee high welfare under captive conditions it is essential that certain key features of their natural behaviours can be expressed. Literature review has shown that especially certain key features of social, ingestive, locomotive and comfort behaviour are of major importance. These behaviours are strongly interrelated with each other. However, for several factors it is still rather complicated to quantify them, especially with regards to optimal group size, the size of the grazing area and movement (distance). The developed housing system is therefore based on that it allows and motivates horses to perform natural behaviour closest to what they show when free roaming, so that high welfare can be guaranteed.
References


Picture on cover available at internet link: http://www.nevadamagazine.com/images/articles/Wild_Horses_MAIN-cr-BrianT.Mur.jpg
Annex # 1

Current housing systems such as

Individual housing in boxes
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<table>
<thead>
<tr>
<th>Opportunity to walk outside (paddock box)</th>
<th>Opportunity to graze for some hours a day</th>
</tr>
</thead>
<tbody>
<tr>
<td>No opportunity to walk outside (stabled 24/7)</td>
<td>Roughage available ad libitum –pure hays or haylages</td>
</tr>
<tr>
<td>Horse can see and hear other horse(s) without physical contact</td>
<td>Roughage available ad libitum –including bedding (straw)</td>
</tr>
<tr>
<td>Horse can’t see or hear and doesn’t have any contact with other horse(s)</td>
<td>Restricted access to roughage –both hays and bedding (straw)</td>
</tr>
<tr>
<td>Horses can hear each other, but not see each other and cannot make physical contact</td>
<td>Horse can see and hear other horse(s) with opportunity to have physical contact</td>
</tr>
<tr>
<td>Box with window(s) so the horse can look outside</td>
<td>Horse can’t see or hear and doesn’t have any contact with other horse(s)</td>
</tr>
<tr>
<td>Box without any window(s) so the horse can’t look outside</td>
<td>Horses can see and hear each other, but not see each other and cannot make physical contact</td>
</tr>
<tr>
<td>Totally closed box</td>
<td>Horses can hear each other, but not see each other and cannot make physical contact</td>
</tr>
<tr>
<td>Opening so the horse can put his head outside the box</td>
<td>Roughage available ad libitum –including bedding (straw)</td>
</tr>
<tr>
<td>No bedding used in the box</td>
<td>Roughage available ad libitum –pure hays or haylages</td>
</tr>
<tr>
<td>Straw used as bedding in the box</td>
<td>Restricted access to roughage –both hays and bedding (straw)</td>
</tr>
<tr>
<td>Sawdust used as bedding in the box</td>
<td>Horse can see and hear other horse(s) with opportunity to have physical contact</td>
</tr>
<tr>
<td>Mix of straw and sawdust used as bedding in the box</td>
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</tr>
<tr>
<td>Some other bedding is used in the box</td>
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Individual housing at stands
The stands used as individual housing for horses is a relic from several decades ago and have officially been identified as animal unfriendly by the animal protection and even the government. Nevertheless, in several countries this form of housing is still seen. Often the agreement is made that no new stand are allowed to be built and the already existing ones should be used. The size of the stand can vary between 1x2m to 1,2x2m. Not a lot of space for a horse. When this system is used to keep horses the possibility to express natural behaviour is almost none, especially since the horse is normally tied to the wall and thus cannot move at all.

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</table>
Stand with an window at the front side so the horse can look outside
Stand with a closed front side so the horse can’t look outside
Opening at the front side so the horse can put his head outside the box

No bedding used in the stand
Straw used as bedding in the stand
Sawdust used as bedding in the stand
Mix of straw and sawdust used as bedding in the stand
Some other bedding is used in the stand

Group housing in closed stables

This system is most commonly used for breeding purposes, stabling several mares with their foals in a closed barn, so that they can move freely and make contact with other horses and foals. In this system the size, access to outside, bedding and group size can vary a lot. The most commonly used size is 7x4m, depending on the number of horses kept in a group stable, horses have relatively more space to move around, especially when compared to the first two systems.

Opportunity to walk outside on a sand paddock
Opportunity to graze for some hours a day
Access to pasture/gras 24/7
Roughage available ad libitum –pure hays or haylages

Group housing in open stables

This system describes a housing system where several horses normally have access to shelter in form of an open barn where they can walk in and out whenever they like. Often such a system includes a reinforced paddock with sand or bricks. This system also differs in size, access to pasture, size of horses, availability of roughage and the number of horses. Horses which are kept in groups in open stables can have a lot of interaction with other horses in the stable. The opportunity to walk outside and the possibility of interaction between the horses makes this system special and friendly.

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<th>Roughage available ad libitum—including bedding (straw)</th>
</tr>
</thead>
<tbody>
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<td>Restricted access to roughage—both hays and bedding (straw)</td>
</tr>
</tbody>
</table>

| No bedding used in the stable |
| Straw used as bedding in the stable |
| Sawdust used as bedding in the stable |
| Mix of straw and sawdust used as bedding in the stable |
| Some other bedding is used in the stable |

| Horses can lay down in the stable |
| Horse can’t lay down in the stand |
| Enough movement possible, x m²/horse is large |
| Less movement is possible, x m²/horse is small |

**Horses kept exclusively on the pasture**

Horses which are exclusively kept on pastures have normally more space to move, graze, play and run; of course this also depends on the size of the pasture and the availability of grass. Keeping the horses exclusively on pasture brings definitely huge advantages with regards to the expression of natural behaviours, but still proper management of such a pasture is necessary to keep the horses healthy.

| Opportunity to walk around |
| Opportunity to graze for some hours a day |
| Grazing is possible 24/7 |
| Grazing is possible for some hours a day |
| Grazing isn’t possible |
| Roughage available ad libitum—pure hays or haylages |
| Roughage available ad libitum—including bedding (straw) |
| Restricted access to roughage—both hays and bedding (straw) |

| Bottom is totally covered with grass |
| Bottom is totally covered with soil |
| Bottom is a mix of grass and soil |
| Monoculture |
| Multiculture |
| Access to food other than grasses, such as bushes, twigs and herbs |

| Horse(s) can shelter under e.g. roof/tree |
| Horse(s) can’t shelter under e.g. a roof/tree |
| Horse(s) can go into shadow caused by e.g. a roof/tree |
| Horse(s) can’t go into shadow caused by e.g. a roof/tree |

| Horses can lay down in the pasture |
| Horse can’t lay down in the pasture |
| Enough movement possible, x m²/horse is large |
| Less movement is possible, x m²/horse is small |
Annex # 2

Table 1. For every essential natural behaviour seen in horses, the requisites for an optimal system and the behavioural consequences when stabled conditions prevent their expression.

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>subcategories</th>
<th>Requirements for optimal housing</th>
<th>Behavioural consequences of deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td>Herd</td>
<td>One stallion with 4-5 mares</td>
<td>Losses interest in sexual reproduction.</td>
</tr>
<tr>
<td></td>
<td>Hierarchy, roles</td>
<td>For social integrity of the band.</td>
<td>Increases accumulative amount of injuries &amp; distress due to aggression during every dispute. Decreased rate of conception. Increased rate of foal &amp; fetal mortality.</td>
</tr>
<tr>
<td></td>
<td>Play, investigative</td>
<td>Play fighting in colts with conspecifics of the same age to learn defense mechanisms.</td>
<td>Does not learn to adapt.</td>
</tr>
<tr>
<td></td>
<td>Territory</td>
<td>1.5 mts distance between all horses when feeding. Ranges from 0.1 up to 11 individuals/km2 varying with distribution of resources.</td>
<td>More aggression over lack of resources.</td>
</tr>
<tr>
<td>Communication</td>
<td>Visual contact.</td>
<td></td>
<td>Weaving, box-walking.</td>
</tr>
<tr>
<td>Agonistic</td>
<td>Teaches youngsters their status/position in the band.</td>
<td>Social instability.</td>
<td></td>
</tr>
<tr>
<td>Comfort</td>
<td>Grooming</td>
<td>Objects to rub against: trees, shrubs or fences. Locations for rolling: places with dry fine soil, sand or mud. Kept in groups for allogrooming.</td>
<td>Frustration.</td>
</tr>
<tr>
<td>Thermoregulation</td>
<td>Shelter for cold, rainy and windy weather. Shady areas for heat. Water holes to cool down.</td>
<td>Susceptibility to diseases.</td>
<td></td>
</tr>
<tr>
<td>Insect avoidance</td>
<td>High, bare places without forage for avoiding flies. Water for avoiding flies. In groups for switching tails in pairs.</td>
<td>Frustration.</td>
<td></td>
</tr>
<tr>
<td>Sleeping</td>
<td>-</td>
<td></td>
<td>Death.</td>
</tr>
<tr>
<td>Locomotory</td>
<td>10-20km</td>
<td>Sufficient space, different surfaces, encouraging paths</td>
<td>Locomotive problems, obesities, hoof problems.</td>
</tr>
<tr>
<td>Ingestive</td>
<td>Quantity</td>
<td>40-50l water.</td>
<td>Dehydration.</td>
</tr>
<tr>
<td></td>
<td>Quality</td>
<td>High in fiber, low in energy, different substances.</td>
<td>Gastric ulcers, deficiencies in nutrients.</td>
</tr>
<tr>
<td></td>
<td>Manner</td>
<td>While walking, together with other horses, not close to feces.</td>
<td>Laminitis, less time spend on feeding, parasite infections.</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
<td>16 hours spread over the whole day.</td>
<td>Gastric ulcers.</td>
</tr>
<tr>
<td>Eliminative</td>
<td>Place</td>
<td>Enough place to select feeding places and latrine areas, soft ground.</td>
<td>Feces on feeding areas leads to compromised feeding, not willing to urinate.</td>
</tr>
<tr>
<td></td>
<td>Social meaning</td>
<td>Recognition and hierarchy establishing.</td>
<td>No known problems.</td>
</tr>
<tr>
<td>Reproductive</td>
<td>Stallion</td>
<td>Experienced, dominant, receptive mares.</td>
<td>Traumatic experiences resulting in impotence and fear of mares, excessive aggression.</td>
</tr>
<tr>
<td></td>
<td>Mare</td>
<td>Courtship of unfamiliar harem or bachelor stallions, good nutrition, presence of stallion to induce estrus, maintenance of bond to a single stallion.</td>
<td>Dispersal from natal band. No estrus. Less reproductive fitness.</td>
</tr>
</tbody>
</table>