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1.Introduction

Knowledge on the natural behavior patterns of horses, whether free-ranging or kept by humans, is of great importance for the development of housing systems. These systems should be arranged in a way, so they constraining the animals as least as possible in their natural development and behavior (Kownacki et al., 1978), as it is claimed by the federal government department for nutrition, agriculture and consumer protection (Zeitler-Feicht et al., 2009) in Germany. Since for a species-appropriate housing system requirements of the species need to be considered, there is also a need for research finding out how horses use different environments and not only the ones horse owners might consider suitable. As a starting point this research aims to figure out whether and how horses do use forests.

Sadly there is a lack in between wildlife research on feral horses, showing that horses do use the forest in manifold ways (Oelke, 1997), and the research on domesticated horses, since most of the time horses are considered exclusively as animals of the steppe, demanding a wide sight with shelter from wind, rain and sun; but forests are often excluded from research studies because they are considered as least used, and least important to the horses´ natural environment. Research on feral Sorraia horses in Portugal and free-ranging horses in nature reserves in Germany shows, that a forest enables feral horses to show natural behavior patterns (Oelke, 1997), which is only possible due to the abundance of forest (Gerken et al., 2008). And even though there is no indication that domestication change the horses´ basic needs (Howald, 2005; Pirkelmann, 2002; Kiley-Worthington, 1990; Walter and Dinse, 2001) the results of such research studies are reflected by least housing situations of horses in Germany, kept for leisure and sports purposes.

1.1. Problem statement

Thus the problem underlying this research study is the gap in between wildlife research and nowadays housing conditions of horses in Germany, or moreover the lack of knowledge in the natural behavior of horses, interacting with their environment (Beever, 2003).

1.2. Research objectives

Therefore this research aims to figure out, whether horses choose for one or the other (forest or open pasture) in certain circumstances, or for certain actions and how often they spend time in the forest in comparison to the pasture.

The purpose is to bridge the gap in between wildlife research and research done on welfare of horses kept for leisure and sport purposes. These two sectors can and should work closer together in order to enable horses, which are kept by humans, to live a healthy and species appropriate life with least constrained natural behavior patterns. Therefore this research is suppose to give a thought provoking impulse for the real needs of our horses, regarding housing and pasturing facilities, and whether the way horses are kept nowadays is suitable for these animals and to the best of our knowledge.

1.3. Research questions

Main question

How do horses use forest, if it is offered on their pasture and they have the choice between open pasture and the woods?

Sub questions

1. Do horses spend certain times of the day/night preferably in or around the forest?

2. Do horses use the forest in certain weather circumstances like wind, hot sun or rain?

3. Which behavior do horses show in and around the forest?

4. Do horses use the forest for feeding more or less than they do use the pasture for feeding?

5. Do horses use the forest for resting more or less than they do use the pasture?

6. Do horses use the forest for social activities more or less than they do show social activities on the pasture?

2. Literature review

The behavior of free ranging horses has been well studied (Duncan, 1983; Schäfer, 1993, King 2002) while the housing situation of horses in Germany and elsewhere does not reflect the knowledge arising from these studies. Several researchers stated that there are no indications that domestication changed the basic needs of horses (Howald, 2005; Pirkelmann, 2002; Kiley-Worthington, 1990; Walter and Dinse, 2001). So the research conducted on free ranging horses can and should be used as guidelines for housing conditions of domesticated horses. The ´guidelines for the evaluation of horse housing systems under animal welfare aspects´ published by the federal government department for nutrition, agriculture and consumer protection (BMELV) in Germany even stated, that all housing systems for horses have to be established in a way, so that individual horses are enabled to show the broadest form of species typical behavior. And in a way that they are save from harm and not constrained in their development (BMELV, 1995). Therefore much more research on the horses´ behavior and their interaction with the environment is needed, so that real species typical behavior can be taken as foundation for the construction of a suitable housing system.

Research on the welfare of domesticated horses has shown that horses which have all year round access to a pasture are "healthier, more balanced and easier to handle" (Howald, 2005) and that the movement patterns of horses are linked to their search for water, social contact and food. The conclusion of this research was that the "pasturing of horses leads to a relatively high amount of exercise and fulfills the natural requirements of horses best" (Frentzen, 1994). But not only the amount of exercise is known to be influenced by environmental factors but also the use of habitat is influenced by weather, predators and food supply (Salter and Hudson, 1978). The influence of the seasons on the choice of habitat could already be proved by research studies on free ranging ponies in New Forest, England and on the Isle of Rhum as well as on Icelandics in a nature reserve in the Netherlands. These studies revealed that horses use the forest during autumn and winter intensively (Putman, 1986; Putman et al., 1987; Gordon, 1989; Kuiters et al., 2003) and that there is a clear selection by the ponies for shelter in the woodlands in the winter and to some extent at night throughout the year (Pratt el al., 1986).

Research on Przewalski horses on the other hand showed that they preferably used the forest during summer time. Thus there are differences in between the seasons, but the importance of the abundance of forest in the natural environment of horses cannot be limited to one specific season. In research studies on reintroduced Przewalski horses in the Hutsai National Park it could be observed that the range of each harem of horses included a patch of forest that were used in summer (King, 2002; King et al. 2004). Keiper and Berger also researched the avoidance behavior of free ranging horses who were seeking refuge from biting flies on an island off the Atlantic coast of Maryland and in the Great Basin desert in Nevada. They found out that forest plays an important role as refuge from biting flies, heat and wind (Keiper et al. 1982).

Nevertheless the factors influencing the use of habitat by horses cannot be limited to weather circumstances or refuge of flies, but also inhale the food supply (Salter et al, 1978), as already stated above. Research on the Camargue horses in France also showed that the abundance of food is the only good predictor of the habitat preferences of horses for feeding activities. Further Duncan also says that horses are very selective foragers, if the availability and the quality of their food is high (Duncan, 1983), thus the question arises whether horses, kept by humans, are offered enough diversity in their diets on grassland pastures, without bushes and trees. Sometimes even with very limited diversity in the types of grass growing there.

Several previous research studies on feral and wild horses, for example in Wyoming and in a nature reserve (Baronie Cranendonck) in the Netherlands, only interpreted the time the horses actually spent in the forest. The results they found showed that parts of forest within the researched area stayed underexploited and the horses did apparently not select the forest for foraging (Crane et al, 1997; Kuiters et al., 2003). Out of these findings it has been concluded that horses do not need the forest to show any species specific behavior. On the other hand there are numerous research studies conducted in nature reserves in the Netherlands and Germany stating that horses do use the forest in manifold ways (Gerken et al. 2008) and this study is suppose to prove this also for horses kept by humans.

From nature preservation in the States there is relatively little research on the fact how the free ranging horses there interact with ecosystem components (Beever, 2003), while with nature reserves in Germany and the Netherlands, where it is nowadays common practice to use horses and cattle, with a minor stocking rate, for nature management (Van Wieren, 1995; Bokdam et al., 2000; Kuiters, 2000), markedly positive experiences were made (Rüther et al., 2002; Sieling, 2002). The horses decrease the amount of especially beech trees and enable a broad range of plants to grow and therewith create living environment for several species (Gerken et al., 2008).

Hence why not offering our horses more diversity on their pastures, in terms of an additional part of forest with different kind of trees and bushes, not only that they have more diversity in the food which is offered to them and in the terrain they can walk over, but also so that they have something to do and to explore, which Grauvogel considered necessary and which was proven by his study on abnormal behavior of horses conducted in 1993. As a starting point this research aims to figure out whether and how horses do use forests if they are offered to them.

3. Methodology

3.1. Research design

Four different herds were observed, stabled at 3 different locations. Each of them had another pasture with another kind of forest and grassland on it. In table 2 Annex 2 the amount of horses per pasture is shown, while Fig.1 on the next page shows the proportion of grassland to forest on each pasture.

Mrs. Constanze Röhm, commissioner of this research, provided contact details of several stable owners, which keep horses on pastures with forest and were willing to contribute to this study. After the goals for this research were clear and the research questions were formulated, the stable owners who agreed on participating in this study were contacted. The most suitable ones to compare and to collect data were chosen, according to information about breed, age and gender of the horses and the type of forest, offered to the horses. The most different stables were chosen in terms of the type of forest, it´s density, the horse breeds and their usage, to be able to show, that none of these factors have an influence on the fact that the horses do use the forest for certain activities and in certain times of the day. Therefore stables with sole deciduous forest were chosen as well as stables with mixed forest with coniferous woodland growing there. Also the breeds of the horses were considered, so a lot of different breeds of horses could be part of the study, to show that there are no or only limited differences in between the breeds. For more information about the single stables, their horses and pastures, see table 2 and Figure 14 in Annex 2. The 36 horses are in between 2 and 24 years old. From 7 horses the age is not known. In each herd clear social structures are established and no new animals were integrated into the herd before or during the observations. All horses are kept on pastures with free access to a forest 24 hours a day, 7 days a week, except for single riding lessons or trail rides.

The research area

For the present research 3 different stables in the surrounding of Nuremberg, Fulda and Leipzig were chosen, each of them in rather mild climate zones and without any extreme landscape structures, influencing the weather, like for example in a valley. In Fig.1 below the size of the pastures and the size of the forests are shown in hectare, for each stable. In total 7,2 ha forest and 6,9 ha pasture, distributed unequally among the pastures. In Annex1 aerial pictures of each pasture can be seen.

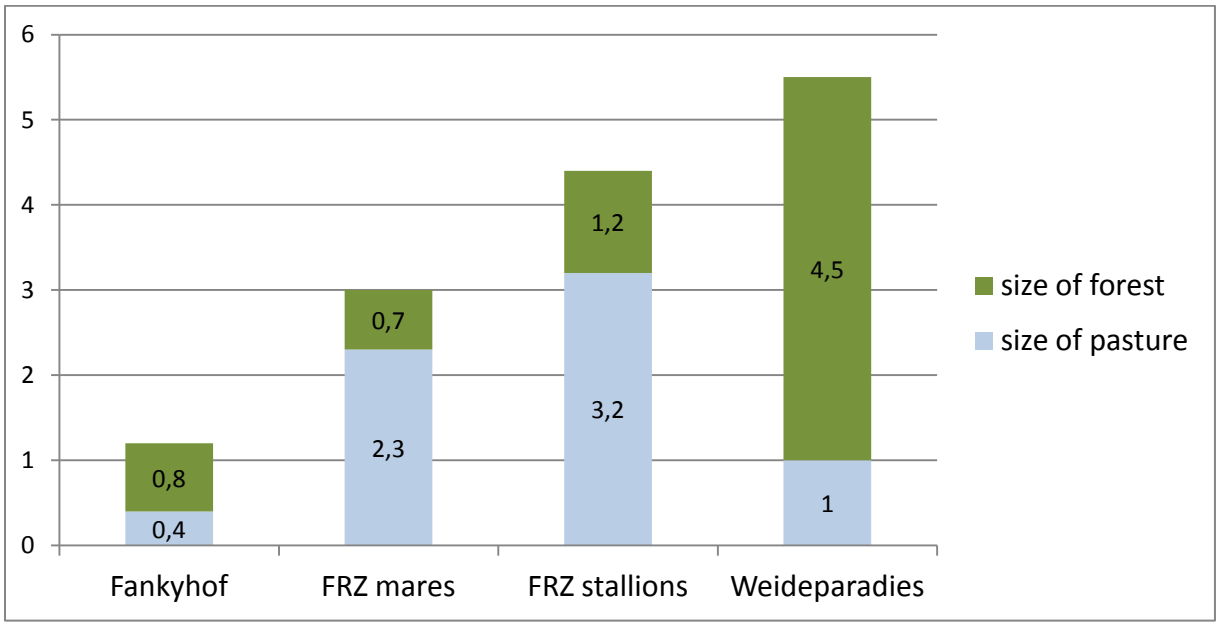

Fig.1: relation – abundance of forest and abundance of pasture

3.2. Data collection

To be able to compare the research results of the four different locations with each other the same research frame conditions have to be applied. The different environmental conditions of the four locations (four pastures) will be taken into account in the interpretation of the results and the discussion of those. In case of disease or injury of any of the horses, that might influence the research results, this will be reported.

Each horse is observed for 15 minutes, three times a day, for five days in a row. Thus in total each horse was observed for 225 minutes, makes a total of 8.100 minutes (135h) for all horses together.

The behavior of each horse was quantified from direct observations. Data has been collected through the use of 15-min focal-animal samples (Altmann, 1974; Klaus, 2008). Observations were made at three time periods (Hausberger et al., 2006): 10:00 – 12:00; 14:00 – 16:00; 18:00 – 20:00 h EDT. These intervals were chosen as they were large enough to allow all members of the herd to be observed once within an interval (Boyd et al, 1988). The observation periods were spread over the day, because it is known that horses use different parts of their home range at different times of the day, moving between grazing sites and refuges from flies (Keiper and Berger, 1982; Pellegrini, 1971). These observations were carried out for 5 days in row for each herd.

The *focal sampling* technique is a method, in which the observer focuses on a single individual for a 15 minute period. The order in which the horses were observed has been chosen randomly prior to the observations and stayed the same throughout the 5 days, in which one herd was observed. The focal sampling has been chosen over the scan sampling method, because it allows a clearer picture of the horses´ behavior, whereas in the scan sampling method data might get lost (because it was only one observer and up to 12 horses). Further the focal sampling is "more reliable since the observer's focus is directed at only one animal" (Altmann, 1974; Houpt, 1991). Sometimes the behavior of two individual horses could be recorded at once, so the observation time of the individual horses can vary ±15min within the 2 hour period. The behavior (categorized in four clusters) shown by single horses of the herd, was documented in a log file (see Annex 5) together with the timeframe in which the behavior was shown. The time frame in which the horses showed a specific behavior was measured with the help of two stop watches, while the time frames were recorded in 30 second intervals. Hence a behavior that has been shown for less than 30 seconds was not recorded. For example walking in between feeding was often not recorded as travelling, but as feeding time. Nevertheless feeding, resting and locomotion typically occur in periods long enough to be captured by most techniques as stated by Ransom and Cade (2009). This was done, because the research did not aim to figure out an exact behavior pattern of horses, but rather to show in what ways a forest is used by the horses. Within the 2 hour observation, every 15 minutes another horse was observed. The focus of the observations has been on the four parameters Feeding, Resting, Traveling and Activity, because these are the most dominating ones in equine behavior (Boyd, 1998). All other behaviors of the horses such as "looking alert" were reported under comments, so that adulteration could be excluded. Other behaviors were shown rarely and had very limited influence on the time spend with one of the four parameters which were recorded.

Explanation of the four parameters, which were reported

The definitions for these parameters are all taken from the research paper ´Quantifying Equid Behaviour – A Research Ethogram for Free-Roaming Feral Horses´ by Ransom and Cade (2009).

Feeding

Feeding behavior usually entails grazing. Grazing occurs as a horse bites off and ingests grasses and forbs close to the ground. Feeding also includes browsing on woody plants and trees (Fig.2; Fig.3), eating snow, drinking, mineral licking, eating feces and pawing at food resources. Also horses move as they graze; therefore, as long as the horse is feeding while it is moving, it will be considered as feeding rather than traveling. There will be no distinction in between different kind of feeding, except for ´feeding of natural resources´ such as grass, leafs, water out of a river and "feeding fed food", which is feeding straw, hay, minerals or water from a drinking trough. This distinction has been made because several horses were fed straw in the forest, thus the time they spend in the forest feeding is not exclusively due to any natural behavior patterns. The times horses spend feeding "fed resources" were excluded, since they would adulterate the results of this research. Nevertheless they will be recorded separately.

Fig.2: horse at Fanyhof, feeding chopped branches

Fig.3: horse at Weideparadies, feeding beech leaves

Resting

Resting behavior is generally a lack of attention and a relaxed state. It may occur in a standing or laying position. This includes both relaxation and sleeping. Horses are able to sleep standing up due to the stay apparatus that allows their body to be supported without active muscular control (Dallaire, 1986). This behavior is typically observed as a body position with the head lowered, eyes closed, and one rear foot slightly elevated. Recumbent rest can be upright or lateral.

Traveling

This parameter includes walking, trotting, cantering, galloping and jumping used for moving from one place to another. The movements in between feeding will not be recorded as travelling, except the movement takes place for longer than 30 seconds. Moving while playing with another horse was also recorded as activity, not as travelling.

Activity

This parameter includes all kinds of social behavior of horses as well as comfort behavior. Comfort behavior takes on a wide variety of forms in feral horses and includes any type of self-enjoyment expression, such as play, investigation, and stimulation. Some examples of comfort behavior are sun-basking, shelter seeking, masturbation, sexual play, object play, locomotor play, play fighting, wallowing and some olfactory investigations. Further all social behavior will be recorded under activity. These are all interactions with other herd members such as grooming, harem social behavior, herding, and elimination with social implications, such as stallions creating fecal piles and repeatedly defecate on them (Ransom et al., 2009). Further also activities of the single horses are going to be recorded under activities such as bucking and wallowing.

All other activities are going to be written down under “comments”, so adulteration can be excluded.

The recording method is thus *continuous recording*, meaning all occurrences of behavior are going to be recorded in order to be able to measure the frequencies, durations and latencies of behavior patterns. Next to the documentation of the type of behavior and the timeframe it is shown in, the position of the horses during their individual observation period was written down at the beginning of their 15 minute observation period on their log files (see Annex 5). Further the current weather circumstances were written down in three different variables. The temperature was measured with a thermometer, in the beginning of each individual 15 minute observation period. Further it was recorded whether the sun was shining or it was cloudy and the third variable was whether it was windy or not. This should show how weather circumstances influence the horse´s position, since temperature has been shown to affect the time budget of domestic horses (Crowell-Davis, 1983) and their temporal use of habitat (King, 2002).

3.3. Data processing

A Kolmogorov – Smirnov test showed a not normal distribution for all data. Thus all data has been processed using non-parametric tests, such as the Kruskal Wallis test or robust parametric tests such as the one-way ANOVA, to find out whether there are significant differences in between the means of two or more groups. To show the results and get an idea of where the differences lie, mostly error bars have been drawn. The most crucial ones can be found in the results chapter. All others that were performed can be found in Annex 3.

Descriptive statistics have been done for all horses, that were involved in this research, together. The research questions on the other hand were answered by analyzing every herd single wise, in order to be able to interpret the results correctly and assign possible differences to the given circumstances of the particular pasture.

4.Results

4.1. Data is not normally distributed

In order to determine whether the data is normally distributed or not Kolmogorov – Smirnov tests have been made. The tests showed a not normal distribution for each of the variables (p=0,000) as can be seen in Table1 below.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Behaviour1fed	,484	540	,000	,470	540	,000
behaviour1naturalresources andwater	,244	540	,000	,816	540	,000
behaviour2	,306	540	,000	,760	540	,000
behaviour3	,315	540	,000	,708	540	,000
behaviour4	,434	540	,000	,498	540	,000
location.of.horse	,435	540	,000	,586	540	,000

Table 1: Kolmogorov Smirnov test for all behaviors and location

Thus, non parametric tests like the Kruskal Wallis test for ordinal variables like the location, and robust parametric tests like the one-way ANOVA (=analysis of variance) for scale data were used to compare means (Petrie and Watson, 2006). . Which test was chosen for which research question and variable is indicated in Annex 3 and 4, previous to the tables, showing the results.

4.2. Location of the horses

Each horse was observed for a total of 15 observation periods, thus for all 36 horses a total of 540 observations. Out of these 540 observation periods all horses together spent 171 observation periods (32%) in the forest and 369 observation periods (68%) on the pasture (see crosstab in Annex 3). In Fig.4 the herds were divided and you can see that groups spent in between 20 and 38 % of their time in the forest. The amount of time spent in the forest was thus not related to the size of the forest. The location of the forest in the third group, the stallions was most hidden, with a very limited view over the rest of the pasture and the gate to the pasture. This could be an indication for the fact that the location of the forest on the pasture is more crucial to the usage of the same, as the size and type of the forest.

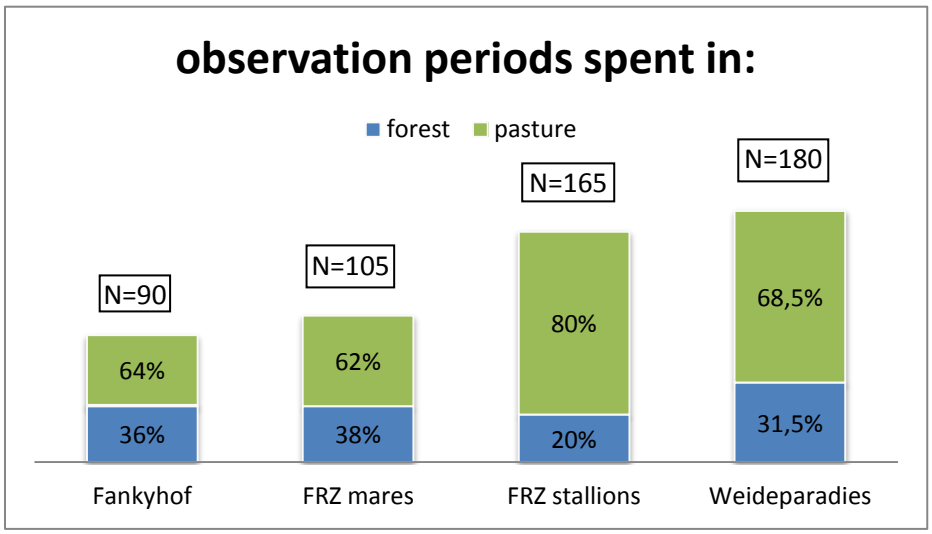

Fig.4: observation periods spent on the forest and on the pasture

4.2.1. Influencing factors for the location

Time of the day

For each location significant differences could be found in between the observation periods. Nevertheless these differences were found in between different observation periods, thus there seems to be no time of the day that is preferably spend in the forest. All herds spend the observation period from 2 – 4 pm preferably on the pasture. Three of the herds spend the evening (6 – 8 pm) preferably in the forest, while one of these herds (Weideparadies) was fed in the forest after this observation period. Thus it cannot be seen as a representative finding. At Fankyhof the horses spend two out of the three periods preferably in the forest, while this might be rather influenced by the cold weather and the straw and hay that was fed to them each morning, in the forest than by the time of the day. All Kruskal Wallis tests and bar charts for this factor can be found in Annex 3.

Weather circumstances

For the weather circumstances three different parameters were recorded: the temperature, whether it was sunny, cloudy or rainy as well as the wind. Since observations were only made while there was either no wind or only light wind, the wind parameter has not been analyzed any further. The influence of temperature and the influence of sun/rain on the location of the horses were analyzed. All tests can be found in Annex 3.

Significant differences regarding the temperature could only be found in the herd of the Fankyhof and the stallions from the FRZ Muldental. The temperatures of the observation periods at Fankyhof and the FRZ Muldental differed quite a lot. The horses at Fankyhof spent preferably (p=0,001) time in the forest if it was colder than 5,5°C (Fig.5) and the stallions of the FRZ Muldental spend preferably (p=0,01) time in the forest when it was warmer than 11°C (Fig.6).

Fig.5: Fankyhof – temperature box plot

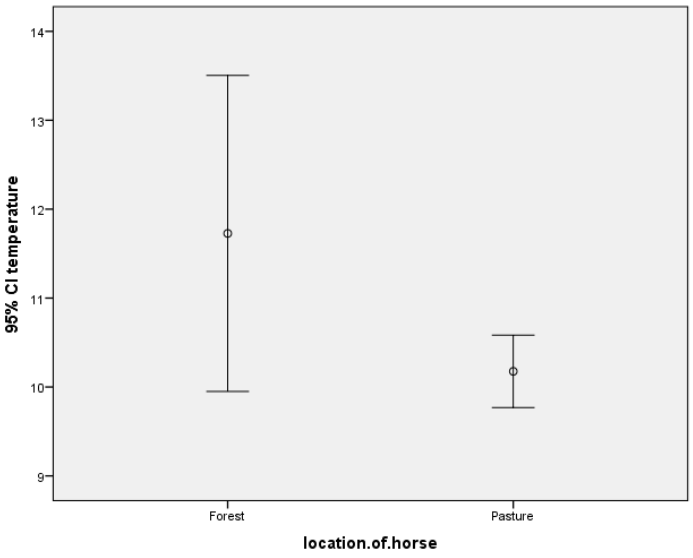

Fig.6: FRZ stallions – temperature box plot

Looking at the sun and rain factor, the only herd without significant differences was Fankyhof. All other groups spent sunny and rainy weather preferably ($p<0,05$) in the forest. Cloudy weather was preferably spent on the pasture.

As an example see the error bar in Fig.7 below, showing the significant differences for the stallions group at FRZ Muldental. All other tests and graphs can be seen in Annex 3.

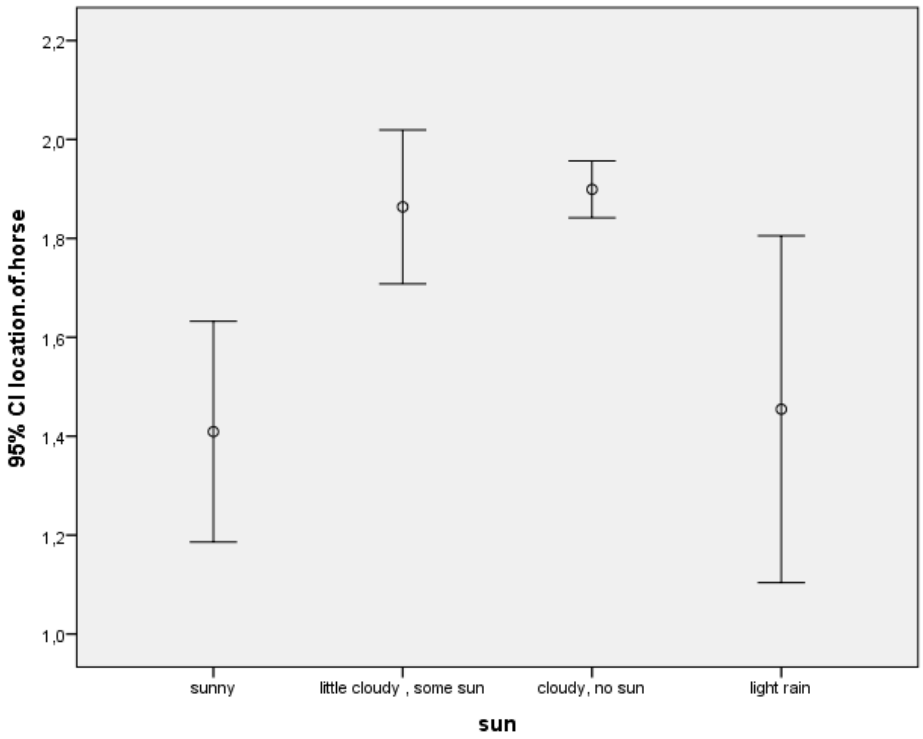

Fig. 7: FRZ stallions – sun/rain box plot

4.3. Behavior shown in minutes

All horses together have been observed for 8.100 minutes, thus 135 hours. Figure 8 below shows how the horses spent these minutes per location. The graph clearly shows that the forest was used for all recorded activities. For ´travelling´ and ´feeding fed resources´ there is almost no difference in between the time the horses spent in the forest and on the pasture. For ´feeding natural resources´ and ´activities´ the pasture was significantly more used (p=0,05) than the forest. The differences for these three types of behavior have been tested for each single herd with a Kruskal Wallis test. The tests and error bars can be found in Annex 4, for each of the three behaviors (feeding fed resources; resting; activity).

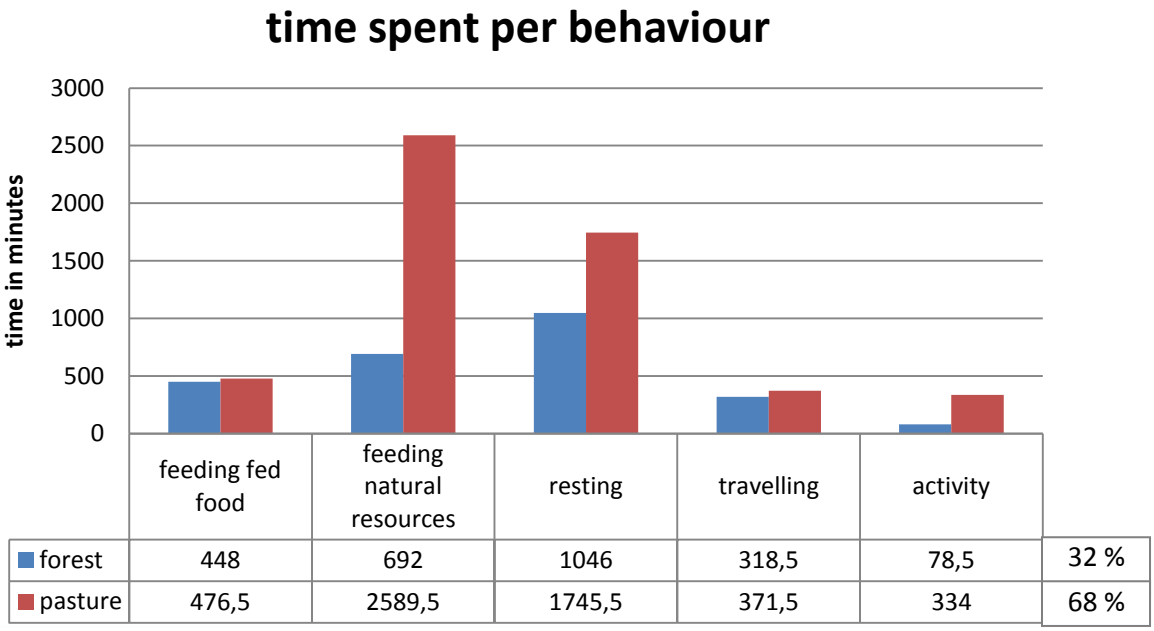

Fig. 8 behaviors shown per minute

The feeding time that was spent feeding hay/straw or concentrates was excluded. After excluding these times all horses together spent 2.135 minutes out of 7.175,5 minutes in the forest, thus more than a quarter of the observed time.

4.3.1. Resting in the forest

Almost 50% of the time that was spent in the forest was spent resting, as can be seen in the pie chart in Annex 4. For the Fankyhof and both herds from the FRZ Muldental significant differences ($p<0,05$) could be found, showing that the horses spent their resting periods mostly in the forest. Nonetheless for the Weideparadies a significant difference was found, showing the opposite. This might be due to the fact that the horses are fed in the forest every evening and travel through it on the search for food rather than using it as a shelter. Further a shelter for the horses of the Weideparadies is on their pasture, next to a gate, leading to another part of grassland.

4.3.2. Feeding natural resources in the forest

Another 33% of the time that was spent in the forest has been spent feeding natural resources. In Fig. 8 above one can see the relation of the time spent for ´feeding natural resources´ on the pasture and in the forest. Natural resources were fed to 80% from the pasture and for 20 % from the forest. All one way ANOVA tests and error bars can be found in Annex 4.

4.3.3. Travelling and activities in the forest

Time spent for travelling and activities was rather limited, but these behaviors have been performed in the forest as well.

For the behavior that was recorded under ´activities´ twice a significant difference ($p<0,05$) could be found. The horses of Fankyhof showed activities significantly more often in the forest than on the pasture. And the stallions of the FRZ Muldental spent significantly more time with activites on the pasture than in the forest, while most of their activities were playing with another stallion as well as chasing and fighting with each other.

5. Discussion

The results of this study showed that the horses spent more than a quarter of the observed time (excluding times in which they were fed; Fig.8) in the forest and used it for either feeding from natural resources (like leafs, branches or tree trunks), resting in it (mostly standing), travelling through it and occasionally also for any activities (for example playing with other horses, grooming each other or wallowing). Thus by far more time was spent on the pasture than in the forest, as expected, even though the abundance of forest was on two out of four pastures more than the abundance of meadows. In the cases in which the forest covered more space than the pasture it could be concluded that the horses use the forest, because of the limited abundance of pasture. But this study gave proof that the forest was used, no matter which size the part of forest has had. The only activity that was in three cases significantly more often shown in the forest than on the pasture was resting. While the group that rested mostly on the pasture was at Weideparadies. In this case a shelter was provided on the pasture, where the horses often rested. So does this mean now, that horses only need a large enough shelter as protection from sun, rain and biting flies? Or isn´t a forest rather an important part of their habitat, used in multiple ways and especially during colder seasons, even though it is by far less used than meadows or other grassland?

In a report published by the federal office for nature reservation in Bonn, about the woodland pasture management with horses and cattle in Germany, it is explicit mentioned that the importance of a part of habitat should not only be judged by the amount of time the animals spend in it (Gerken et al., 2008).
Unfortunately several previous research studies on feral and wild horses, for example in Wyoming and in a nature reserve (Baronie Cranendonck) in the Netherlands, were interpreted that way. The results they found showed that parts of forest within the researched area stayed underexploited and the horses did apparently not select the forest for foraging (Crane et al, 1997; Kuiters et al., 2003). Out of these findings it has been concluded that horses do not need the forest to show any species specific behavior. On the other hand there are numerous research studies conducted in nature reserves in the Netherlands and Germany approving the findings of the present research, that horses do use the forest in manifold ways (Gerken et al. 2008).

5.1. Forest as shelter

The influence of season has not been part of this research, but previous studies proved that horses do use the forest during autumn and winter intensively (Putman, 1986; Putman et al., 1987; Gordon, 1989). The only herd in this research, that was still observed during the end of winter also showed a relatively high amount of time spent in the forest (two out of three observation periods were more often spent in the forest than on the pasture). This could well be due to differences in temperature, however the differences were only statistically significant for two out of the four herds, and the population is too little to draw conclusions on this finding. Nonetheless this tendency is supported by further research findings of previous studies on feral ponies in a nature reserve in Southern England, declaring that there is a clear selection for shelter in the woodlands in the winter and to some extent at night throughout the year (Pratt el al., 1986).

This choice is partially also influenced by other weather circumstances like rain, sun or wind, as has been proven by this and previous studies. Wind, while not statistically analyzed in this research, has already been proven to be a significant factor for the Camargue horses to choose for a forest as habitat. This impact was possibly rather due to a decreased attack of biting flies (Duncan, 1983), than due to the wind itself. Another factor that could be linked to the biting flies as well is the sun. This could also be seen in herds of Takhis which were reintroduced into the Hutsai National Park in Mongolia. The ranges of each of the harems included a patch of forest that was used in the summer (King, 2002; King et al., 2004). These findings affirm the present research, showing that horses tend to spend sunny times rather in the forest than on the pastures, as well as rainy times. Therefore it can be concluded that horses do use the forest as refuge from biting flies, heat and the wind (Keiper et al., 1982). From reintroductions of feral horses into wildlife reserves it is also known that horses tend to use the forest to hide in it, as security of predators. E.g. the feral Sorraia horses of Oelke ran directly into the forests after their release into a nature reserve and hid for over a week (Vanselow, 2005). Thus by far not all artificial shelters that can be found on nowadays pastures can compensate these needs, and there are several more benefits horses gain out of a forest.

5.2. Forest for comfort behavior and social activities

Even though there was only one herd showing more ´activities´, including grooming in the forest than on the pasture, it could be observed that in each forest several trees were obviously preferably used for grooming (Fig.9). For other activities there seem to be no preference towards the forest or the pasture, and the stallions were even playing more likely on the pasture than in the forest, while this could also be due to the fact that their forest was in the back of the pasture and to have an overview over the pasture and towards the entrance, the stallions had to stand on the meadows.

Fig. 9: Fankyhof - tree used for grooming

Fig.10: FRZ stallions – horse grooming itself

Thus besides the grooming on trees (Fig.10), there seems to be no reason for horses to choose for the forest rather than the pasture, for any activity. This was also concluded by Duncan, who studied the feral horses in the Camargue. The research findings of the present research are in line with his statement, that social behavior has no effect on the horse´s selection of habitat (Duncan, 1983).

5.3. Forest as feeding source / browsing damage

Vanselow (2009) explains in her book ´Pferdeweiden – Weidelandschaft´, that nobody is in doubt about the fact that a too intensive use of the woodland pastures with cattle and horses was the reason for the intense damage of the woods and the prevention of their rejuvenation. On account of this woodland pastures were forbidden in several parts of Germany, with some exceptions for nature reserves (Vanselow, 2005). In these landscape management projects, with a minor stocking rate, markedly positive experiences were made (Rüther et al., 2002; Sieling, 2002). Meaning severe browsing damages appear rarely and the horses and cattle even create through the light browsing damages a unique living environment for several types of plants and animals which otherwise wouldn´t have a chance to survive. In the present study it was revealed that the horses spent one quarter of the observed time in the forest, while the time of the day and of the observation period seem to have no influence on the choice for habitat. A remarkable portion of this quarter (33%) was spent feeding natural resources such as leafs, young trees (especially beech trees), moss and lichenics. In each of the forests numerous light browsing damages (Fig.11 &12) could be observed, while only in very few cases full grown trees were affected. The majority of these browsing damages did not affect the trees themselves, but could become a problem in working forests, in case the wood shall be sold. Thus in these cases the management of the animals and the forest is even more important (e.g. fencing of young trees). Any grown trees with a trunk diameter of approximately 5 cm or more as well as coniferous trees were mostly not affected at all.

Fig.11 Moss, cropped from the trees

Fig.12 Lichenics cropped from the trees

Duncan ignored the tree and shrub layer as food source, in his study on the Camargue horses, because he agreed with previous research stating that horses obtain almost all of their food from the herb layer (Skeleton, 1978). This stands in contrast with the findings of this research that horses do use the forest for feeding (Fig. 13) and with the findings of the present research of browsing damage by horses (Fig.11,12). Especially the food sources that can be found in a forest might be crucial to a horses diet and therefore the actual time they spent feeding in a certain habitat should not be overestimated (Gerken et al., 2008). The research on the Icelandic horses in a nature reserve in the Netherlands also showed that horses use woodland vegetation mostly over autumn and winter months (Kuiters et al., 2003), which might be an indicator, not only for the fact that there are less food sources on the meadows, but also for the need of certain minerals.

5.4. Forest for impulse diversity – physically and cognitive

All horses in this study were noticeable relaxed and even-tempered. Whether this is rather to the fact that the horses are kept in groups, that they stay on the pasture 24/7 or due to the forest itself is questionable. But still, the forest played a huge part in keeping the horses busy. This was especially the case with feeding and comfort behavior. During the observation period it was several times observed, that horses did not only feed leafs and branches from a height they could reach, but also figured out ways to reach leafs at the top of the young trees, as can be seen in Figure 13 below. They pushed the young trunks down, either with their chest or with their neck to reach the upper parts of the trees. Also the (in comparison to the pasture) low density of food, which is taken in with one bite, and the movement in between these bites is actually more species appropriate for the horses than the feeding on green grassland.

The forest can also be a possibility to increase impulses in the horses´ environment. First of all physically, for the horses´ hoof quality but also to make the horses more sure-footed, due to the uneven ground. And on the other hand also on a cognitive level, because with a forest a diverse input of impulses is ensured, like Grauvogel already suggested in his study in 1993.

Fig.13 Icelandic, pushing down a young beech tree with its´ chest

6. Conclusion and recommendations

The present research study shows proof that the fact that horses use forests in manifold ways is neither depending on the size and type of the forest nor is it depending on the breed, age or gender of the horse. All groups used the forest for all four recorded activities (feeding, resting, travelling, activity), even when the abundance of forest was less than the abundance of pasture, as in two cases. The fact that the horses used most of their time in the forest for resting, even if a shelter was offered on the pasture or in the forest, clearly shows that the horses feel comfortable and protected in a forest. Further it could be proved that the weather, thus temperature and sun has an influence on the choice of habitat by horses, since the horses used the forest mainly in cold and warmer weather and during sunshine or rain. The time of the day on the other hand seems to have no influence. The horses used the forest in all observation periods. Out of 8100 minutes observation time 692 minutes were used to feed natural resources in the forest. Thus further investigation is needed to find out what exactly the horses are feeding and weather these resources might be even necessary for a balanced diet of the horses. Nonetheless rarely severe browsing damages were seen (2 trees in all forests together) and looking at the density of the food resources, a forest can be considered even more species appropriate for feeding horses than a pasture would be, because the horses have to move in between the bites and they are longer busy to reach the same amount of intake than on green grassland. So this study goes one step further than previous research, saying that keeping horses on pastures fits their demands best (Frentzen, 1994). Looking at previous wildlife research and the results of the present research it get´s clear that the claim of nature reserves like the Hutewald in Solling-Vogler, to allow forests on horse pastures (Gerken et al.,2009) also for private horse owners is reasonable and even necessary.

Nonetheless due to the relatively small sample of this research it is not yet representative enough, hence further research should be done, especially on night time activities in the forest, since this research only covered 6 hours of daytime activity. Since this research made clear that the activities the horses perform in the forest are more important than the time they actually spent in it, further research data should also be collected via direct observations. Further research should also investigate what exactly it is that the horses feed in the forest, whether they could get these nutrients from other resources as well, or if the forest can even avoid malnutrition. What should be beard in mind as well is the low stocking rate in which horses do not do any severe damage to the forest. Stocking rates as in nature reserves are not possible for sport and leisure horses, since the horses need to be stabled on a manageable pasture, keeping economical factors in mind. But the present research showed that horses with relatively small space also don´t damage trees to an extend that it would be a threat to the forest. Even though the parts of forest were in two – three cases relatively small, the horses did not destroy any parts of the forest. Nevertheless the density of horses that can be kept per ha forest should be further researched as well.

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- Marita and Hartmut of the Freizeitreitzentrum Muldental
- Sonja and Inge of the Weideparadies

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List of figures and tables

TABLES

FIGURES

Figures in Annex:

Annex 1 – aerial photos of pastures

landscape pictures of pastures; source: Google Earth Planimeter

Pasture 1 – Fankyhof Nuremberg

Pasture and forest in total, approximately 1.177 hectare

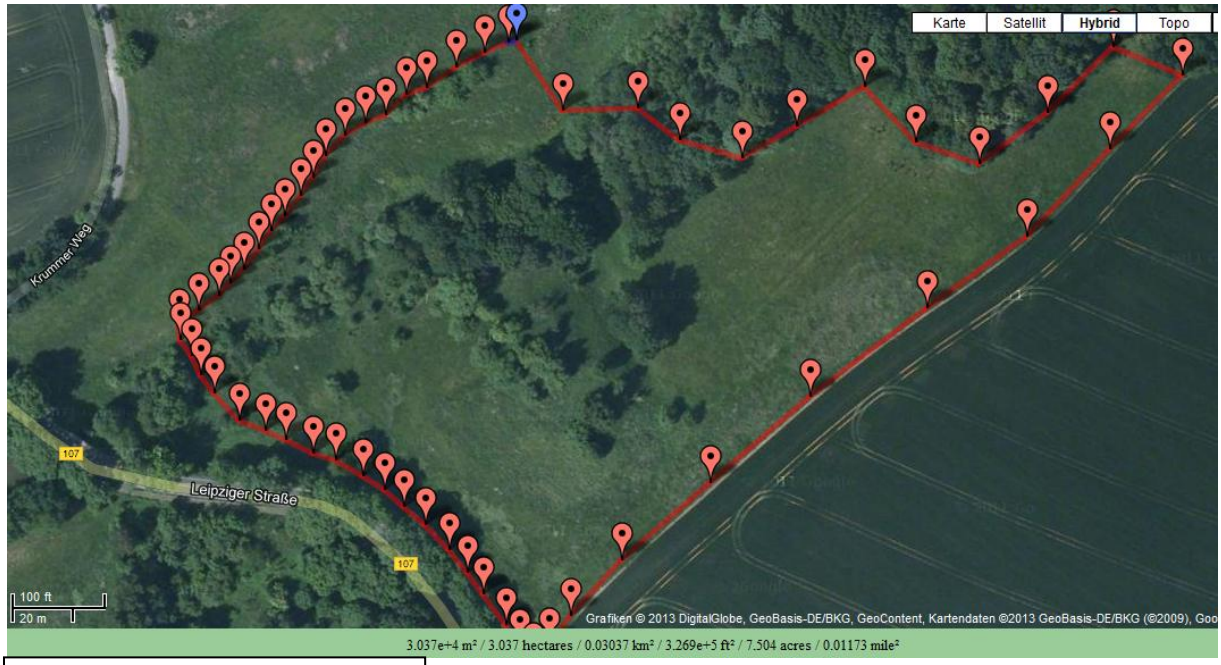
Picture 1: pasture Fankyhof

Only the forest measures around 0.8 hectare:

Picture 2: forest Fankyhof

Pasture 2 – FRZ Muldental Leipzig

Pasture and forest in total, little more than 3 hectare



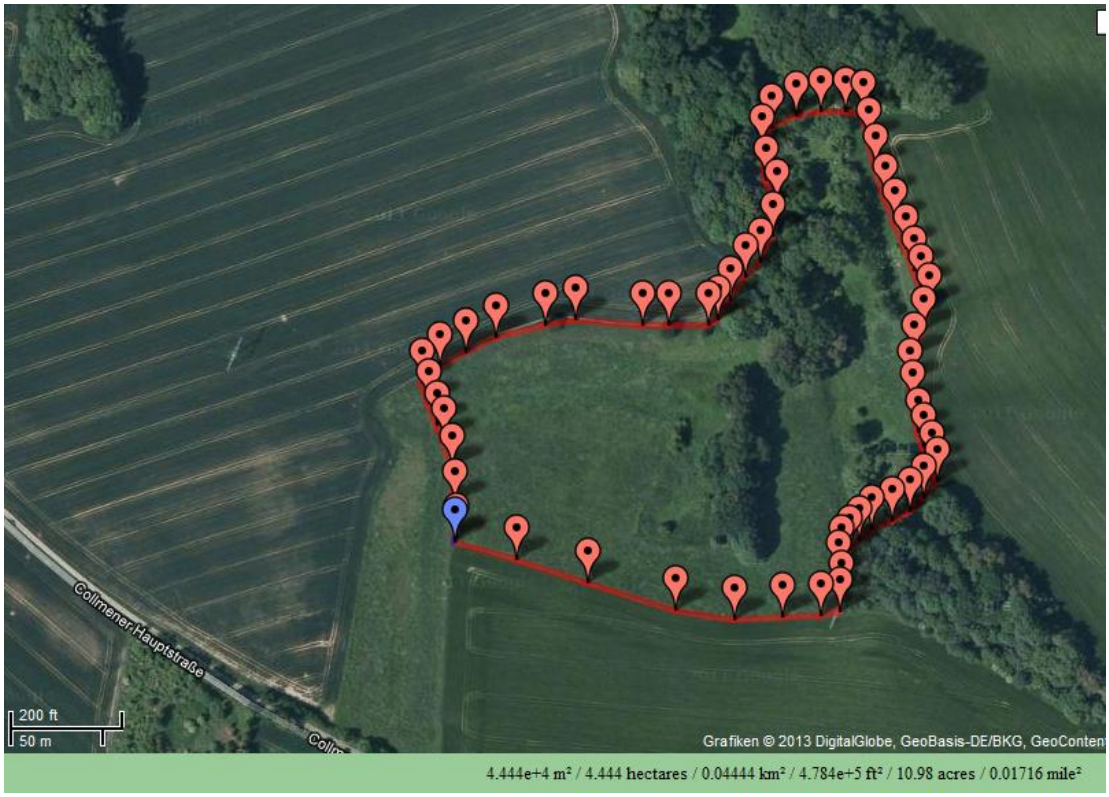
Picture 3: mare pasture FRZ Muldental

Only the forest measures around 0.7 hectare

Picture 4: mare forest FRZ Muldental

Pasture 3 – FRZ Muldental Leipzig

Pasture and forest in total, 4.444 hectare



Picture 5: stallion pasture FRZ Muldental

Only the forest measures around 1.2 hectare

Picture 6: stallion pasture FRZ Muldental

Pasture 4 – Weideparadies Haunetal

Pasture and forest in total measure approximately 5.467 hectare

Picture 7: pasture Weideparadies

Only the forest measures round about 4.5 hectare

Picture 8: forest Weideparadies

Annex 2 – Information on the single stables / horses

Zu 3.1. Additional information to Research Methodology

Information about the single stables, their horses and pastures.

Stable	Horses	Breeds	Utilization of horses	Forest and pasture	Type of forest	Observation period	Comments
1. Fankyhof, Nuremberg	5 mares, 1 gelding	New Forest pony, Haflinger horse, Dutch Riding pony, Shetland ponies	Riding lessons, trail rides; approximately 2 hours per horse per day	0,4 ha pasture and **0,8 ha forest**	mixed forest; spruces, and different deciduous trees (beech, birch, maple, poplar, etc.)	31.3.– 6.4.'13	Horses stood on this pasture the whole wintertime through; they are fed straw in the forest, also the water tank is in the forest
2. Weideparadies Haunetal	7 mares, 5 geldings	Fjord horse, Islandic, Haflinger Crossbred, Arabian, Fellpony, donkey, thoroughbred Crossbreds, German Riding Pony	Horses are not used at all	1 ha paddocks and pasture and **4,5 ha forest**	mixed forest; mainly spruces and beeches; some birches, and other deciduous trees	11.5.– 16.5.'13	The horses are not used at all; Feeding management consists of hay, spread over the paddock in the morning and spread in the forest over night
3. FRZ Muldental, Leipzig	7 mares	Warmblood, Arabians	Some of them already broken in; but not used during observation period	2,3 ha pasture and **0,7 ha forest**	deciduous trees and some fruit trees	23.4– 27.4.'13	Horses were only pastured on this part for the five days of observation; Horses are not fed additionally
4. FRZ Muldental, Leipzig	11 stallions	Warmblood, Arabians, thoroughbreds	Riding lessons, ~1hour per day	3,2 ha pasture and **1,2 ha forest**	deciduous trees; mainly beeches and birches	28.4.– 2.5.'13	Horses were only pastured on this part for the five days of observation; horses are not fed additionally, except for those going in the riding lessons
Total	**36 horses**			Between 1–5,5 ha (forest: 0,8 -4,5 ha)		**30.3.– 2.5.'13**	

Table 2 information on stables/horses/pastures

In the following pie-graph one can see the amount of horses (and one donkey) per breed:

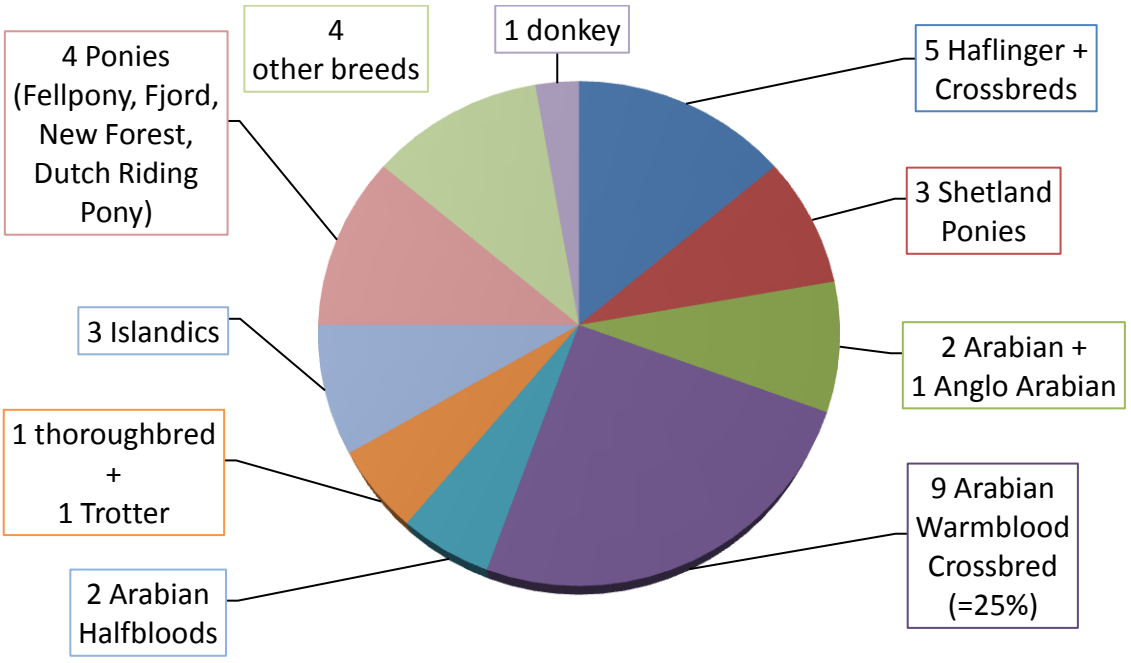


Fig 14: horse breeds

Annex 3 – Tests and graphs for location of the horses

Results

Zu 4.2. Location of all horses (in the 540 observation periods) divided into the three periods:

		location.of.horse		Total
		Forest	Pasture	
observation period	10 - 12	44	136	**180**
	2 - 4	41	139	**180**
	6 - 8	86	94	**180**
Total		**171**	**369**	**540**

Table 3 location of all horses per observation period

Zu 4.2.1. Influencing factors for the location

Time of the day - Sub question 1

Do horses spend certain times of the day preferably in the forest?

H0 = There is a significant difference of location in between the observation periods.

H1= There is no significant difference of location in between the observation periods.

Because the data is not normally distributed and the three categories (observation periods) are an ordinal variable, a Kruskal Wallis test was made to find out whether there are significant differences regarding the location of the horses in between the three observation periods. All tests are attached to this report in Annex 3.

Fankyhof - Kruskal Wallis test showed significant differences in between observation periods regarding the horse´s location. In the graph one can see that the first and third observation period was significantly more often spent in the forest than the second one.

Ranks

	observ.period	N	Mean Rank
location.of.horse	10 - 12	30	41,50
	2 - 4	30	**56,50**
	6 - 8	30	38,50
	Total	90	

Test Statistics[a,b]

	location.of.horse
Chi-Square	11,036
df	2
Asymp. Sig.	**,004**

Table 4 Kruskal Wallis for observation periods Fankyhof

In the error bar one can see that the horses of Fankyhof spent the first and the third observation period more often in the forest than the second one.

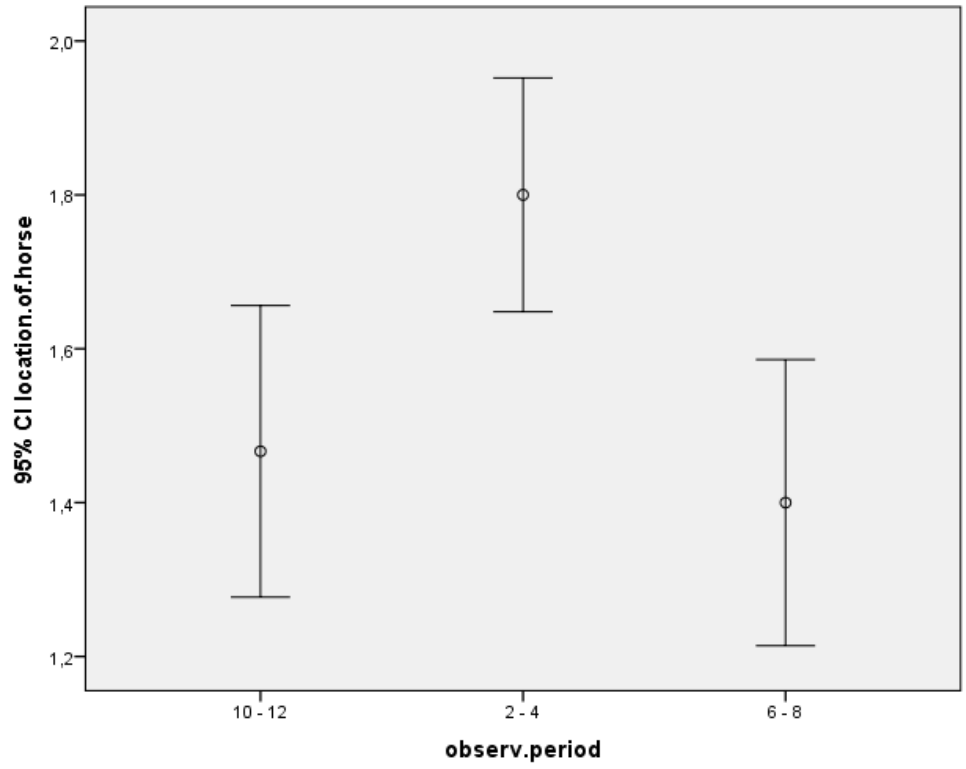


Fig. 15 Error bar Fankyhof – observation periods

FRZ Muldental mares - Kruskal Wallis test showed significant differences in between observation periods regarding the horse´s location. In the graph one can see that the first observation period was significantly more often spent in the forest than the second and third one one.

Ranks

	observ.period	N	Mean Rank
location.of.horse	10 - 12	35	40,00
	2 - 4	35	56,50
	6 - 8	35	62,50
	Total	105	

Test Statistics[a,b]

	location.of.horse
Chi-Square	14,480
df	2
Asymp. Sig.	,001

Table 5 Kruskal Wallis for observation periods FRZ mares

In the error bar one can see that the horses of Fankyhof spent the first and the third observation period more often in the forest than the second one.

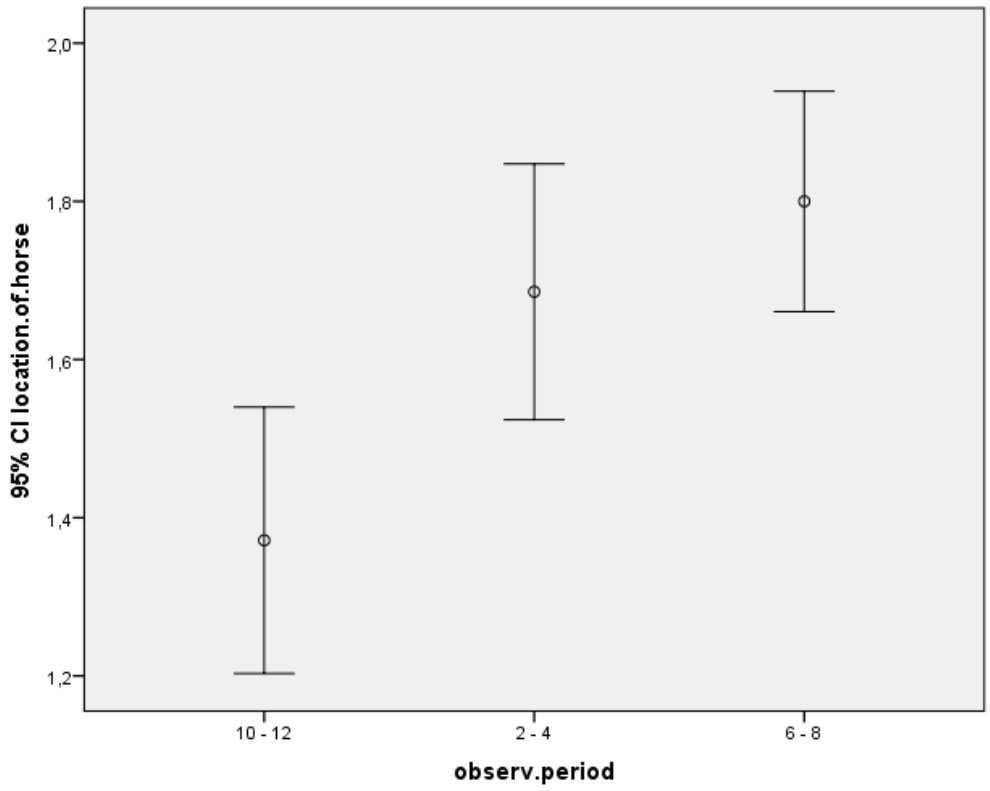


Fig 16 Error bar FRZ mares observation periods

FRZ Muldental stallions - Kruskal Wallis test showed significant differences in between observation periods regarding the horse´s location. In the graph one can see that the first observation period was significantly less often spent in the forest than the second and third one one.

Ranks

	observ.period	N	Mean Rank
location.of.horse	10 - 12	55	94,00
	2 - 4	55	82,00
	6 - 8	55	73,00
	Total	165	

Test Statistics[a,b]

	location.of.horse
Chi-Square	10,899
df	2
Asymp. Sig.	,004

Table 6: Kruskal Wallis for observation periods FRZ stallions

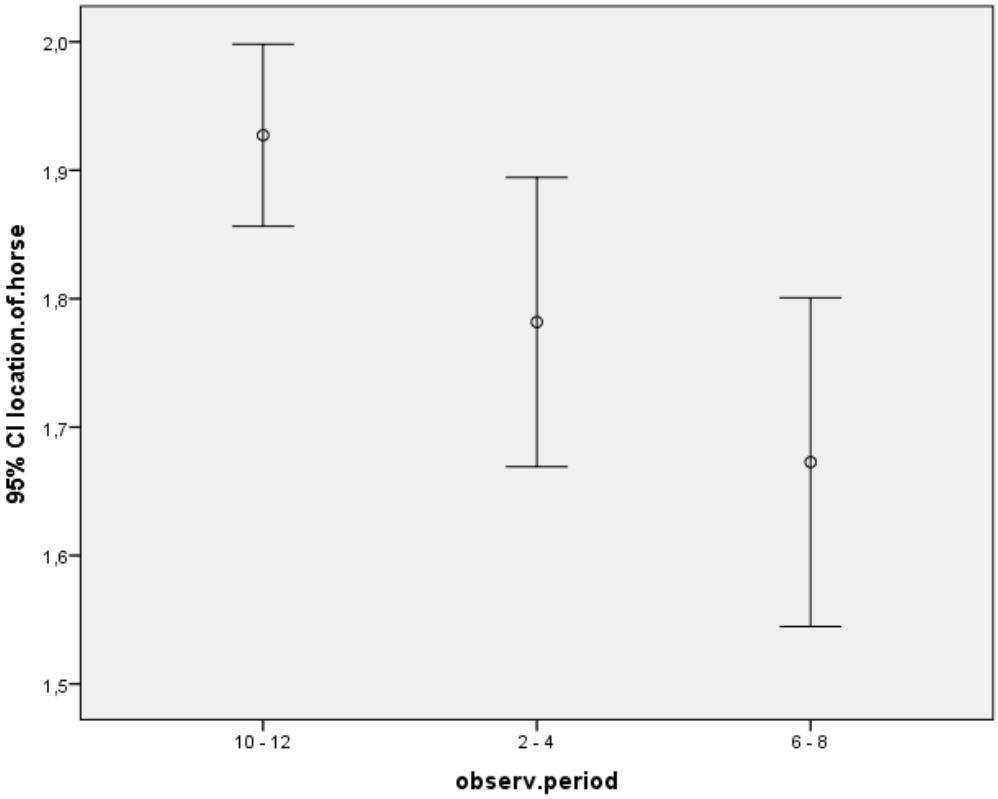


Fig 17: Error bar FRZ stallions observation periods

Weideparadies - Kruskal Wallis test showed significant differences in between observation periods regarding the horse´s location. In the graph one can see that the third observation period was significantly more often spent in the forest than the second and third one.

Ranks

	observ.period	N	Mean Rank
location.of.horse	10 - 12	60	116,00
	2 - 4	60	101,00
	6 - 8	60	54,50
	Total	180	

Test Statistics[a,b]

	location.of.horse
Chi-Square	70,007
df	2
Asymp. Sig.	,000

Table 7: Kruskal Wallis for observation periods Weideparadies

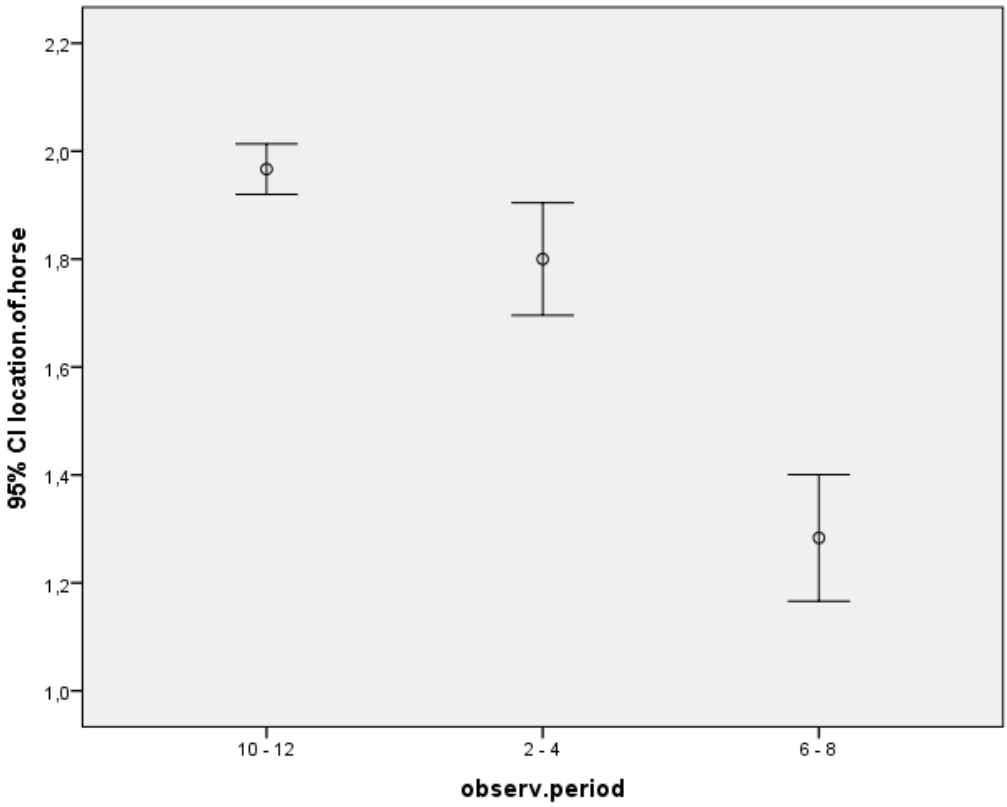


Fig 18 Error bar Weideparadies observation periods

Weather circumstances – Subquestion 2

Do horses use the forest in certain weather circumstances like wind hot sun or rain?

H0= There is a significant difference in between the weather circumstances, regarding the location of the horses.

H1= There is no significant difference in between the weather circumstances, regarding the location of the horses.

Temperature

To find out whether the temperature has a significant influence on the location of the horses a one-way ANOVA was carried out, even though the data is not normally distributed. This can be done because the one way ANOVA is a robust test among the parametric ones and because temperature is a ratio variable, and there were more than 2 groups to compare.

Sunny/rainy

To find out whether sun and rain have an influence on the location of the horse a Kruskal Wallis test was used, since this was an ordinal variable.

Temperature

Stable 1 – Fankyhof

For the horses at Fankyhof, the one way ANOVA test showed a significant difference (p=0,001) in between the locations, depending on the temperature.

ANOVA

temperature

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	179,454	1	179,454	12,280	,001
Within Groups	1271,355	87	14,613		
Total	1450,809	88			

Table 8 one way ANOVA for temperature Fankyhof

The error bar below indicates that the horses spent most time in the forest, when it was colder than 5,5°C. And they spent most time on the pasture when it was warmer than 5,5°C.

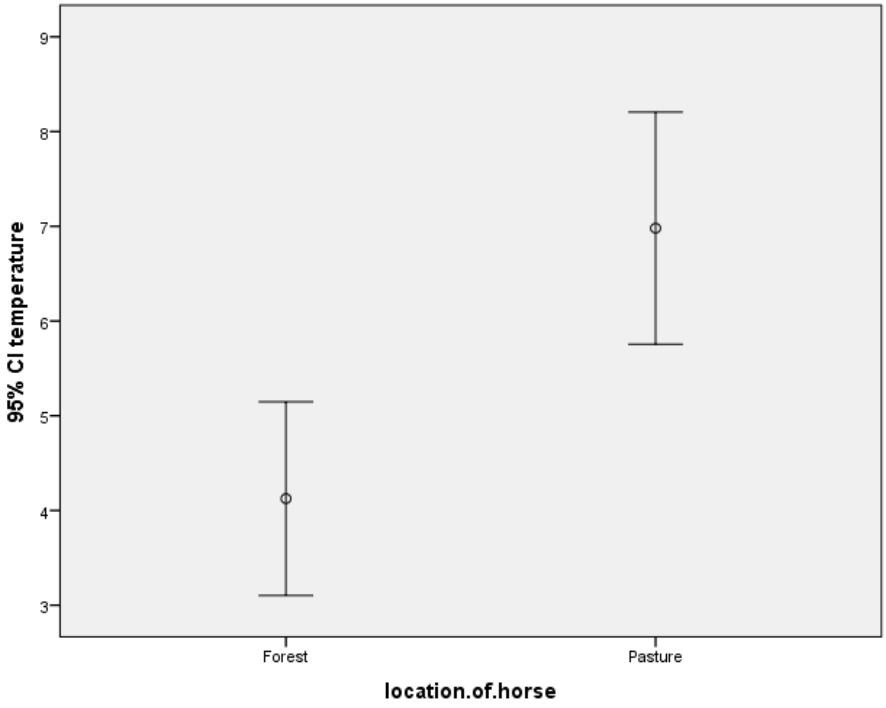


Fig 19 Error bar Fankyhof temperature

Stable 2 – FRZ Muldental MARES

For the mares **no** significant difference could be found.

The one way ANOVA test and an error bar to this test can be seen in Annex 3.

Stable 3 - FRZ Muldental – STALLIONS

According to the one way ANOVA there is a significant difference (p=0,01) in the location of the stallion herd of the FRZ Muldental, looking at the temperature.

ANOVA

temperature

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	63,468	1	63,468	6,731	,010
Within Groups	1527,507	162	9,429		
Total	1590,976	163			

Table 9 one way ANOVA for temperature FRZ stallions

In the following graph it is shown that the stallions spend significantly more time on the pasture, when it was colder (from 10°C upwards) and had a much broader range of temperature when spending time in the forest.

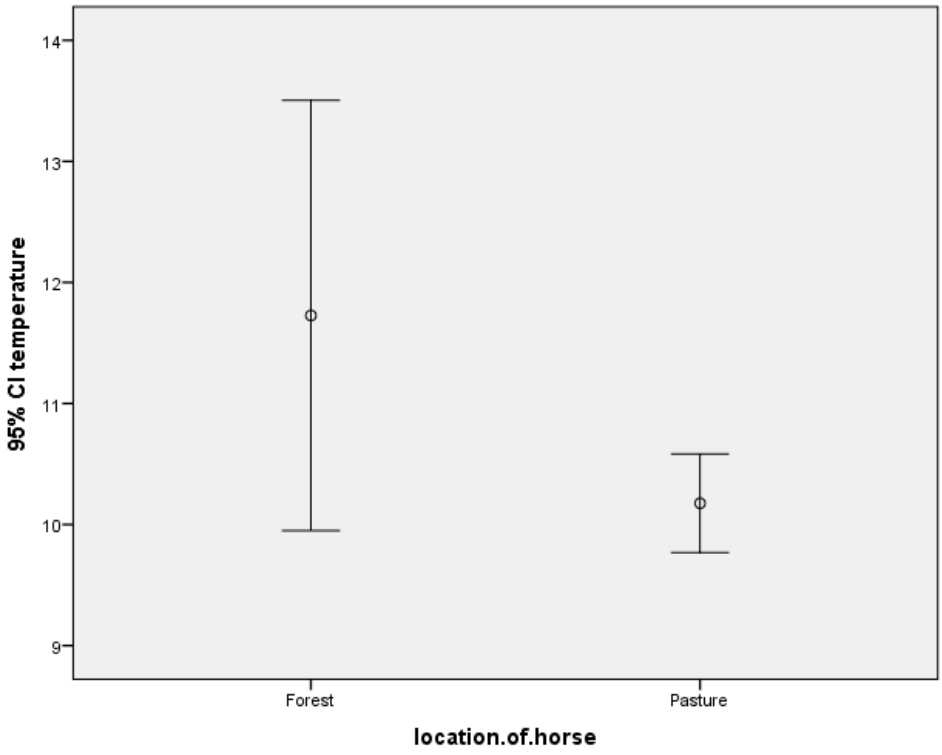


Fig 20: Error bar FRZ Stallions temperature

Stable 4 – Weideparadies

The one way ANOVA showed **no** significant difference (p=0,07) for the temperature at Weideparadies.

Sun/Rain

Stable 1 – Fankyhof

The Kruskal Wallis test showed **no** significant difference for the horses of the Fankyhof

Stable 2 – FRZ Muldental MARES

The Kruskal Wallis test showed a significant difference for the mares of the FRZ Muldental

Ranks

	Sun	N	Mean Rank
location.of.horse	Sunny	70	51,25
	little cloudy , some sun	14	73,00
	cloudy, no sun	7	50,50
	light rain	14	43,00
	Total	105	

Test Statistics[a,b]

	location.of.horse
Chi-Square	11,060
df	3
Asymp. Sig.	,011

Table 10: Kruskal Wallis for sun/rain FRZ mares

In the error bar below it can be seen that the mares of FRZ Muldental spend rather time in the forest when the weather was cloudy or it even rained lightly.

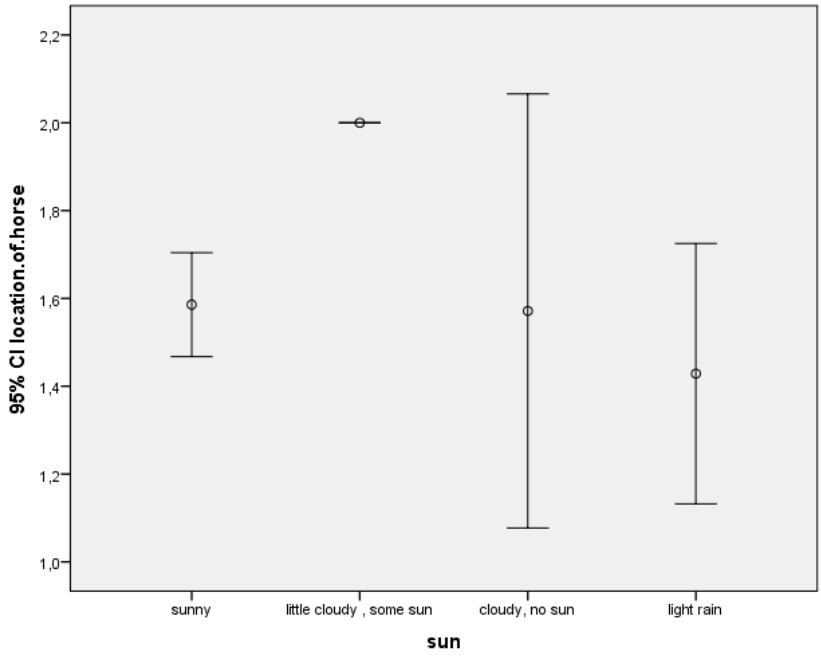


Fig 21. Error bar FRZ mares sun/rain

Stable 3 –FRZ Muldental STALLIONS

The Kruskal Wallis test showed a significant difference for the stallions of the FRZ Muldental

Ranks

	Sun	N	Mean Rank
location.of.horse	Sunny	22	50,55
	little cloudy , some sun	22	87,82
	cloudy, no sun	109	90,72
	light rain	11	54,27
	Total	164	

Test Statistics[a,b]

	location.of.horse
Chi-Square	36,072
df	3
Asymp. Sig.	,000

Table 11Kruskal Wallis for sun/rain FRZ stallions

Stable 4 – Weideparadies

The Kruskal Wallis test showed a significant difference for the horses of the Weideparadies.

Ranks

	Sun	N	Mean Rank
location.of.horse	Sunny	60	73,80
	little cloudy , some sun	24	109,50
	cloudy, no sun	48	90,25
	light rain	36	78,00
	Total	168	

Test Statistics[a,b]

	location.of.horse
Chi-Square	15,697
df	3
Asymp. Sig.	,001

Table 12 Kruskal Wallis for sun/rain Weideparadies

The horses of the Weideparadies spent as well especially time in the forest during sunny weather or during light rain.

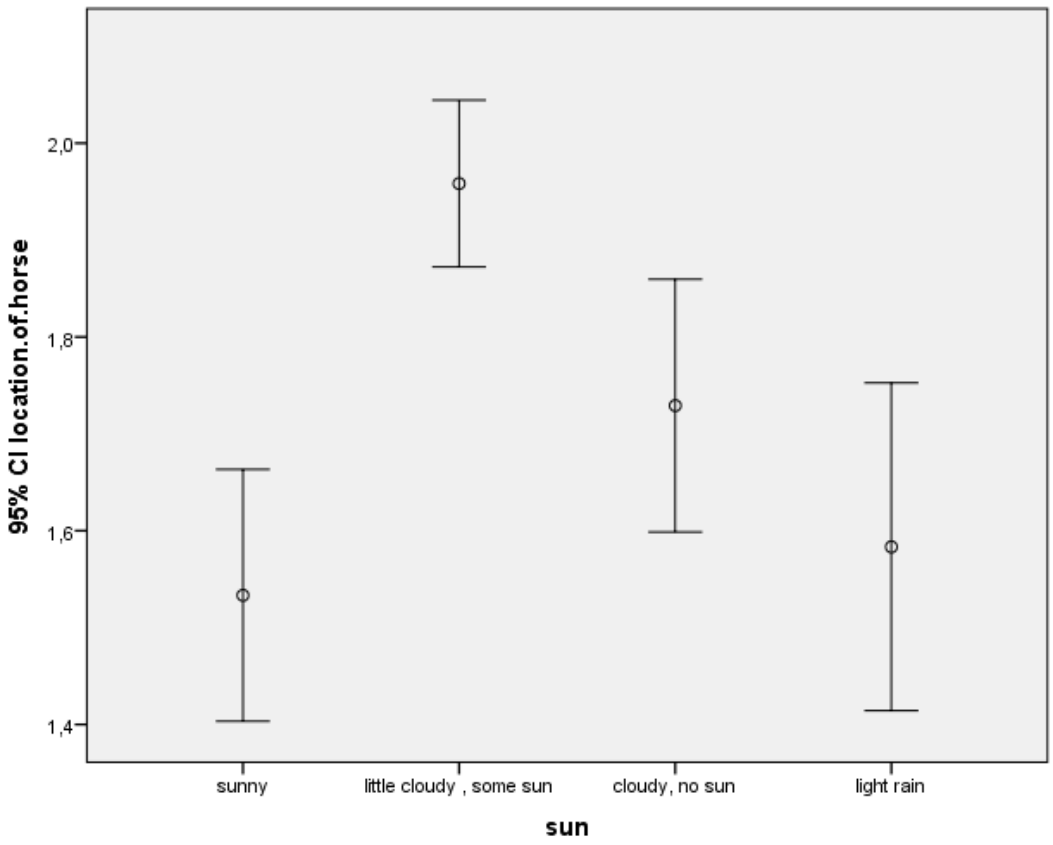


Fig. 22 Error bar Weideparadies sun/rain

Annex 4 – Tests and graphs for behavior of the horses

Zu 4.3. Behavior shown in the forest

Behaviors shown in minutes - Sub question 3

Which behavior do horses show in and around the forest?

Behaviour	feeding	resting	travelling	Activity
Time shown (min)	692 min	1046 min	318,5 min	78,5 min

Table 13 time spent in forest divided into behaviors, excluding "feeding fed resources"

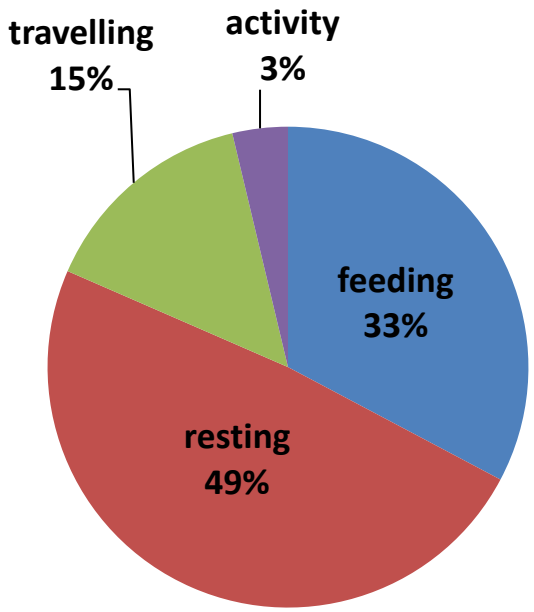


Fig 23 time spent in the forest, divided into behaviors

Zu 4.3.2. Feeding natural resources in the forest

Feeding natural resources - Sub question 4

Do horses use the forest for feeding natural resources significantly more or less than they do use the pasture?

H0 = There is a significant difference in between the time horses spend feeding natural resources in the forest and the time horses spend feeding natural resources on the pasture.

H1= There is no significant difference in between the time horses spend feeding natural resources in the forest and the time horses spend feeding natural resources on the pasture.

Since the time spent for feeding natural resources is scale data the one way ANOVA analysis was carried out.

Stable 1 – Fankyhof

The one way ANOVA test showed a significant difference (p=0,000) in between time spend for feeding natural resources in the forest and time spend for feeding natural resources on the pasture.

ANOVA

behaviour1naturalresourcesandwater

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1392,236	1	1392,236	46,164	,000
Within Groups	2442,824	81	30,158		
Total	3835,060	82			

Table 14 one way ANOVA for feeding natural resources Fankyhof

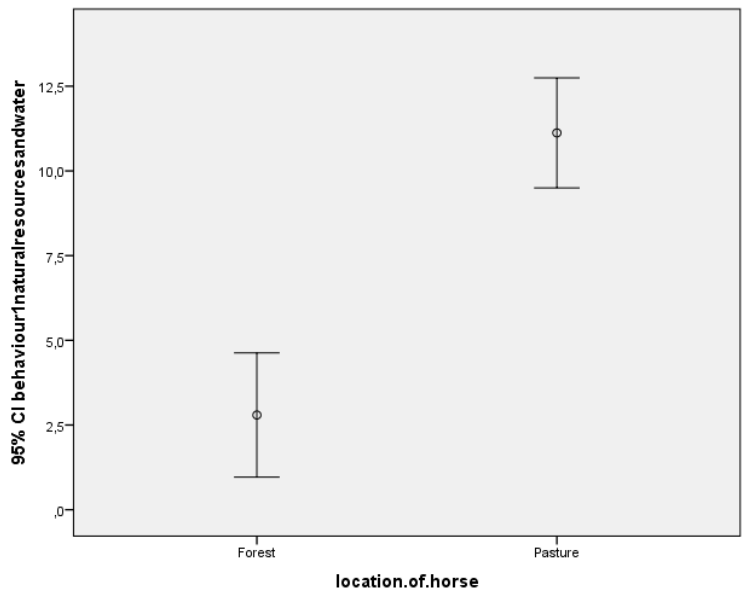


Fig 24 Error bar Fankyhof feeding natural resources

Stable 2 – FRZ Muldental MARES

The one way ANOVA test showed a significant difference (p=0,000) in between time spend for feeding natural resources in the forest and time spend for feeding natural resources on the pasture.

ANOVA

behaviour1naturalresourcesandwater

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1191,433	1	1191,433	61,803	,000
Within Groups	1985,629	103	19,278		
Total	3177,062	104			

Table 15: one way ANOVA feeding natural resources FRZ mares

Stable 3 – FRZ Muldental STALLIONS

The one way ANOVA test showed a significant difference (p=0,000) in between time spend for feeding natural resources in the forest and time spend for feeding natural resources on the pasture.

ANOVA

behaviour1naturalresourcesandwater

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	903,358	1	903,358	35,545	,000
Within Groups	4142,545	163	25,414		
Total	5045,903	164			

Table 16 one way ANOVA feeding natural resources FRZ stallions

Stable 4 – Weideparadies

The one way ANOVA test showed a significant difference (p=0,000) in between time spent for feeding natural resources in the forest and on the pasture.

behaviour1naturalresourcesandwater

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	539,050	1	539,050	18,251	,000
Within Groups	5257,250	178	29,535		
Total	5796,300	179			

Table 17 one way ANOVA feeding natural resources Weideparadies

The error bar below shows the significant difference in between feeding time spend on the pasture and feeding time spend in the forest.

Zu 4.3.1. Resting in the forest

Resting - Sub question 5

Do horses use the forest for resting significantly more or less than they do use the pasture?

H0= There is a significant difference in between the time horses spend for resting in the forest and the time horses spend for resting on the pasture.

H1= There is no significant difference in between the time horses spend for resting in the forest and the time horses spend for resting on the pasture.

Since the time spend for resting is scale data the one way ANOVA analysis was carried out.

Stable 1 – Fankyhof

One way ANOVA showing that there is a significant difference (p=0,039) in between the time spent for resting in the forest and the time spent for resting on the pasture.:

behaviour2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	133,117	1	133,117	4,391	,039
Within Groups	2667,664	88	30,314		
Total	2800,781	89			

Table 18 one way ANOVA resting Fankyhof

In the error bar below it can be seen that the horses of Fankyhof spend significantly more time resting in the forest than they did on the pasture.

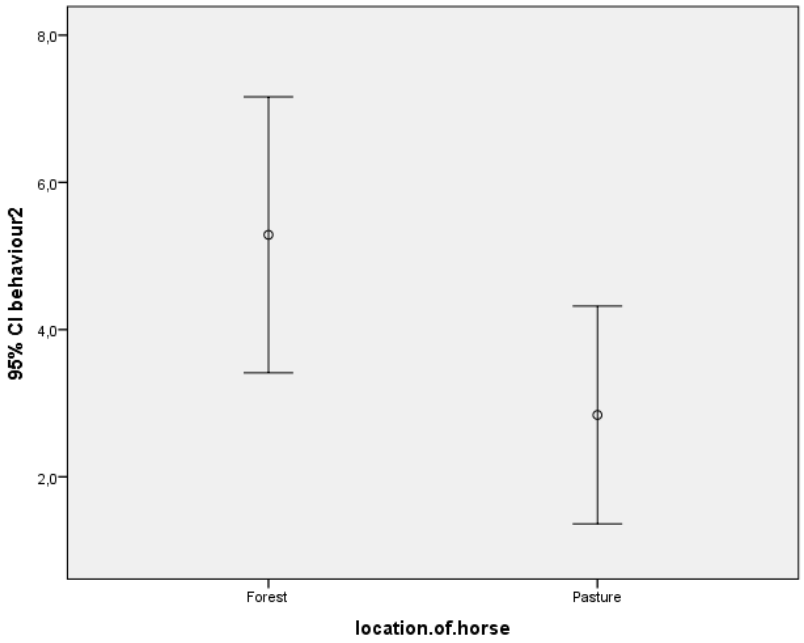


Fig 25 Error Bar Fankyhof resting

Stable 2 – FRZ Muldental MARES

One way ANOVA showing a significant difference for the mares at FRZ Muldental.

ANOVA

behaviour2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1105,826	1	1105,826	46,253	,000
Within Groups	2462,521	103	23,908		
Total	3568,348	104			

Table 19 one way ANOVA resting FRZ mares

The mares as well preferred the forest for resting as can be seen in the error bar below.

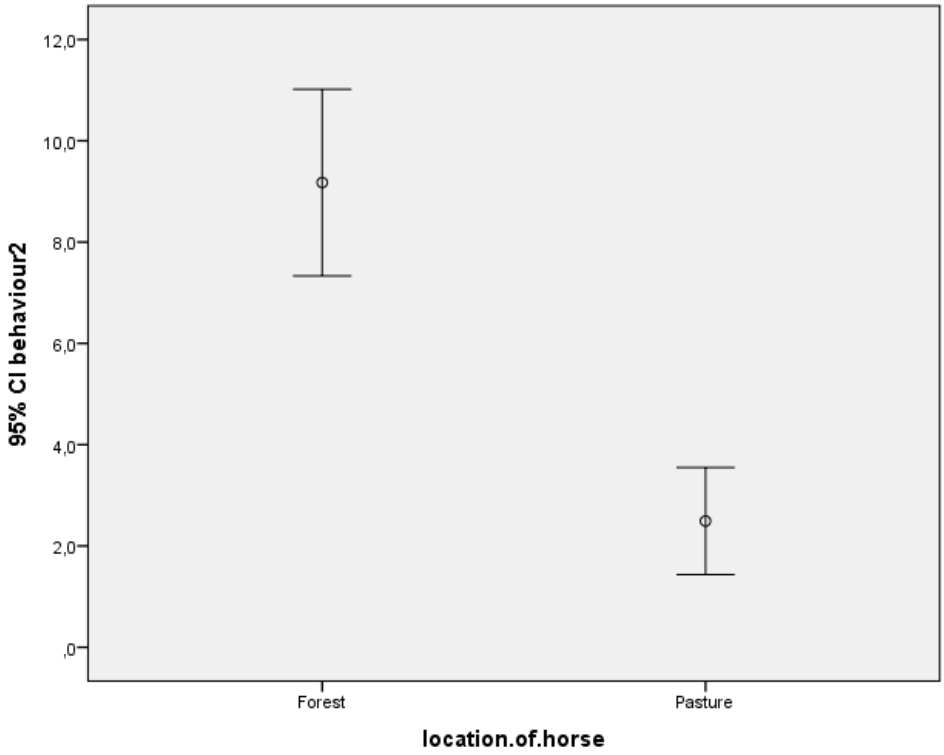


Fig. 26 Error bar FRZ mares resting

Stable 3 – FRZ Muldental STALLIONS

The one way ANOVA shows a significant difference for the stallions of the FRZ Muldental regarding the time they spent resting in the forest and the time they spent resting on the pasture.

ANOVA

behaviour2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1011,451	1	1011,451	33,197	,000
Within Groups	4966,330	163	30,468		
Total	5977,782	164			

Table 20 one way ANOVA for resting FRZ stallions

As can be seen in the error bar below they also spent more time resting in the forest than they spent resting on the pasture.

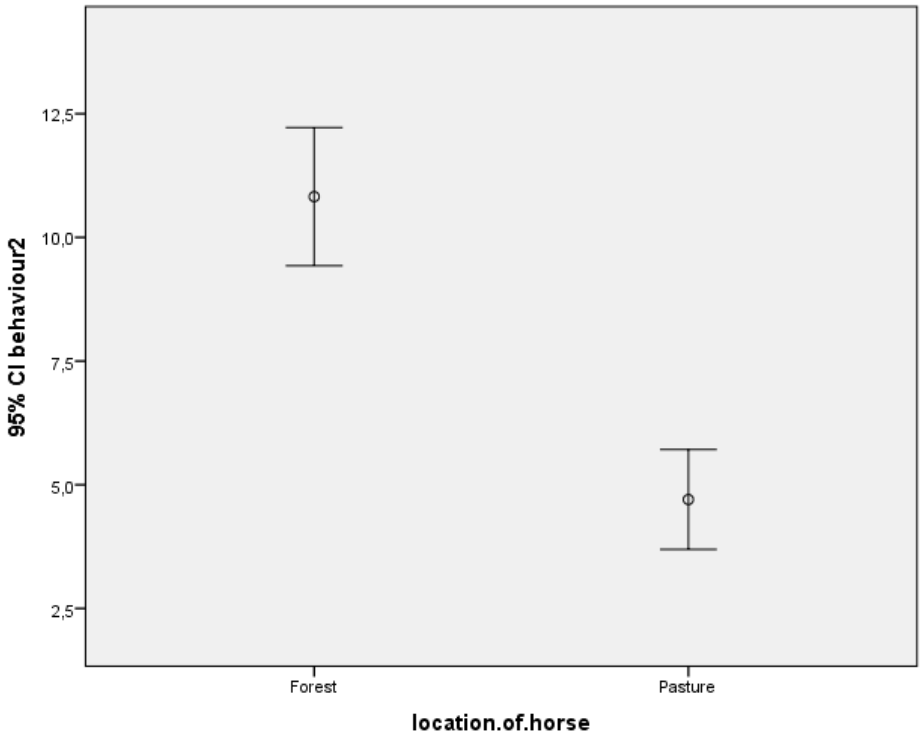


Fig. 27: Error bar FRZ stallions resting

Stable 4 – Weideparadies

One way ANOVA showing a significant difference (p=0,000) for the horses of Weideparadies regarding the time they spend resting in the forest and the time they spend resting on the pasture.

ANOVA

behaviour2

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1036,909	1	1036,909	31,584	,000
Within Groups	5843,736	178	32,830		
Total	6880,644	179			

Table 21 one way ANOVA for resting Weideparadies

But in the case of the Weideparadies the horses spend more time resting on the pasture/paddock than in the forest. It was the only pasture with a shelter. This shelter was placed on the paddock.

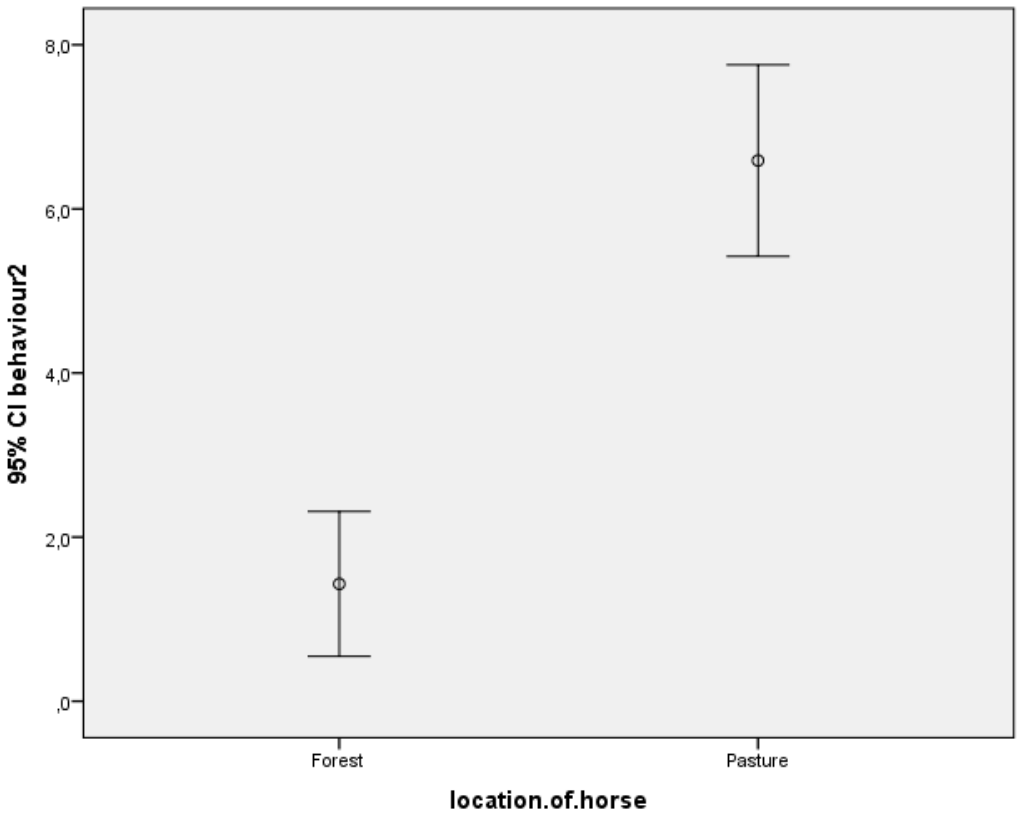


Fig. 28 Error bar Weideparadies resting

Zu 4.3.3 Activities

Social activities - Sub question 6

Do horses use the forest for social activities significantly more or less than they do show social activities on the pasture?

H0= There is a significant difference in between the time horses spend on social activities in the forest and the time frame horses spend on social activities on the pasture.

H1=There is no significant difference in between the time horses spend on social activities in the forest and the time frame horses spend on social activities on the pasture.

The Kruskal Wallis test was chosen because the data is not normally distributed and this test is a non parametric one that can be used for more than two groups.

Stable 1 - Fankyhof

Kruskal Wallis test showing a significant difference (p=0,035) in between social activities shown by the horses in the forest and on the pasture

Ranks

	location.of.horse	N	Mean Rank
behaviour4	Forest	40	49,19
	Pasture	50	42,55
	Total	90	

Test Statistics[a,b]

	behaviour4
Chi-Square	4,436
df	1
Asymp. Sig.	,035

Table 22 Kruskal Wallis for activity Fankyhof

In the error bar it can be seen that there was significantly more time spend with social activities in the forest than on the pasture.

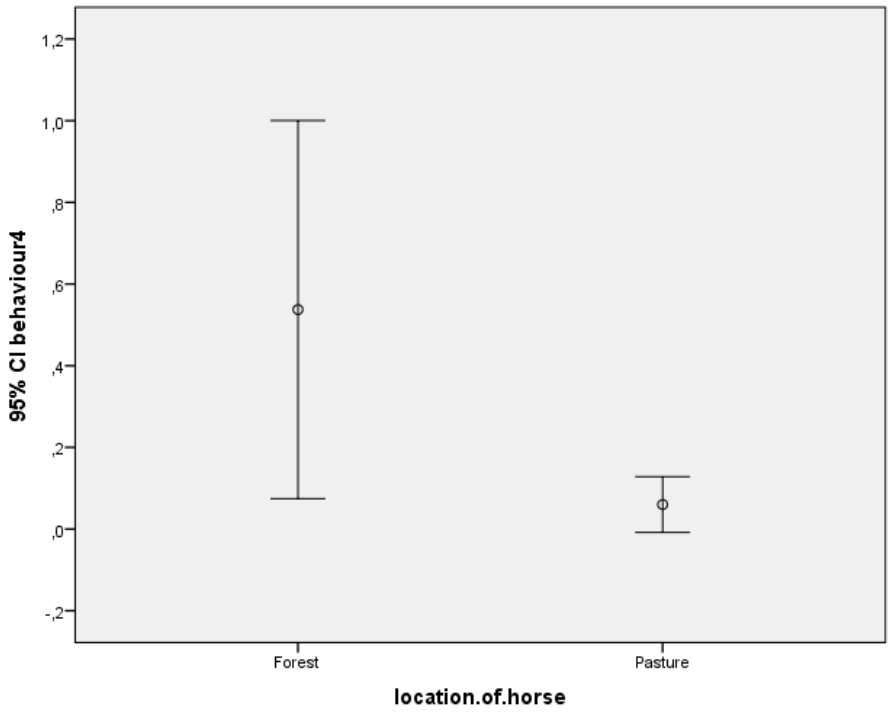


Fig 29 Error bar Fankyhof activity

Stable 2 – FRZ Muldental MARES

Kruskal Wallis test showing **no** significant difference for the mares of the FRZ Muldental, regarding the location where they show social behavior.

Ranks

	location.of.horse	N	Mean Rank
behaviour4	Forest	40	54,13
	Pasture	65	52,31
	Total	105	

Test Statistics[a,b]

	behaviour4
Chi-Square	,313
df	1
Asymp. Sig.	,576

Table 23 Kruskal Wallis for activities FRZ mares

Stable 3 – FRZ Muldental STALLIONS

Kruskal Wallis test, showing a significant difference (p=0,025) of the stallions at FRZ, regarding the location where they show social behavior.

Ranks

	location.of.horse	N	Mean Rank
behaviour4	Forest	34	68,38
	Pasture	131	86,79
	Total	165	

Test Statistics[a,b]

	behaviour4
Chi-Square	5,050
df	1
Asymp. Sig.	,025

Table 24 Kruskal Wallis for activity FRZ stallions

The stallions spend significantly more time with social activities on the pasture than in the forest.

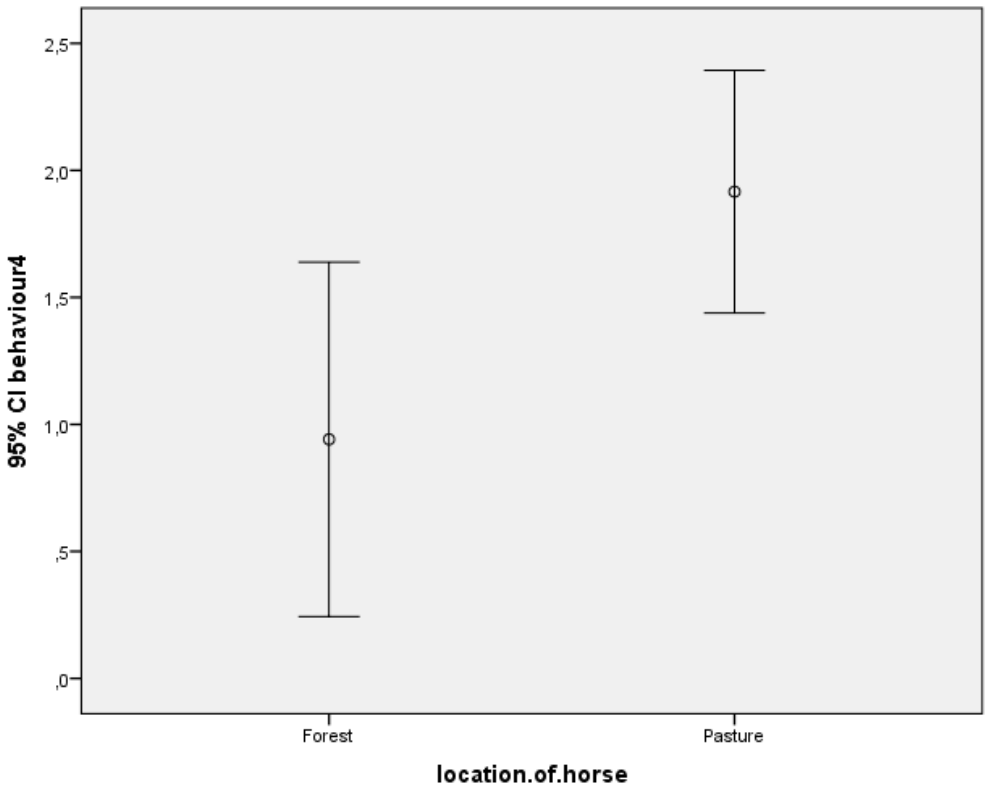


Fig. 30 Error bar FRZ stallions activity

Stable 4 – Weideparadies

Kruskal Wallis test showing **no** significant difference of social activities shown in the two locations, by the horses of Weideparadies.

Ranks

	location.of.horse	N	Mean Rank
behaviour4	Forest	57	83,84
	Pasture	123	93,59
	Total	180	

Test Statistics[a,b]

	behaviour4
Chi-Square	2,856
df	1
Asymp. Sig.	,091

Table 25 Kruskal Wallis for activity Weideparadies

Annex 5 – example log file for observations

Stable: ____________________ **Date:** __________

Observation period: (tick off applicable) ◯ 10-12 am ◯ 2 – 4 pm ◯ 6 – 8 pm

Horse: __________(name);__________(breed);__________(age);__________(gender)

Individual observed time: (15 minutes) ________until________ **Position** of the horse: (start:)__________(end:)__________

Weather circumstances: ________°C;__________(cloudy, middle, sunny);__________(no, light, stormy wind)

PASTURE

Behavior shown	Time frame 1	Time frame 2	Time frame 3
Feeding			
Resting			
Traveling			
Active			

FOREST

Time frame 1	Time frame 2	Time frame 3

Comments:____

____