Variation in individual behaviour of semi-wild Scottish highland cattle (*Bos taurus spp.*) in relation to weather conditions, day-time and habitat

Aimed at active & resting related behaviours

Bachelor thesis of Wildlife Management

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Summary

Conventional dairy husbandry systems acknowledge animal welfare guided by Brambel's five freedoms. The concept of natural, or normal behaviour would in contrast to Brambel's convention, be based on stability through chance and offers a less anthropocentric and more naturalistic approach. The present study has been done to get insight in the origin constellation of behaviours and the natural proportion of activity and resting related behaviours. The acquired results could provide guidelines for naturalness, leading to improved welfare in conventional husbandry. Since no natural species of the *Bos* genus are left to study the behaviour of, a lesser domesticated, or natural *Bos taurus* race had to be chosen instead: Scottish Highland Cattle proved to be an adequate representative for the origin wild species. The study group consisted of 14 oxen of the same age class to ensure homogeneous measurements. Research took place on a 220 ha sized part of the Dutch national park Drents-Friese Wold under semi-wild circumstances. There, the SHC oxen are utilized as a tool in nature area management as an alternative for mechanically mowing patches of the land. For the present study, the area was divided into four habitat types: Meadow, forest, meadow-forest edge and heathland. Data sampling occurred on 34 days during February and April of 2013. The observed behaviours were: Foraging, walking, running, scratching horn, scratching foot, scratching object, grooming, exploring, agonistic action, agonistic reaction, laying, ruminating, and excretion. The behaviours were recorded instantaneous in using two sampling methods: Focal and scan sampling. Focal sampled data have been used for calculation of event behaviours, while state behaviours were calculated with scan sampled data. With exception of horn scratching and grooming, group behaviour can interpolated to an individual because of small intra-specific variation. The oxen expressed a diurnal activity pattern with two peaks of active related behaviour: One right after sunrise and the next before sunset. Although literature suggests otherwise, weather factors showed no relation with behaviour frequencies. The oxen showed a clear preference for the meadow. Only particular areas of each habitat type have been occupied which might be related to the optimal foraging theory. A clear preference of execution of behaviours was shown per habitat type: Meadow was mainly used for foraging, heathland for laying, meadow-forest edge for ruminating and forest for walking. However, no significant differences of habitat use were found between day-times. The proportion of active and resting related behaviours proved to be 3 to 1 and can be seen as an external representative for a normal balance in addition to naturalness in behaviour. This proportion is based on the possibility of auto-motivational behaviour performance by the oxen under unconstrained circumstances. In contribution to the SHC oxen´s habitat use and behaviour pattern, their effect on the environment supports achieving the aim of the park management to keep that area open.

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1. Introduction

The in the year 1965 coined concept of welfare regulating freedoms within husbandry systems by the British Farm Animal Welfare Council in part state that; an animal should be free to perform normal behaviour (Brambell, 1974). The term "normal behaviour" is conspicuous and in some studies seen as behaviour of wild animals of which behaviour evolved without human interference (Kilgour, et al., 2012), or evolution solely within the confines of natural selection (Driscoll et al., 2006). In following, normal behaviour is approached in the current study as natural behaviour. The promotion of natural behaviour should, according to this welfare paradigm, instigate increased animal welfare (FAWC, 2006). In shedding light on natural behaviour of production animals such as dairy cattle, in the current study, the behaviour of *Bos taurus* was observed.

The *Bos taurus* is a bovine species used in conventional farming systems. The present conventional housing systems of production cattle do not provide enough opportunity for the animals to unroll their natural behaviour patterns (Fischer *et al.*, 2011).In addition, horns, which are a natural feature of the *Bos* genus, are removed through domestication. Thus the exhibition of behaviours is constrained. Sympathetic, or active related behaviours are not being stimulated so stress inducing factors cannot be compensated by natural responses. Therefore the kept cattle experience long-term stress (Korte, 2001), which results in a disturbed physiological balance making the animal more prone to sickness (Mormède, 2007; Zutphen et al., 2009). Beyond that with the ever increasing herd-sizes, "zero-grazing" is put into practise. Keeping the animals indoors year-round, further increases risk of incidence of deceases. (Ekesbo, 2011). So exposing natural behaviours could well be of importance for health and welfare in husbandry (Gonyou, 1994).

The wild ancestor of the *Bos taurus*, the Aurochs (*Bos primigenous*) is long extinct and its natural behaviour is, in result, unknown (Clutton-Brock, 1999). To mitigate this issue, the concept of "naturalness in behaviour" was coined in this study. In order to get insight in naturalness in behaviour of *Bos taurus* species; Scottish highland cattle was observed. To approach the concept of naturalness pragmatically, behaviour was classified two-way in active and resting relatedness. Furthermore behaviour was divided in state and event behaviours. These classifications led to sharp insights of behaviour patterns under influences of natural dynamics. Cattle are not only utilised for production in food industry. As in the National park Drents-Friese Wold, also different livestock species and races are being used as natural tools for nature management. Grazing is a prominent method in preventing succession and is widely employed in a range of vegetation structures as bovine species on grassland; and sheep and goats in both moorland and shifting sands (Bakker, 1983). These animals are exposed to the dynamic influences of their natural environment. Observations were conducted in the nature reserve where the animals were released in 2009: 220 ha in the Drents-Friese Wold, a fenced semi-natural habitat, consisting of a forest- heathland –meadow-mosaic, situated in northern Netherlands.

The oxen live subjected to the natural dynamic influences and are free to react appropriately. In consequence it is thought, that they show a more "natural", or normal balance in activity and rest than their commercial counterparts. This study was aimed at getting insight in how behaviour of oxen is influenced by external factors and in what way this constitutes naturalness in behaviour.

In conclusion there is a lack of knowledge about original behaviour in production cattle.

Moreover, the effect of natural dynamic influences, such as habitat, in cattle's behaviour is not known in detail. This includes knowledge about the effect of several habitat types and the variation within these habitat types of the cattle's behaviour.

1.1 Aim

It is of interest to know which behaviours are shown under unconstrained, and therewith natural, circumstances. This includes behaviour under the influence of external factors and if therefore cattle prefer to carry out behaviours unaffected by domestication.

Furthermore it is desired to get insight in which way cattle control their spatial environment and by what natural dynamic influences behaviour is affected. Therefore the aim of this research was to find an identification of naturalness in behaviour of *Bos taurus*.

This means getting knowledge about the variation in behaviour in cattle species under natural circumstances. Doing so, the variation in individual behaviour and their daily activity pattern should be explored. The composition of both active and resting related behaviours is then also of importance because it provides insight in the natural balance of behaviour exhibition. The frequency of those variations should then be compared to possible external influences (weather conditions and time of day) and usage of their habitat. This knowledge should then illustrate behaviour exhibition under unconstrained circumstances.

It is of interest weather the found results can be used as natural references, so that this study could contribute to adaptations in cattle housing-systems.

2. Research questions

The questions in terms of *Bos taurus'* behaviour can be derived from how the oxen make use of their habitat; if they perform specific behaviours in particular areas, if this usage is influenced by external factors like weather conditions and time of day and if there is a standard of activity.

These possible relations can be measured through noting the frequencies of a variety of behaviours under effect of the natural dynamic influences.

To get insight in the above named relations and in achievement of the aim the following research questions have been developed.

What is the relation between the variation of active and resting related behaviours in semi-wild SHC individuals with day-time, habitat and weather conditions?

1. What is the individual variation in state- and event-behaviours?
2. How is the habitat used?
3. What is the relation between behaviour and habitat?
4. What is the relation between day-time and habitat use?
5. What is the relation between behaviour and day time?
6. What is the relation between behaviours and weather?
7. How are active- and resting- related behaviours proportioned?

In contribution, it is of interest for the park management what effect the SHC oxen´s habitat use and behaviour pattern have on their environment. Therefore a second research question has been developed:

What impacts have the oxen on their surroundings?

2.1 Hypothesis

As a systematic approach and to give a direct overview, a matrix has been constructed to make clear which variables are hypothesised to be inter-related (fig. 1).

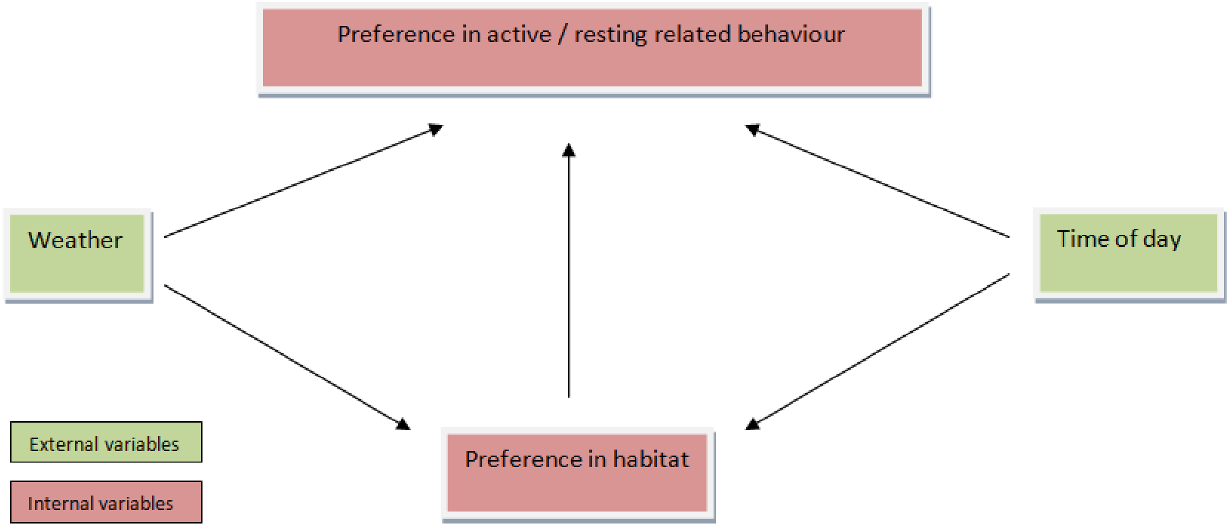

Figure 1. Conceptual model of hypothetical inter-relations between the research variables
The external variables are indicated in green and are the independent variables.
The internal variables are indicated in red and are dependent.
The arrows indicate at which variable the hypothetical influence is directed and also states the H_1

Finishing the above described theory, a statement had to be formed. With this proposition the named research question can be supported. Hence, the hypotheses are formulated as followed:

H_0= There is no significant relation between the variation of active and resting related behaviours and the time of day, habitat and the weather conditions.

H_1= There is a significant relation between the variation of active and resting related behaviours and the time of day, habitat and the weather conditions.

These hypotheses are to be tested during the period of data analysis.

3. Material and Methods

The *Bos Taurus* cattle´s day pattern and preference on the basis of independent factors such as weather variables and day time are of interest. This includes information about variation, proportion and frequency of the certain behaviours. Therefore it was of importance to observe exclusively the behaviours and relate them to the given circumstances instead of interfering the study population by taking any intervention.

3.1 Study Population

Choice of the study population

For reaching the aim of this study, free ranging or semi-wild cattle had to be observed. The term "semi- wild" qualifies as partially wild living animals, which are not tamed nor additionally fed, but live in a fenced and managed nature-area. However, in the case of this particular research it is only possible to choose for a domesticated *Bos taurus* species.

Hence, for this study the Scottish Highland is chosen as the cattle race being the semi-natural reference for production cattle (*Bos taurus*). The SHC is an old meat production race of *Bos taurus*, which, due to its thick fur coat and natural appearance is a popular choice as an alternative for mowing and can be deployed year-round. This cattle-species is the most capable race bred for wild conditions. (Felius, 1996) Thus in this study case the animal can be seen as a part of nature. Furthermore other B*ovini* species can be compared to distinguish between the naturalness in behaviour and its change through speciation.

A group of oxen is used for this study, enabling the possibility to carry out a research on a homogenous population and thus providing comparison between individual behaviour systems. Furthermore this group fulfils the condition to live in a semi-natural habitat. These factors suffice to carry out research on minimally constrained behaviour.

The group of the SH oxen consist of 14 individuals of which 8 form the sample size, because of their distinguishable morphological features. In 2010, two groups of each seven oxen were introduced in the study area. These 2 separate groups have congregated in a single unit over the past years. All of the 14 oxen are born in September and October of 2009 and are therefore all part of the same age class. Since SHC is a gregarious animal, all individuals can be seen as group members and hierarchal order was not expected to have a significant impact on the behaviour pattern nor on preferred habitat. Therefore the hierarchical order is not considered in this survey.

SHC is an ancient Celtic breed of cattle of witch both sexes have handlebar shaped horns and a thick coat of fur. Males size up to an average of 1,28 m at shoulder height and can weigh up to 600-800 kg. They thereby grow slightly larger than females. (Felius, 1996)

General information about production cattle (*Bos taurus*)

The following information is result of observations made on housed and mixed-sex research populations:

In large herds, free ranging cattle form sub-groups of 20 to 30 animals. Their social interaction is influenced by foraging and ruminating. The behaviour within a herd is highly synchronized, which means that the main activities like foraging, ruminating and resting mostly happen at the same time. The causation for synchronized behaviour is that cattle as gregarious animals have the affection to stay close to the other members of the herd. (Sambraus, 1978) Usually a cattle-herd, structured matrilineal, consists of several females, their calves and one bull. Moreover they have individualised social relationships (Sambraus, 1978).This means that each individual of the group knows and recognizes each other. With an age of about two years, the pubescent bulls leave the herd and build a group together with two or four other young bulls (Sambraus, 1978). The latter group composition can be compared to the group of the 14 castrated bulls of the study species. Older bulls in contrast, live solitaire (Sambraus, 1978).

The function of hierarchical order is to prevent conflicts and therefore having access to food, water or sexual partners with the lowest amount of energy. The dominant animals of a herd are mostly the ones which are older and bigger. When introducing a new animal into a stable herd, the hierarchical order is defined by horn-including fights within the first two days. Afterwards mostly non-physical threatening happens. While aggression in cows reduces with age, bulls are the most peaceful until the age of 3. From 3-4 years of age, intensity of contests increases until the age of 6. Moreover bulls repeatedly keep trying to reach a higher hierarchical status, even if contests took place between the same individuals in earlier instances. (Sambraus, 1978) Nevertheless, this fact does not say that the general belief that mammalian males are more aggressive than females, was true. A study in social behaviour in SHC refuted this assumption: There was no difference of statistical significance in aggressive behaviour against subordinate individuals between males and females (Reinhardt & Reinhardt, 1985).

With an exception in social interaction, *Bos taurus* species keep a distance of about 3,0m (measured from head to head) to more dominant individuals. This distance can increase to 9-12m while foraging. (Sambraus, 1978) However, cattle have a basal need of physical contact: Allogrooming not only keeps the fur it clean, but also strengthens the social relationships. This social interaction stands in relation with the hierarchical order: Cattle of the same rank position groom each other more often than animals of different positions. (Ekesbo, 2011)

Vocalisation is mainly used in social and sexual interaction (Sambraus, 1978) or if an individual gets separated from the herd (Ekesbo, 2011). For that reason this behaviour was not expected to be recorded at the oxen. Nevertheless, the group of oxen was found separated three times in various constellations. During these separations, vocalisation was observed and eventually stopped with arrival at the rest of the group.

Cattle are very enquiring. In younger age this behaviour is important for the learning process. In older age instead, it helps the animals adapting to new surroundings and circumstances. (Sambraus, 1978)

The diurnal activity pattern, which is nearly uniform in housed production cattle species, is mainly influenced by light and darkness. Also weather- and vegetation-conditions have a modifying effect on the activity rhythm. In temperate climate zones, the daily rhythm of on meadow kept cattle begins at dawn: A period of grazing is followed by drinking and after that a period of allogrooming acted out. This pattern ends with a resting period. (Sambraus, 1978)The first grazing periods begin in the early morning and the second in the afternoon before sunset (Ekesbo, 2011). 4-12 Hours per day are spend on foraging. The rest of the time mainly consist of resting: 6-10 Times per day cattle have a 30 minutes slow-wave sleep phase. (Sambraus, 1978)

3.2 Study site

National Park Drents-Friese Wold

The National Park Drents-Friese Wold (NP DFW from now on) is a national park situated in the 2 provinces Drenthe and Friesland centred at Amersfoort coordinates 216419, 546327 in the Netherlands (fig. 2). The park covers 6100 ha of nature and culture ground with an altitude varying from 4 to 23m. The mean annual precipitation is measured between 825 and 850mm and the temperature between 8.9 - 9.2 degrees Celsius. The monthly mean precipitation and temperature are in February: 45-50mm and 2.0-2.6C^{o}, in March: 65-70mm and 5.0-5.5C^{o}, and in April: 45-50mm and 7.5-8.0C^{o} (KNMI, 2013). NP DFW has been assigned to the European Nature 2000 settlement and is owned and managed by several nature protection organizations as: Staatsbosbeheer (SBB), Natuurmonumenten and DrentseLandschap. The national park consists of a mixture of habitats like forest, heathland, shifting sands and river valley grasslands.

Figure 2. Northern Netherlands with an enlargement of the Drents-Friese Wold

Prinsenbos

The SHC are settled in the Prinsenbossince2010, a fenced area of 220 ha situated in the north-eastern part of NP DFW at coordinates 219433, 546566 varying in height from 8 to 24 m. About 125 years ago the forest was initially planted as production forest with commercial logging as its main goal. Bordering this forest at the western edge was a farm, called Uilenhorst, with farmland, of which since 10 years now, only a ruin remains. Since then the forest and farmland have been merged and now, since approximately 10 years different grazers are roaming the area in order to maintain and diversify the half open area. The area is also subject to logging to create open areas and to connect dispersed patches of heath land. The aim of SBB is to create a naturalistic area with natural transitions through the use of semi-natural or historical measures. Year-round grazing by large herbivores as horses, Bovine, sheep and goats species in their own grazing niches is their main method. The Prinsenbos is grossly split up into 3 habitat types which are described below and depicted in figure 2. The recording of behavioural data will be related to these habitat types.

Habitat types

Forest: The most prominent habitat type in the Prinsenbos with 159 ha making up a total of 73% of the whole area. It is typical woodland with low vegetational and a-biotic diversity consisting for the most part out of production pines as Japanese larix (*Larix kaempferi)*, Norway spruce (*Picea abies*), and some Scots pine (*Pinus sylvetris*). Deciduous tree species as Pedunculate oak (*Quercus robur*), beech (*Fagus sylvatica*) and American oak (*Quercus rubra*) are less represented with less than 15% of total tree coverage.

The total forest coverage was divided in 7 parts (fig. 3.) for the study. This distinction is based partly on dominant tree species and is aimed towards illustrating global displacement of the oxen while sampling.

Meadow: 25 ha of the least prominent habitat-type, covering 11% of the Prinsenbos. The meadow consists of herb rich grassland in the northwest of the Prinsenbos, bordering agricultural ground. A mostly flat and relative vegetative species consistent patch of former agricultural grassland, with hydro cultural ditches which have been dammed. Species as Perennial Ryegrass (*Lolium perenne*), Velvet Grass (*Holcus lanatus*) and Common Bent (*Agrostis capillaris*) make up the larger part of the diversity.

Although the meadow patches are all interconnected, a distinction is made between different patches. The meadow area was split up into 6 different patches. These distinctions are made to map the displacement and usage preferences of the oxen.

Meadow-forest edge: The edge areacovers3ha and therewith only makes up 1% of the total area. The edge between the habitat types forest and meadow is chosen to be named as separate habitat type, since the forest edges are hypothesised to provide differentiated functions in relation with the forest and meadow habitats. This assumption was made in the pilot when the oxen were dispersed on these edges, both in forest and meadow habitat, showing a variety of behaviours. These edges are recorded when the group is divided in both habitats with a dispersal of approximately 25 meters on both sides of the habitat border. Also for methodological reasons it was the most accurate way to prevent faults in habitat description, whether the oxen are position in the forest or on the meadow. Meadow-forest edge is characterised by overthrown trees on grass ground. This area was divided into 5 patches for the study.

Heath land: With 33 ha (15%) of coverage this habitat-type is divided into three different gradients of wetness; The wet gradient covers the smallest district of the whole heathland, the moist gradient covers the largest area of heathland and the second largest area is dry heath land. The wet moorland consists out of moor grasses as *Juncus effuse* and *Molinia caerulea* and heather species *Erica tetralix* and some *Calluna vulgaris.* Moist heath land consists more or less of the same species, with less *Juncus effuse* and *Erica tetralix*and higher dominance for *Calluna vulgaris.* The dry moorland is dominated by Calluna vulgaris, *Empetum nigrum* and some dispersed Scots pine's and Common juniper's (*Juniperus communis*). On the dry heath land some fine-leaved sheep's fescue (*Festuca filiformis*) is also found, and together with Scots pine.

There are eleven heath land parts within the Prinsenbos, which are surrounded by forrest and/or grassland. Each heathland part will be numbered with an order of occurrence southwards. The certain heath land part will then be recorded at each observation to record if there are preferences between the heath areas. The forest edges on the heathland are less prominent in comparisson with the forest edges on the meadow and the pilot has not shown actual preference of the oxen of these particular sub-habitats.

Habitat use

Other than in the behaviour sampling, in this case the whole herd was observed and their location was noted during the behaviour observation session. More than half of the oxen-group needed to be present in one of the habitat types. The individuals sampled on behaviour needed to be a part of those eight or more oxen.

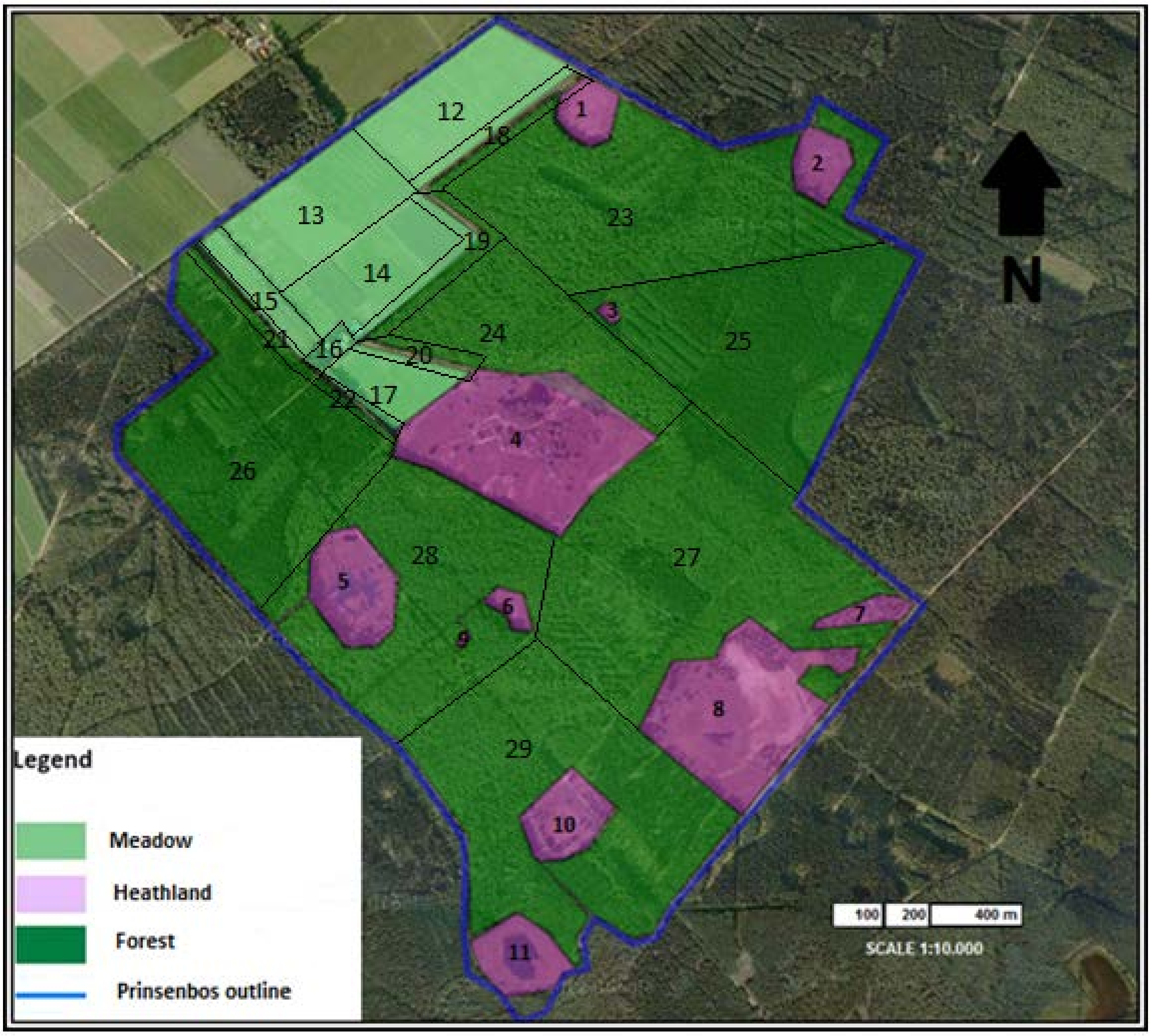

Figure 3.The Prinsenbos in NP DFW, sub-divided into 4 main habitat types with global location numbering
Numbers 1 – 11 indicate the heathland patches. Numbers 12 – 17 indicate the meadow patches. Numbers 18 – 22 indicate the forest edges on the meadow. And numbers 23 – 29 indicate different forest areas.

3.3 Data sampling

Sampling sessions

In the sampling period, which lasted from February 11th till April 11th, all field data were collected in the Prinsenbos. In this period behaviour was sampled through the use of 2 sampling methods. The first method was scan sampling in which at a 15 minute interval, behaviour of all 14 individuals was scanned. As the pilot showed, noting these behaviours takes up approximately 1 minute. In the remaining 29 minutes the secondary method-focal sampling- was put into practise. Halfway of the same focal sample, at minute '15, another scan sample was taken (fig.4).

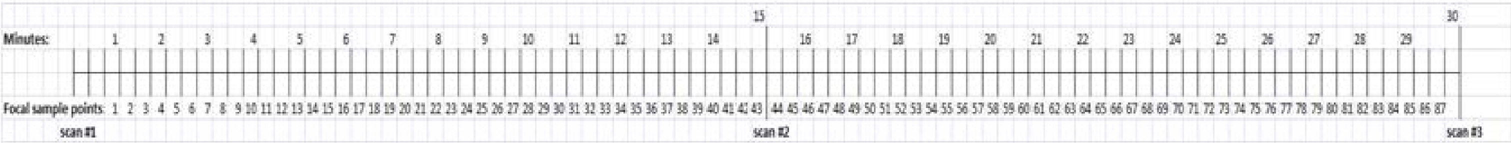

Figure 4Time table of scan and focal sampling overlay
This figure represents a half hour focal sample in which the sampling frequency is put out to the minutes which encompass a single bout.

During these 29 minutes, at every 20 second-interval, an instantaneous behaviour sample was taken for a focal animal. In the fifteenth minute a scan sample of all visible oxen was taken additionally. This scanning obstructed observations of the subjected focal for max. a minute and was commented on the focal-sheet as such. In total 87 focal samples were taken per 29 minute sampling bout. At minute 30' the second scan sample was taken, followed by a 15 minute pause in which the next 2 focals were identified for the 3rd and 4th focal sampling bout, which was executed from minute 45 till 75. This was followed by another 15 minute switch for the last 2 focals (fig.5).
For methodological reasons, the time over day was divided into 4 periods. A scan sampling session took place in 1 of the 4 day-periods during 2 hours, taking 8 scan samples (when the oxen-group was found immediately) and 87 focal samples per individual.

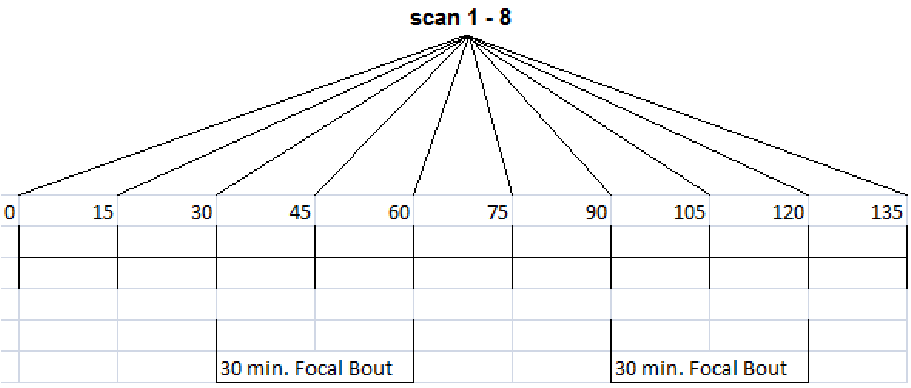

Figure 5Scan and focal samples per day-time
This figure illustrates the time spread applicable to all 4 day-times.
The numbers indicate the 15 minute intervals present in a day-time.
The period provides time for 10 scan samples, leaving 2 scan possibilities as a buffer.
The focal bouts can be applied anywhere in between 3 scan samples lasting 30 minutes, if at least a minimum of 15 minutes break is in between them.

Observations were carried out by 2 observers, meaning that with focal sampling, 2 individuals could be sampled simultaneously. Per measurement-period, 2 to 4 individuals were observed. The scan samples were taken cooperative; with one observer scanning and the other noting.
The sampling bouts either took place during the morning, noon, afternoon or evening period (noted as "day-time" on the work sheets) and in one of the 4 habitat-types and were both recorded on the worksheet. The weather variables were all mediated for the 30 minute bouts of focal sampling. For scan sampling the weather variables were noted instantaneous per 15 minute interval afterwards and were also recorded on the worksheet.
In the 9 weeks of sampling, 4 days per week, Monday till Thursday, were used for data collection and behaviour was sampled on 34 days in total. Since behavioural alteration due to human presence was to be minimized during the observations, the four days of data-sampling were chosen deliberately on working days: As the study site also forms a recreation area for people, it was expected to have a higher number of visitors on the weekend, who may have influenced the behaviour of the oxen. In these 34 days 4 sampling bouts per observer were recorded per day. Thus, all the individuals were sampled once every sampling day. These 8 bouts were split halfway, so both 4 bouts would take place on 2 different consecutive day-times (table 1). All 8 individuals were focal sampled once per day. If all animals were visible and distinguishable, which the pilot showed to be extremely hard in the forest habitat, but more realistic on the meadow and heath land, 8 scan samples were taken per "day-time" and 8 on the following "day-time". Therewith every day 16 scan samples of all 14 oxen were taken and one 30 minute focal sample of each ox was recorded.
Of the external variables, day-time is the only fully predictable one and thus the total number of sampling bouts could be mediated over all 4 day-times. The weather related variables could not be planned as such and frequencies and reliability were assessed in retrospect.

Table 1. Schematic overview of weekly sampling planning (*week 1*)
The 4 days on which data was sampled in all 9 weeks are noted in the top row.
The first column lists the 4 different day-times and the numbers 1 to 8 indicate
the 8 individual oxen thus presenting a schematic overview of which oxen are sampled
at what day-time which day. The order in which the animals are sampled is randomized using a dice.

Day-time	Monday	Tuesday	Wednesday	Thursday
morning	1,5,2,3			8,5,6,7
noon	6,4,8,7			2,3,4,1
afternoon		5,3,7,1	3,7,8,1	
evening		8,2,4,6	4,5,6,2	

3.4 Data collection

Pilot

First of all a distinction between relevant operational behaviours has been made in the pilot in the form of an ethogram. This preliminary data collection was executed through the use of the ad libitum sampling method. All relevant behaviour patterns were recorded without paying special attention to latency, frequency or duration. Also no focal animal was selected, but different individuals were observed to get a broad overview of most, possible executed behaviours. The classification into state- or event-behaviours was preselected from the pilot study and literature.

During the whole research-period the oxen's behaviour should be studied without being influenced by the observers in any way. Therefore the time from the observers´ arrival until the animals´ behaviour was settled again, was measured each time during the pilot study. In this way the set point or latency of the beginning of the observations during the period of data-collection could be predicted. But also the oxen became used to the presence of the observers: The pilot study showed that the latency reduced progressively already after 4 visits and was reduced from 40 minutes to no more than 20. However it was intended to not interrupt the animals at all. Therefore the maximal subject-observer-distance has been chosen at which the animals were not affected, but were still visible with binoculars for the observers. The tested distance proved solid at a 100 meter distance to the closest ox.

Sampling rule - Scan sampling

One observer visually scanned the animals, communicated this and the other observer noted the shown behaviours on the worksheet in order not to miss any behaviour performance while writing. This observation model was repeated every 15 minutes for 8 intervals per day-time. With this method all 14 oxen could be sampled simultaneously, although especially in the forest several individuals might have been missed. Of the 14 oxen, only 9 could be identified while 5 could not, these 2 groups were distinguished on the worksheet. During the pilot, only those behaviours, which are categorized as state behaviours were recorded with scan sampling. Meaning those, which are frequent and are displayed over longer consecutive periods of time, such as foraging, walking, ruminating and laying. Over time it proved that also event behaviours could be recorded with scan sampling because they proved to be frequent. Whether these event behaviours were recorded with the same precision as in the focal method should be displayed afterwards during the period of data analysis. (See chapter "Results, Method comparison")

Sampling rule- Focal sampling

As the secondary sampling rule, focal sampling was chosen. This means that out of the 14 oxen, within the identified 8, a single individual was observed for 29 minutes by one observer. In this time-span the above mentioned scan sampling behaviours, along with additional event behaviours (horn, foot and object scratching, exploring, grooming, excretion and agonistic-action and -reaction) were recorded with the focal sampling method. Those are probable to be missed in scan sampling (Houpt, 1991; Doran, 1992). These behaviours were recorded on the specified focal sampling worksheet (App.II). The observed focal animal changed per focal session; sampling a total of 8 individuals every day. For each session, the sampling subjects were chosen in a random order. Continuing thus on all 8 individuals, all 8 individuals would have their behaviour evenly recorded on several occasions under the effect of the different external variables.
To circumvent intra observer bias a sampling bout was videotaped and scored on several occasions during the field data collection period. In these bouts the differences in observations had to be assessed to keep different interpretations to a minimum and thus establish consistency throughout the survey.

The observations were done by 2 observers, so 2 individual ox could be scored at the same time. If the animals were hardly visible, only 1 individual could be observed at a time. In this case, 1 observer continuously observed the focal while the other recorded the shown behaviours on the sheet. Both observers needed to be consistent in their observations and needed to obtain similar results when observing the same individual simultaneously. To prevent inter observer bias, the ethogram was established in consensus of both samplers during the pilot study first. Also a sample of behaviour was measured simultaneously to asses and improve inter observer reliability.

Recording rule- Instantaneous sampling

A recording rule describes in which way the behaviour is measured (Martin & Barteson, 2007).As the recording method instantaneous sampling (IS for short) is chosen: With this method, information is condensed and several different behaviours can be measured simultaneously. Instantaneous sampling was applied to both scan and focal sampling. Observation sessions were divided into successive periods of time, or intervals of which the duration was objectively specified during the pilot. For focal sampling, an interval of 20 seconds was chosen and for scan sampling 15 minutes was the appropriate interval. At each interval, the at that instant occurring behaviour was noted with an “x” at the corresponding behavioural pattern on the focal sampling worksheet. The scan samples are noted with codes instead of an “x”, as the occurring behaviour was thus specified per individual. The intervals were initiated by an application on a Smartphone called “interval timer”, producing an audio signal at the specified interval. The most efficient interval time was established during the pilot in which a 30 minute sample of behaviour was recorded using continuous sampling. In this sampling bout the behaviours; horn scratching and foraging were recorded. The scores were set out on a time-line and overlaid with different time intervals to asses which interval misses none of the event behaviours, but still was practical to execute considering the time needed for the observer to record and not miss the next interval.

An overview is made about which individuals were sampled at each session (App. IV). The numbers represent the 8 identified oxen which are evenly spread and randomized throughout the whole sample period and day-times. During each day time in which focal samples were taken, also 8 scans samples were taken when possible.

3.5 Motivation for sampling method

For the detection of variation in behaviour of semi-free-ranging Scottish highland cattle in relation to external factors a choice in sampling method has to be made.

Focal- and scan-sampling

A sampling rule describes which subjects are observed at what time. As sampling method two different rules are chosen to be combined for this survey. Focal sampling as well as scan-sampling gave the most target-oriented conclusion to the research-question, when combining the results of both.
Considering the sampled behaviours consist out of event- as well as state-behaviour groups, not every sampling rule is suitable for recording each behaviour-group. With focal sampling one individual is observed over a certain time period. Also since both behaviour groups can be included in recording, it gives an accurate conclusion of all instances of behaviours shown in individuals. (Martin & Barteson, 2007) Due to the fact that only one animal can be observed at a time, it is logical that more sampling bouts are required.
With scan sampling instead the whole group, or at least all visible individuals, can be scanned at a time. This method was repeated at intervals and all behaviours were recorded. In scan sampling,

event-behaviours are likely to be missed. This rule may have also been biased, since certain behaviours are more conspicuous than others.
However, scan-sampling gives more specific information about variance in behaviours of the study population. Moreover it enables to obtain data that are evenly shown in all individuals. (Martin & Barteson, 2007) Furthermore scan sampling is an often used method for defining the amount of behaviour occurrence like Ransom and Cade (2009) and Jian-bin Dunbar and Di-qiang Wen-fa (2006) also did in their studies.

Both sampling rules are practical to be combined properly: Both methods can be carried out during the same observation session, so that time is used adequately. Furthermore the loss of information given by one can be compensated by that of the other method. (Martin & Barteson, 2007)

It had to be considered that nearly all in-situ observation methods can be very difficult: An animal can move out of sight and has to be followed, which can conceal the observer-unaffected behaviour (Martin & Bateson, 2007).

Recording- Instantaneous sampling

It was chosen to make use of a time method, since–in contrast to the amount of behaviour occurrence- the exact duration of each behaviour was not necessary to obtain.

Measuring behaviour in certain sample intervals enables to record several behaviours simultaneously. However, instantaneous sampling is more suitable for state behaviours. (Martin & Barteson, 2007)In first instance continuous sampling seemed a suitable recording method for this survey. For the recording of event behaviours, the all occurrence method seems applicable due to the conspicuousness of these behaviours. Moreover they are not likely to be missed with all occurrence-recording method. This can be executed during the scan sampling, if the interval is broad enough. Nevertheless, down from 15 minute intervals, no significant differences were found in instantaneous and continuous sampling. (Mithloner, 2001) Furthermore continuous sampling can be unpractical dealing with larger focal group sizes and few observers (Ransom & Cade, 2009).

After overlaying the results of a continuous 30 minute sample with an instantaneous sample of the same session, in which several different intervals were tried, an accurate comparison of both methods was made: The comparable interval suffices when no behaviours were missed and a minimum amount was recorded double. The conclusion was made that sampling with intervals of 20 seconds concluded the same precise results as in continuous sampling. It was therefore chosen to use instantaneous sampling, providing the same accurate data as well as better time efficiency for the observers.

In accordance with the answering of the research questions, instantaneous scan sampling method seemed most efficient. In this way a reliable result of their activity pattern could be acquired.

3.6 Variables

Active and resting related behaviours

The behaviours which were recorded conclude: Foraging; walking; running; scratching-horn,-foot or –object; grooming; exploring; agonistic action & reaction; ruminating; laying; excretion and other (App.I).

Since the present research is aimed at behaviour related to activity and that related to rest. It was of interest to know how the frequency of occurrence from the particular behaviours, but also from both behaviour groups, is composed and whether they are related to external factors. The decision of classification into the behaviour groups was based on the functions of the autonomic nervous system:

Resting behaviour is often described as the maintenance of the body and is promoted by the parasympathetic nervous system. It controls most of the body's organs and regulatory functions such as gut motility and urinary output. The sympathetic nervous system in return, influences the reactions on stress such as the so called flight-or-fight-response. It is suggested to maintain survival as the sympathetic nervous system is responsible for priming any action of the body. (Brodal, 2004)

Figure 6 Mobility: Trotting.

Figure 7 Foraging: Browsing.

Figure 8 Body care: Grooming.

In conclusion all activities which belong to the functions mobility, foraging (fig.6 and7; Smid, 2013), body care (fig.8; Bijsterbosch, 2013), exploration and agonistic behaviour were counted as active related behaviours. Activities belonging to resting related behaviours were more intricate to define: Ruminating and excretion, part of digestion, are shown while standing but was seen as resting behaviour. An in first instance similar looking behaviour as vigilance belonged to active related behaviours, however. It was hard to draw this thin line between active and resting related behaviours. Therefore the exact determination of behaviours belonging to activity and rest were made during the field study when it became more clear which behaviours were shown when and in which combination.

The above named activities can be divided into event- and state-behaviour. While event behaviours have a short duration and can be noticed as points in a time period, state behaviours are exhibited as long term activities.

The activities body care and agonistic behaviours include the use of horns in activities. These behaviours are chosen to be measured to get insight in the need and frequency of horn usage. It was expected that housed hornless cattle, show deviated behaviour. Considering the fact that much *Bos taurus* species are bred hornless or get the horns removed (Brem et al., 1982), a natural factor is that the SH oxen are able to act out the original function of horns.

In *Bos taurus* species, horns are used for various functions: Fighting, divided into wrestling and ramming behaviours, is not only used to define the hierarchical order, but also –resulting from the latter- to state the privilege of reproduction. (Caro et al., 2003) Hierarchical position can also simply be demonstrated by repeatedly ramming the horns into the ground. Playing with horns on the opposite, does not determine hierarchical order but is actually classified as play behaviour. Moreover horn playing is mainly performed in oxen. Another function is body care by using the horns for scratching parts of their own body (fig.9; Bijsterbosch, 2013). *Bos taurus* species would reach every part of their body caudal from the line between withers and elbow except from the anus. (Sambraus, 1978) The SH oxen in contrast are also able to reach the anus due to their greater horn length. Due to the higher flexibility in relation to most other cattle species, the welfare rate is assumed to be higher in the SH oxen.

Figure 9 Scratching horn

Figure 10 Agonistic action

While showing agonistic behaviour (fig. 10; Bijsterbosch, 2013), cattle lower the head and sometimes paw the ground. In addition, bulls can use their horns for scratching the ground (Ekesbo, 2011). While showing agonistic behaviour, pawing and ground scratching with the horns has not been observed in the SHC oxen.

The following data were measured at loose housed *Bos taurus* species with access to meadow. The described behaviours will also be recorded in the semi-wild oxen.

Ruminating can be noticed by chewing by opening the jaw vertically, striking out with the lower jaw diagonally, grinding by passing of the lower jaw on the upper teeth (fig. 11; Bijsterbosch, 2013). The time in which each bolus, the mass of food that gets ruminated, lasts about one minute. Per day 10-15 periods of ruminating happen of which each lasts about 30 minutes. 80% of ruminating happens while lying. (Sambraus, 1978) Before rumination can begin, the animal needs to be relaxed and in a calm situation (Ekesbo, 2011).

Figure 11 Ruminating

In contrast to other grazers like horses, cattle are not able to sleep while standing. If possible, *Bos taurus* species choose open areas, which are not exposed to the wind for laying. (Ekesbo, 2011) Before laying down (fig. 12; Bijsterbosch, 2013), they usually scratch the ground with the fore feed, which causes flat hollows. If these hollows already exist due to already frequent usage, scratching is not shown before lying down anymore. On average, cows lay 600 minutes per day, while bulls lay 100 min longer. (Sambraus, 1978)

Figure 12 Laying

The frequency and mass of defecation depends on rigidity and mass of food, as well as on season and temperature. On average cattle defecate 10-15 times per day under high food offer circumstances. Under harsh circumstances, like low food availability and dry season, defecation happens only 4-8 times per day. Healthy animals always excrete dung only while standing or walking. Defecation happens in higher frequencies in stress-situations. Those excretions have a higher water proportion. While urinating, bulls raise their tail. But in contrast to cows, the back of bulls stays strait. Oxen do not extend their penis while urinating due to castration (fig. 13; Bijsterbosch, 2013). (Sambraus,

1978) In shrub areas, such as forest or heath land, it was there fore almost never noticeable when an animal was urinating. Hence, the behaviours defecation and urination were combined and recorded as excretion in the present research.

Figure 13 Urinating without extended penis

Like most prey animals, *Bos taurus* species are very cautious when experiencing something new or strange in their surroundings. In such situations, cattle usually stampede *fast* readily if they are frightened by the new or unknown. (Ekesbo, 2011) If danger is far enough away, they first calculate if stampeding is necessary by exploring (fig. 14; Bijsterbosch, 2013).

Figure 14 Oxen explore an approaching person

Individual recognition

Being able to distinguish the individuals of the group, discerning characteristics had to be found. Therefore the colour of the fur and the position of horns were recorded per individual.

The group consists of one black ox, 4 yellow and 9 red oxen. Of the yellow and red animals the position of horns was described in more detail: Symmetry, or lack in, of both horns is the first conspicuous feature. With angle of the horn, angle of incline from the horn is described. Some horns are formed more or less straight, almost seeming to have an angle of 180^{o} , while others have an angle of about 120^{o}. The tops are either directed outwards, inwards to the face, up or to the front (fig.15; Leerschool, 2013).

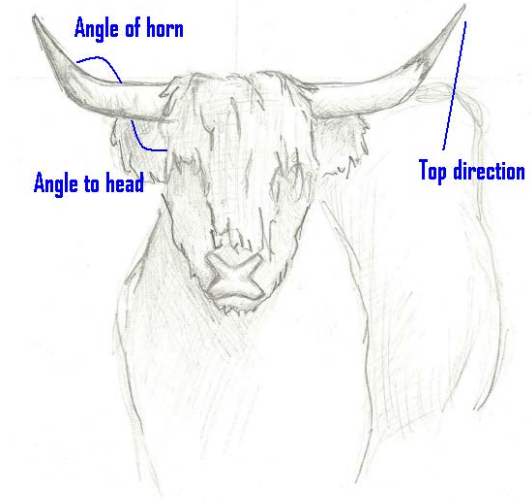

Figure 15. **Description of horn position from the front**

With angle to the head the lateral position of the horn is described. From the frontal view in figure15it is an angle of 90^{o}, some other horns are positioned at a smaller angle, too. The end of the horn can be positioned above eye- or nose-level, which can be seen from a lateral view more easily (fig. 16; Leerschool, 2013).

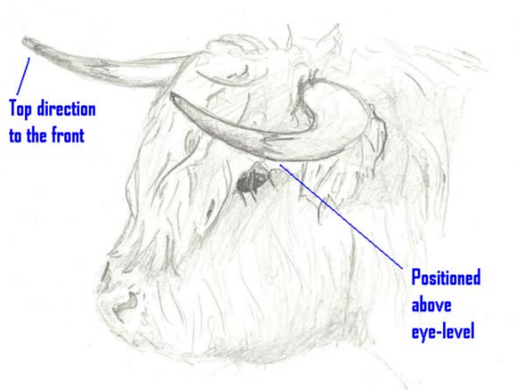

Figure 16.Lateral description of horn position

All specifications of the horns could only be estimated from distance and are therefore not measured accurately.

The particular individuals used for the study were only individualised by their fur colour and horn position. In some researches animals have also been marked by colours with a small stripe at both sides of their flank. (De Miguel et al.,1991; Kaufmann et al.,2013) This group of SHC is very shy and not used to be handled by humans. These animals could therefore not be marked without any serious intervention. It was therefore decided to use the fur colour and horn variance which was slightly more difficult for the observers, but less intrusive for the animals.

The characteristics used for identification of the 8 individuals forming the study species are described in table 2 (Bijsterbosch; Heising; Schröder, 2013):

Table 2.Morphological characteristics of study population

Ox number	Characteristics	Picture
I	Yellow; one of the two yellow oxen whose horn tops are directed upward, steep horn angle of about 110°	
II	Yellow; second of the two yellow oxen whose horn tops are directed upward, horn angle of about 140°	
III	Black	
IV	Red; asymmetric horns, both tops directed inwards, left horn: ends on eye-level right horn: ends on nose-level	

V	Red; asymmetric horns, both tops directed inwards, left horn: ends on eye-level right horn: ends above eye-level	
VI	Yellow; angle to head about 80^o, Horn tops directed to the front, while positioned on eye-level	
VII	Yellow; angle of horn about 120^o, direction of tops upwards	
VIII	Red; angle to head about 80^o,direction of tops to the front	

Weather

Weather conditions were measured to identify a possible explanatory factor for behavioural and spatial preferences of the SH oxen. Environmental conditions play an important role also in husbandry. By measuring the external factors in natural circumstances, the results of influence on behaviour could then also implementable for extrapolation to studies in the husbandry-sector.

For assessing the different weather variables, several methods were used depending on the specific variable: In the Pilot, standardised tests in the field have been done with a mobile weather station, model *Testo 410-2*. The data did not differ significantly from those of a fixed meteorological station at a linear distance of 5km in the village Appelscha. Measurements were carried out with the model

*Cresta PMT 980*there.In addition to the mobile weather station this model also records solar radiation and wind direction.

Per variable the appropriated method is described below. These factors were noted on the worksheet retro actively. These following variables were thoroughly assessed with a ratio scale: Precipitation (mm/h) is recorded at a standard height of 2,5m.Together with temperature (degrees Celsius), humidity (%) is measured at a height of 3m. Velocity (km/h) is measured at a height of 12mas well as the nominal scale variable wind direction (South/West/etc.). Solar radiation was also measured in ratio scale (watt/m²).

Every 5th minute the meteorological data were updated online, so that they could be read easily afterwards. The data of the variables were taken at the beginning and the end of each focal recording period. Then a mean value could be calculated for each session. The scan samples were directly linked in time with the weather variables.

Day-time

Day-time, or time of day is a period of time during the daylight at which behaviour of the oxen were observed without any artificial light source which could influence their behaviour. As weather variables, also the day time was expected to have a relation with specific behavioural patterns determining their day activity pattern. To be able to make connections with day time and the enactment of specific behaviours, this variable needed to be made operational. This was conceived by dividing day-time into 4 segments consisting out of morning, noon, afternoon and evening. Considering each month has a different duration of day-light periods, the 4 segments were adapted to each month proportionally.

In table 3 the mean times of sunset and sunrise are shown in each month within period of data collection. In adaption to that, the 4 segments are calculated.

Table 3.Time schedule for data collection-period

	February	March	April
Sunrise	8:15 am	7:15 am	7:05 am
Sunset	5:30pm	6:35 pm	8:20 pm
Segments (ca.):	2h, 20min	2h, 50min	3h, 20min
Morning	8:15 am - 10:35 am	7:15 am – 10:05 am	7:05 am – 10:25 am
Noon	10:35 am – 12:50 pm	10:05 am – 12:55 pm	10:25 am – 1:45 pm
Afternoon	12:50 pm – 3:10 pm	12:55 pm – 3:45 pm	1:45 pm – 5:05 pm
Evening	3:10 pm – 5:30 pm	3:45 pm – 6:35 pm	5:05 pm – 8:20 pm

4 Data-preparation & Analysis

4.1 Data preparation

For both sampling methods individual code books were established. For focal sampling, data was registered with a population size of all identifiable oxen; N=8. The scan samples were registered with a population size of N=14 to get an impression of overall behaviour and animal displacement. Of these 14 oxen, only the same 8 oxen as in focal sampling were identified plus a ninth one. The mean behaviour of the remaining 5 oxen was calculated to get congruous data with the identified 9 individuals.

As data of both methods were processed into separate codebooks, analysis was also done separately. The results of both methods were compared afterwards.

4.2 Data analysis

During pre-data-analysis, the assumption of using the scan method for the state behaviours and focal for event behaviours, was tested in comparing both datasets (see App. VIII).
This was achieved through aggregating both datasets in total percentages per animal (1 – 8) and per behaviour (1 – 14).

Both methods were instigated for different approaches, but were based on the same method and were practised simultaneously. They were tested as paired samples using paired sample t-test.

To get an overtime idea of the consistency of both methods, the means of behaviour were calculated per week as one observation-unit. The 4 workdays were used to get an even distribution of the amount of recorded animals. Not every individual could be recorded daily due to being out of sight and thus daily distributions were not even for both methods. Moreover, observations took place only during 2 day-periods, each. When calculating the mean of 4 working days, each day-period was included twice per observation-unit. These weekly means of behaviour with N=8 (for each identifiable ox) were then also tested for both methods with the paired sample t-test.

To get insight in the measure of consistency of behaviour between individuals, the scores of the mean weekly state behaviours, which were paired samples since the oxen were measured simultaneously and are thus related, are tested for differences using the Friedman pair wise comparison test.

The assumption was made that behaviour frequency is related to time of day. Day-time was split into 4 segments because of limited sample size. Relative frequencies of behaviour were then compared between the 4 day-times. Behavioural data per day time were considered to be related due to testing the same N=8. They were tested for significant differences using the Friedman pair wise comparison test.

The weather variables were measured at every scan sample and were mediated for every half hour focal sample. To create a testable sample size, the mean of the ratio scalded weather variables; temperature, humidity, wind force, radiation, precipitation which are all ratio scaled, was taken per day half. For the half days, a new variable was created with 1 and 2 (1=morning + noon & 2=afternoon + evening) to incorporate time of day behaviour patterns which would otherwise bias the effects of weather on behaviour. All weather variables were tested for normality. Radiation and precipitation were divided into classes with 1 d.f. because of profound skewness and kurtosis due to the abundant zero values, thus capacitating usage in the GLM model. The ratio scaled variables were put in GLM as covariates, radiation and precipitation as random factors and day-time as a fixed factor. All behaviours were then checked for normality, if homoscedastic and for linearity of the residuals. Variables were manually removed from the GLM-model to achieve the highest significance.

The percentages of habitat occurrence were calculated from the overall numbers of scans per habitat (n=29) and classed into the four basic habitats (heathland, meadow, forest and meadow-forest edge).

The relation of variation in frequency of behaviour and habitat is tested through the use of the four classes of habitats. Percentages were then calculated per behaviour, per animal, per habitat. Also the percentages were calculated per behaviour, of which of each behaviour 100% lies in the four habitats and an insight of the proportions of each behaviour per habitat is created (e.g. Foraging: meadow:50%, forest edge:25%, Heathland:15%, Forest:10%). In following, the dataset was restructured with habitat as the index variable in order to perform the Friedman pair wise comparison test and the respective significances were tested of each behaviour in relation to habitat.

The possible relation between habitat and day-time was exposed with the calculation of percentages of habitat use per daytime per week. The differences in percentage of habitat use per daytime were tested for significance with the Friedman's 2-way ANOVA pair wise comparison.

The behaviours were subdivided into active and resting related behaviours. The four main behaviours, foraging, walking, ruminating and laying, which are the state behaviours, were used to describe the activity-rest distinction. The event behaviours were not considered because of the meagre percentage they contribute and did not significantly affect the differentiation. Total percentages of active (foraging & walking) and resting (ruminating & laying) related behaviours were calculated for each of the oxen (n=8). The activity and rest proportion was then tested for respective significant difference with the paired sample t-test. Active and resting proportions were then calculated for four daytimes and for each of 13 hours after sunrise. Finally the mean frequency of active behaviour was then calculated over time, mediated per week, to discover a possibly trend.

5 Results

The results are based on 34 days within 9 weeks of behaviour-sampling.
In total, ox 1 and 7 have been sampled 34 times, ox 2 31 times, ox 3 and 4 38 times, ox 5 and 8 36 times and ox 6 has been observed 37 times (table 4).

Table 4 Total counts of focal sampling per individual

Ox number	Counts of focal samples
1	34
2	31
3	38
4	38
5	36
6	37
7	34
8	36

Table 5 Total counts of focal sampling per measurement-period

Measurement-period	Counts of focal samples
Morning	59
Noon	76
Afternoon	74
Evening	75

Because of animals out of site, also discrepancies in even distributed counts per day-period occurred (table5): Over the whole 34 days, 59 focal-samples have been taken in the morning, 76 in the noon, 74 in the afternoon and 75 in the evening. In total 284 focal samples have been taken.
Scan samples of all 14 oxen were taken in 15 minute intervals every day. Also the number of scans differ per week (table 6): 39 scans have been sampled in week 1; 53 scans in week 2 and 7; 40 in week 3; 59 in week 4 and 5; 49 in week 6; 45 in week 8 and 42 scans were taken in week 9.

Table 6 Total counts of scan sampling per week

Week	Counts of scan samples
1	39
2	53
3	40
4	59
5	59
6	49
7	53
8	45
9	42

Table 7 Total counts of scan samples per measurement-period

Measurement-period	Counts of scan samples
Morning	110
Noon	114
Afternoon	104
Evening	111

Within the number of scans per day-period, discrepancies are low (table7): In the morning, scans have been sampled 110 times; 114 scans were sampled in the noon, 104 in the afternoon and 111 in the evening. In total 439 scans have been taken over the 34 days.

Table 8 Counts of a total of 5.436 instances of scan samples per state behaviour

Behaviour	Counts of scan sample-instances
Foraging	2.981
Walking	632
Laying	746
Ruminating	540

With the scan method 5.436 instances of behaviour were measured of which, 2.981 instances of foraging were recorded, 632 instances of walking, 746 instances of laying and 540 instances of ruminating which makes out a total 91,6% of total scans (table 8). In hours this means from beginning to end of the study period (taking the varying day length in account) that, per day 4:50h – 7:42h was spend on foraging, 0:50h – 1:52h was spend on walking, 1:40h – 0:47h was spend on laying and 1:07h – 0:47h was spend on ruminating while standing.

With the focal method 23.189 instances of behaviour were measured of which, running was observed 49 times, scratching horn 325 times, scratching foot 42 times, scratching object 954 times, grooming 352 times, exploring 348 times, agonistic action 138 times, agonistic reaction 26 times and excretion 33 times (table 9).

Table 9 Counts of a total of 23.189 instances of focal samples per event behaviour

Behaviour	Counts of focal sample-instances
Running	49
Scratching horn	325
Scratching foot	42
Scratching object	954
Grooming	352
Exploring	348
Agonistic action	138
Agonistic reaction	26
Excretion	33

5.1 Individual behaviour

The behaviours, which have been observed, were: Foraging, walking, running, scratching horn, scratching foot, scratching object, grooming, exploring, agonistic action, agonistic reaction, laying, ruminating, and excretion. (Ethogram, App. I)

In the following figures the percentage of behaviour occurrence are illustrated per ox. The state behaviours are displayed based on the scan database (fig. 19), while the event behaviours are displayed based on the focal database (fig. 20).

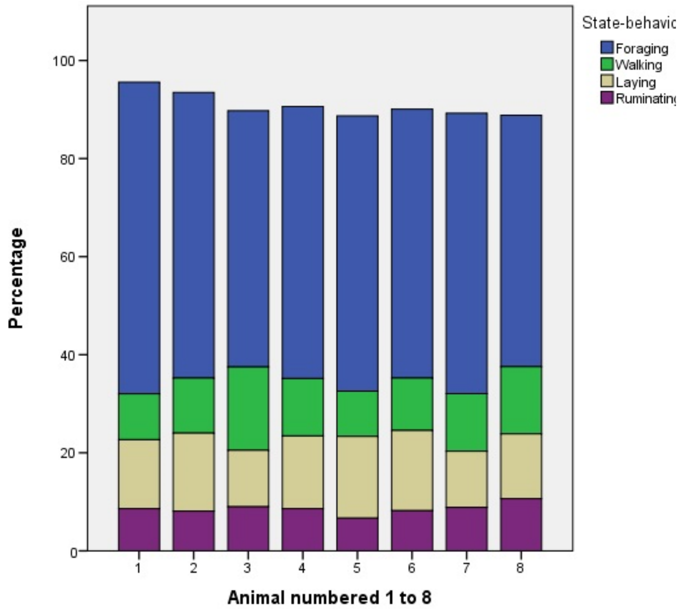

Figure 19 Occurrence of state behaviours per ox based on scan data base

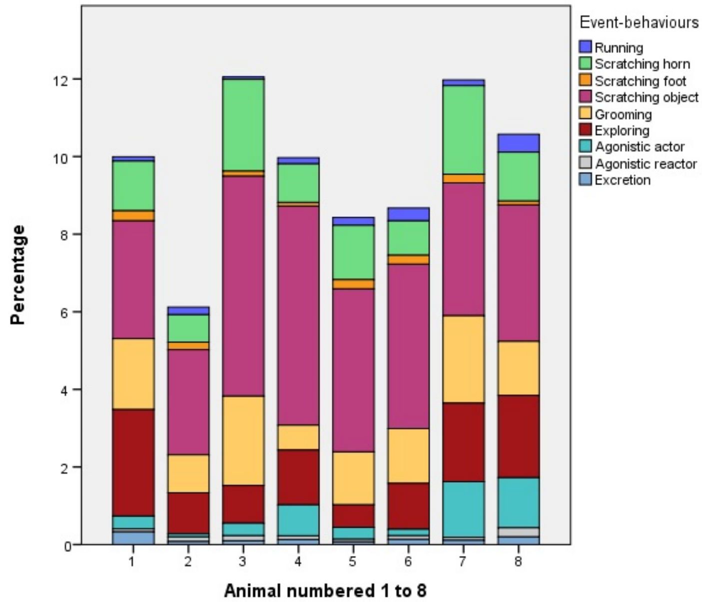

Figure 20 Occurrence of event behaviours per ox based on focal data base

As illustrated in figure 19, the behaviours foraging, walking, laying and ruminating make up most part of the 13 behaviours. Those 4 main behaviours are used for further calculations as representative behaviours for active- (foraging and walking) and resting-related behaviours (laying and ruminating). In scratching behaviours, objects are mostly used, while scratching with feet is least performed. Excretion, running and agonistic behaviours have almost never been performed.

Of state behaviours, foraging, ruminating and laying were consistent in the group and varied little with no significant differences amongst the oxen (x^2=13,79, d.f.=7, P =0,055; x^2=10,85, d.f.=7, P =0,145; x^2=5,84, d.f.=7, P =0,562). Walking was partly consistent throughout the group apart from a single deviation (x^2=17,12, d.f.=7, P =0,017): Ox 3 and ox 5 showed significantly different measures of walking (x^2, d.f.=7, P =0,030) with ox 5 at the higher end and ox 3 at in the lower spectrum.

In event behaviours, scratching foot and scratching object were similarly shown in the group and no significant differences were found (x^2=3,28, d.f.=7,. P =0,858; x^2=5,21, d.f.=7, P =0,635). Scratching horn was tested significantly different overall, but did not result in any pair wise significances (x^2=16,10, d.f.=7, P =0,024). Grooming was also tested significantly different between some group members (x^2=24,85, d.f.=7, P =0,001): Oxen 2, 3, 4 and 7 showed deviations, with oxen 7 and 3 showing relatively more grooming behaviour and 2 and 4 relatively less than the group resulting in significant differences between 2 and 3 (P =0,030) , 2 and 7 (P =0,018), 4 and 3(P =0,035) and 4 and 7 (P=0,021).

5.2 Habitat use

With about 57%, the oxen spend over half of their time on the meadow. The remaining three habitat-types where habituated in descending order: Forest +/- 18%; Heathland +/- 15%; Meadow-Forest edge +/- 10% (fig. 22).

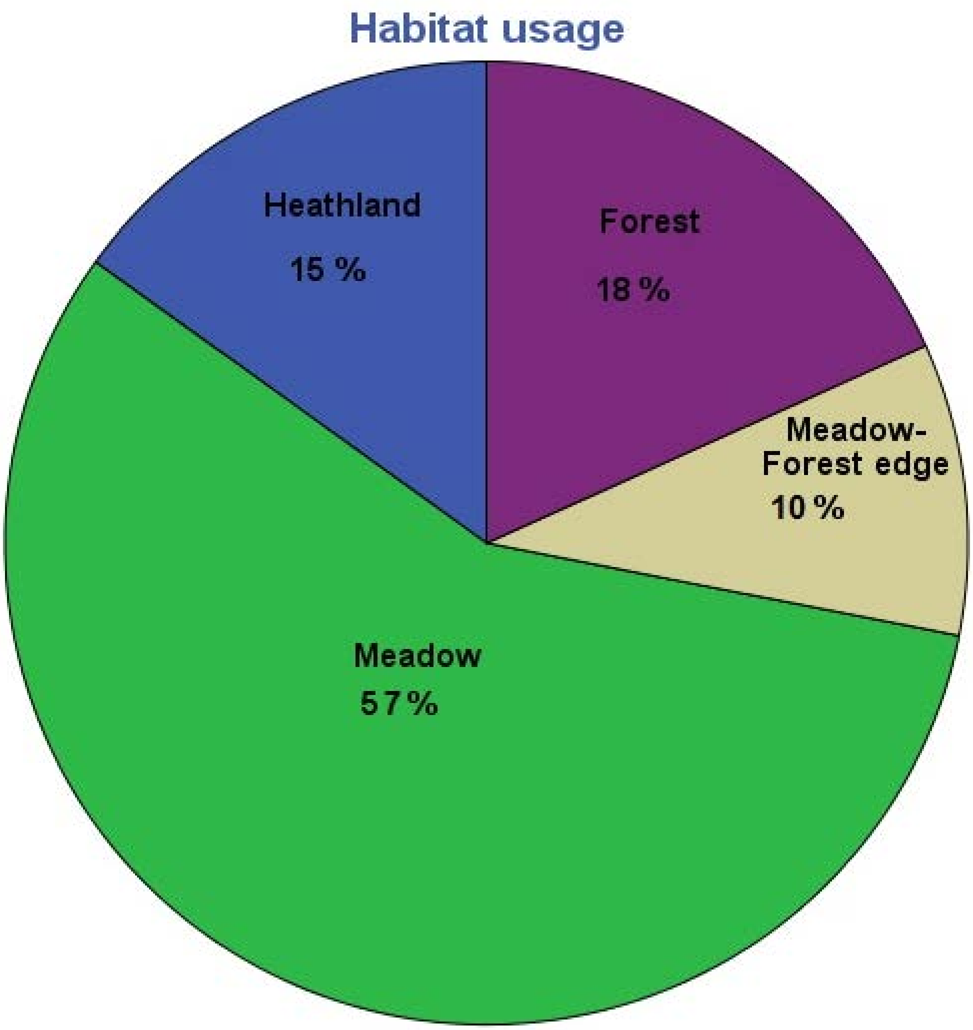

Figure 22. Overall habitat usage of the group of oxen.

There was no clear pattern found of mean percentage of usage per habitat type over the 9 weeks. Figure 23showsthe percentage of area usage per habitat type. The main heathland areas used by the oxen, are area 4 (fig.24)with about 67%, followed by area 8 with about 29%. Only four of the eleven heathland areas have been used (area 4, 5, 8 and 10). In meadow, three of the six areas have been mainly used with about 31% (area 13), 29% (area 14) and 20% (area 12). Five of the seven forest areas have been used, of which area 24 and 27 were preferred with about 39% and 31%. Three of the five areas in meadow-forest-edge have been used, of which area 19 was clearly preferred with about 84%.

Map 5 represents the numbering of the habitat types' sub areas. The total areas of each habitat type are as follows: Forest covers an area of 73%, heathland 15%, meadow 11% and meadow-forest edge only 1% of the Prinsenbos. Relative to area size however, clear preferences are established. Preference is in descending order: Meadow- forest edge, Meadow, Heathland and Forest (table 5).

Table 10. Relative usage of habitat-types derived from area size and actual usage

Habitat-type	Usage	Area size	Calculation $(U/A)/(\sum_{U/A})*100$	Relative usage
Forest	18%	159ha	0.11/6.17*100=	2%
Heathland	15%	33ha	2.28/6.17*100=	7%
Meadow	57%	25ha	0.45/6.17*100=	37%
Meadow- Forest edge	10%	3ha	3.33/6.17*100=	54%

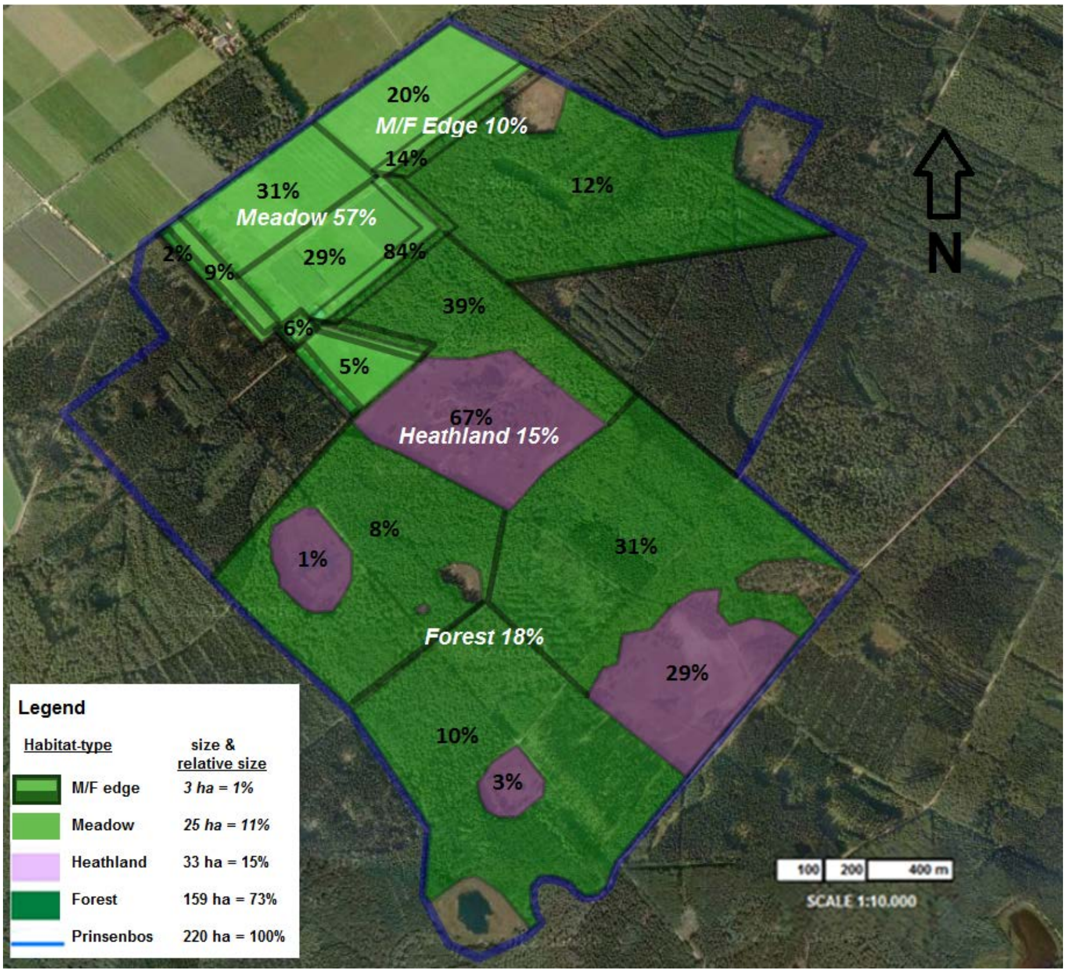

Figure 23 Study area sub-divided into 4 main habitat types with percentages of usage.
The black coloured percentages are calculated in usage per habitat type. The uncoloured areas have not been visited. The white coloured percentages represent the usage of the habitat types in the total study area.

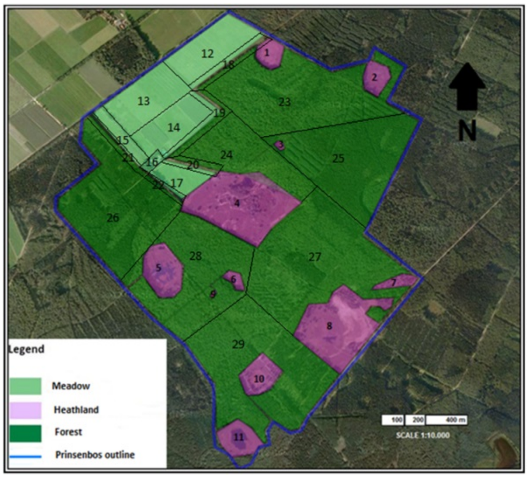

Figure 24 The Prinsenbos sub-divided into 4 main habitat types with area numbering

Behaviour frequency per habitat-type

The occurrences per main-behaviour in each habitat have been compared: All of the 4 main behaviours show significant differences in behaviour occurrence per habitat type (foraging:X^2=32,533, d.f.=3, P=<0,001; walking:X^2=21,933, d.f.=3, P=<0,001; laying: X^2=25,133, d.f.=3, P=<0,001; ruminating: X^2=20,056, d.f.=3, P= <0,001).

The various pairwise respective significant differences in performance per behaviour between the several habitat types, as shown in figure25, are as followed:
The occurrence of foraging was shown significantly more in meadow than in meadow-forest-edge (P=0,002),more in forest than in meadow-forest-edge and (P=<0,001) and more in forest than in heathland (P=0,021). Walking was shown with a significantly more in forest than in meadow-forest-edge (P=<0,001)and more than in heathland (P=0,011).
Laying occurred significantly more in heathland than in forest (P=0,002), more in meadow-forest-edge than forest (P.=<0,001) and more than in meadow (P=0,021).
Ruminating occurred significantly more in meadow-forest-edge than heathland (P=0,001) and between than in and forest (P=0,001).

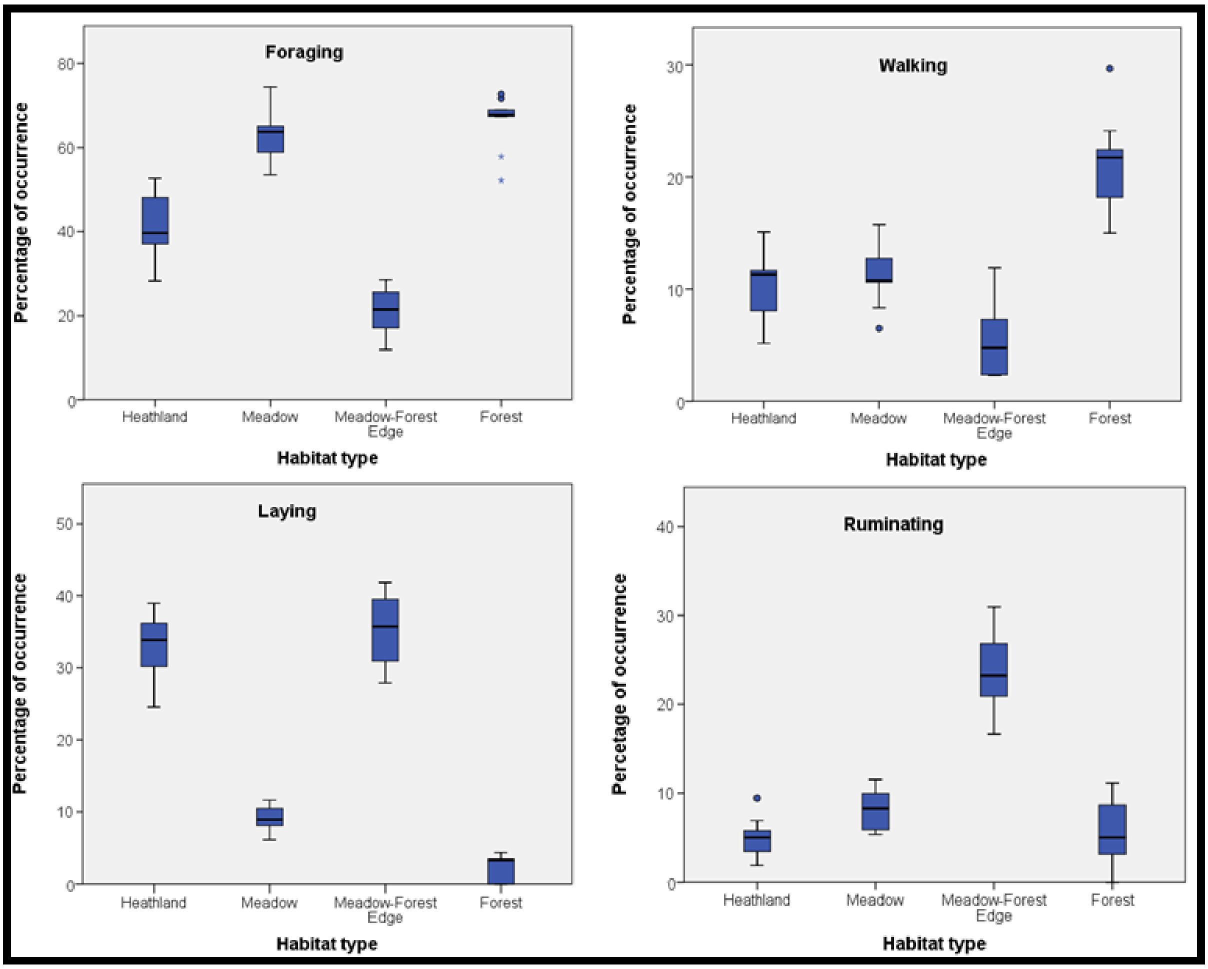

Figure 25 Comparison of occurrence between the habitat-types per main behaviour (N=9).

The following figure (26) illustrates the total percentages per behaviour divided by the four habitat types. All of the 4 behaviours are executed most while in the meadow. Laying is the most occurring behaviour in heathland. In meadow-forest-edge, ruminating is the most frequent behaviour. Forest is mostly used for walking and foraging. It is also clear that laying is almost non-occurring in the forest.

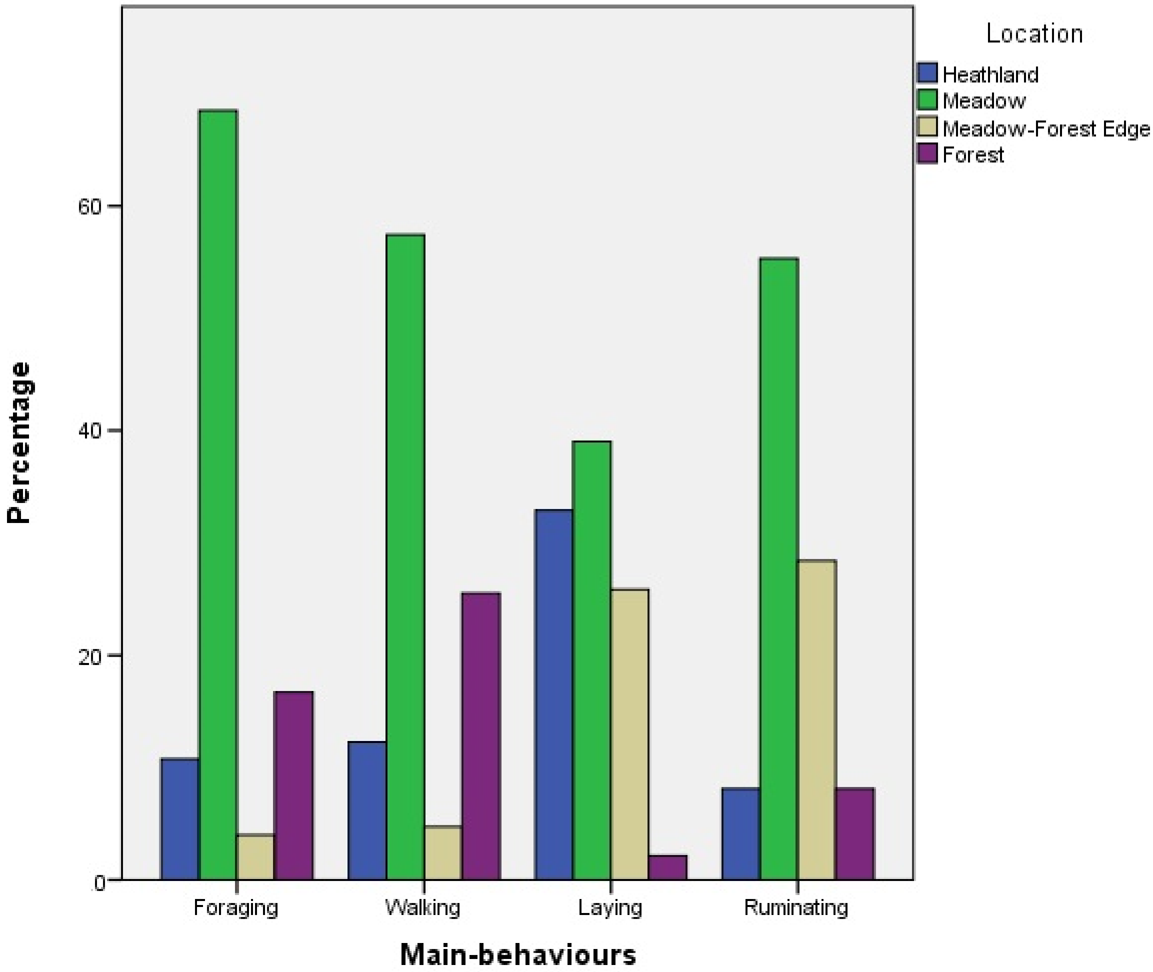

Figure 2 Total percentage of habitat usage per behaviour

Figure 27 shows the total percentage of behaviour occurrence per habitat. The left out percentages are the remaining behaviours which make out, clearly illustrated here, a very small percentage of overall behaviour. Heathland is mainly used for foraging and laying, while meadow and forest are mainly used for foraging. The time spend in meadow-forest-edge is mainly filled with resting related behaviours (laying followed by ruminating). Other than in the remaining habitat types, in heathland active- as well as resting related behaviours occurred with a more or less even distribution.

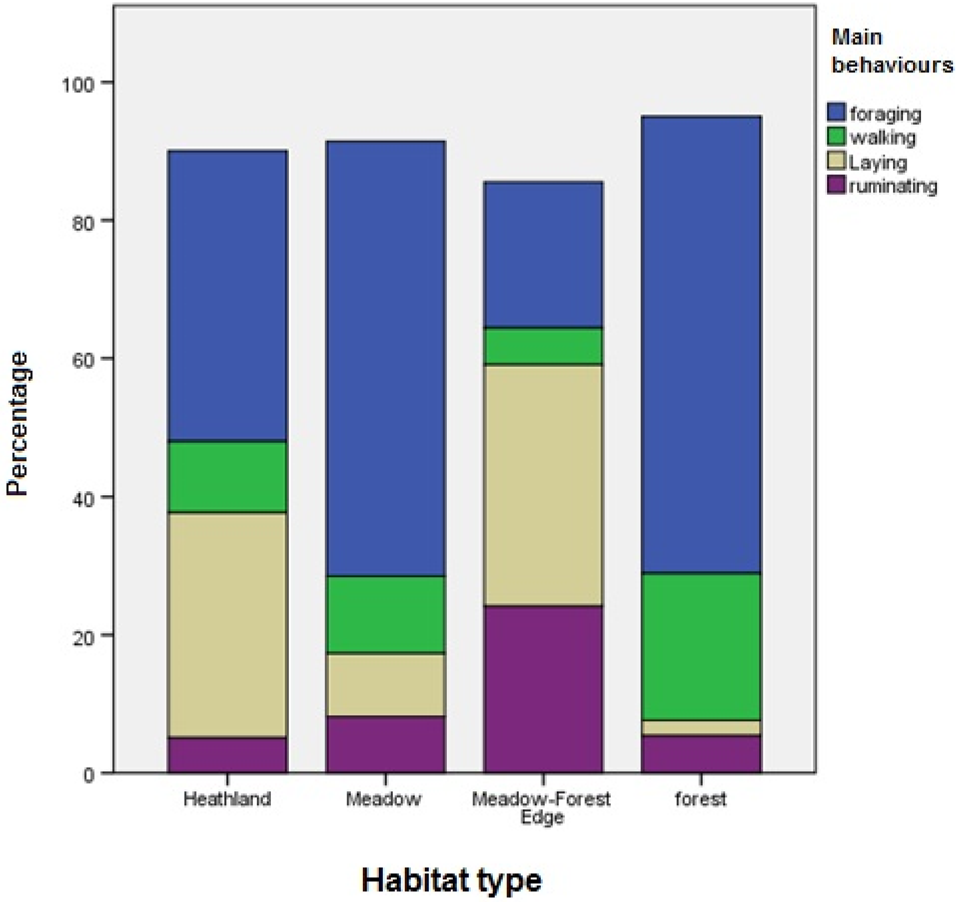

Figure 27 **Percentage of behaviour occurrence per habitat type**

Habitat use over the day

In figure28 the distribution of habitat usage per day period is illustrated. Meadow is most used in each day-period. Forest, as second most used habitat, has a high usage in the morning with almost 40%, while it is never used in the afternoon and shows a significant difference between those daytimes (X^2=13,435, d.f.=3, *P*=0,004). Heathland is the third most used habitat followed by meadow-forest-edge. By looking at each single habitat, it is noticeable that each habitat type has a different day-time in which it is mostly used by the oxen, but other than forest in morning and afternoon, no significant differences are found between day times.

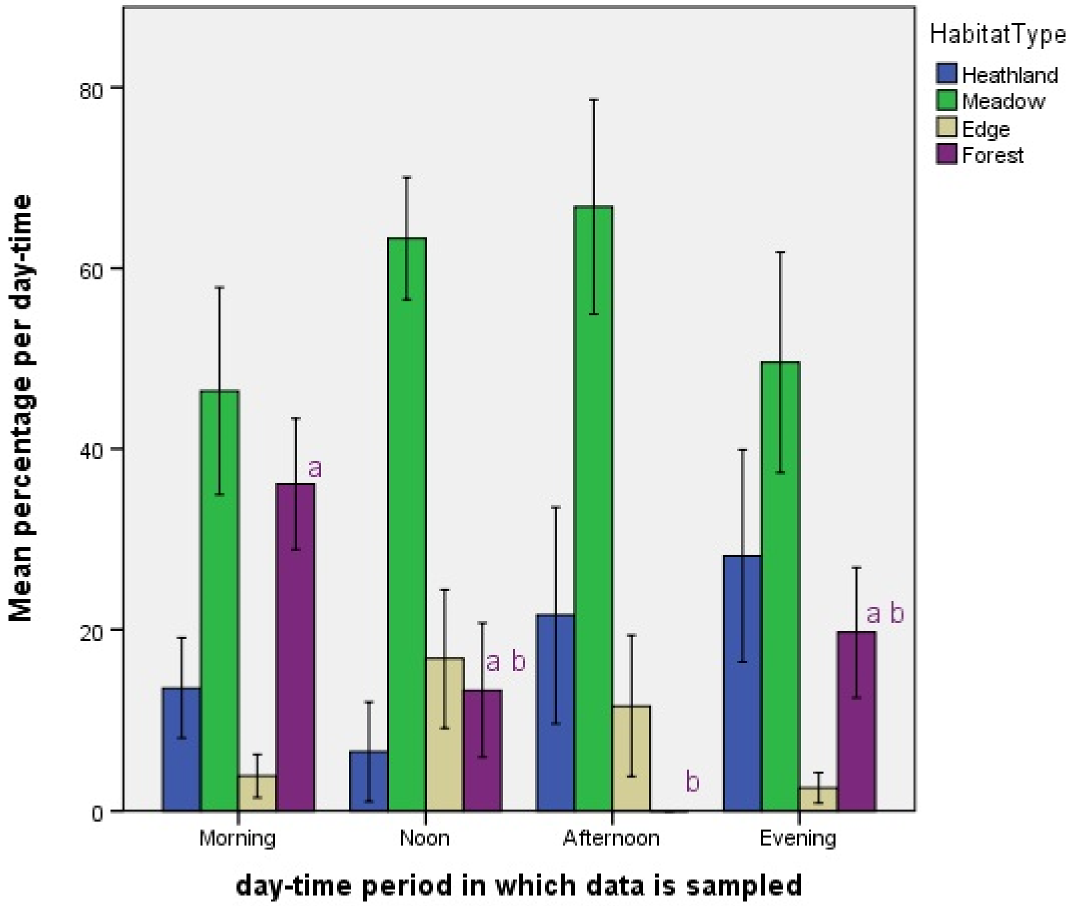

Figure 28. Proportions of habitat use per day-times
Habitat use is calculated of the weekly mean per day-time.
The single deviation is found in the morning and afternoon difference of forest use (a, b)

5.3 Behaviour over the day

Occurrence of each of the 4 main behaviours during the day (fig.21) clearly illustrates that foraging is the most occurring behaviour. A diurnal behaviour pattern can be seen in this graph: The day begins with foraging and walking with complete absence of laying in the morning. In the noon, both behaviours decline and are alternated by laying and ruminating. Further on, in the afternoon, ruminating declines, while the percentages of time spend laying peaks. Foraging and walking replace laying and ruminating in the evening, again. Walking is least affected by daytime of the four behaviours.

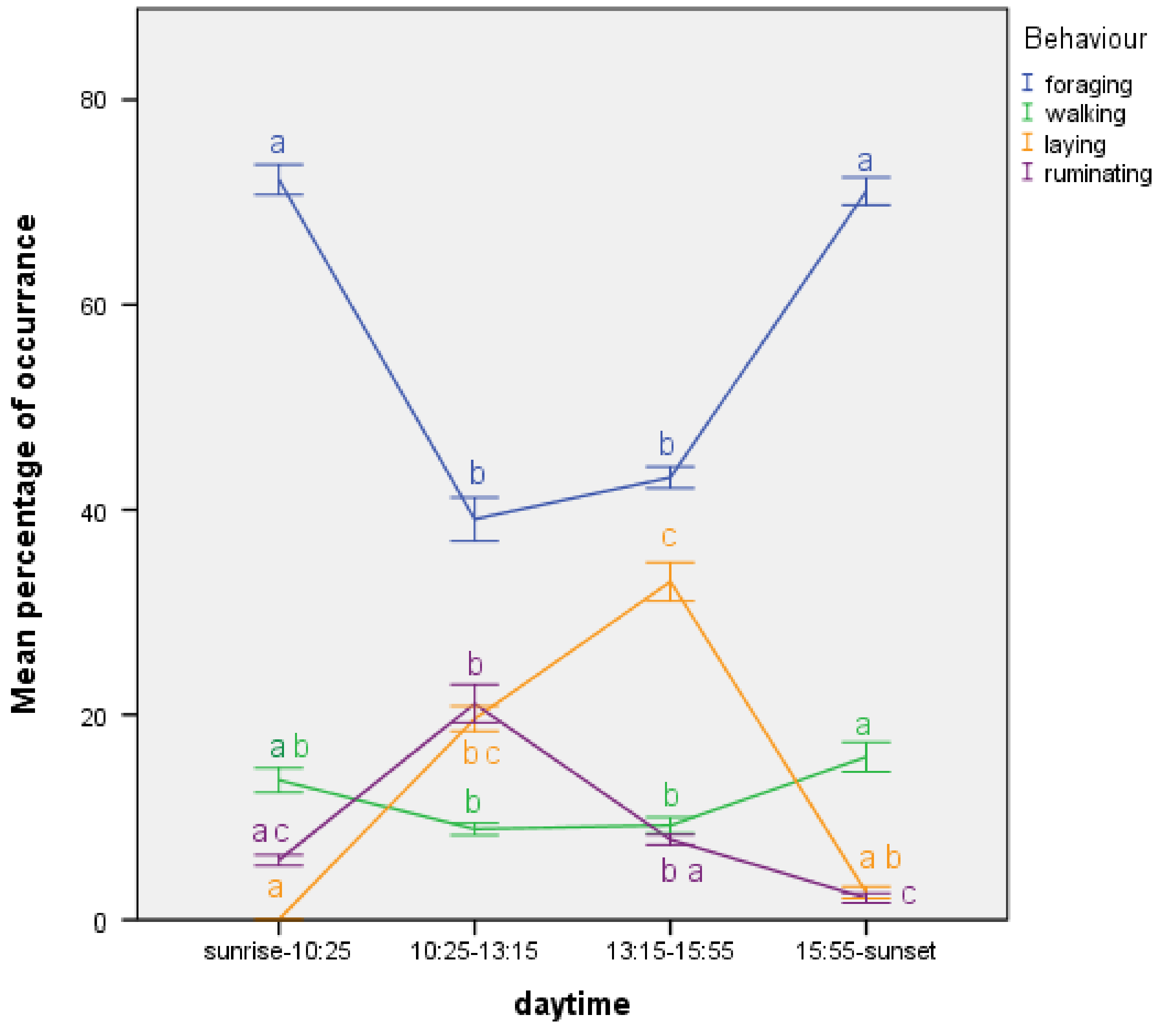

Figure 21 Mean occurrence of state behaviours over the day

The percentages are the mean of occurrence per behaviour, per day time and the error bars show the standard error (N=8). The non-coincident letters illustrate significant differentiation per behaviour.

The day-times where subject to change over the nine weeks in relation to increase in day length and the times here are an generalisation of the actual times.

All state-behaviours show a significant difference in performance between the several day-times (foraging: X^2=24,600, d.f.=3, P=0,00; walking: X^2=14,520, d.f.=3, P=0,02; exploring: X^2=12,402, d.f.=3, P=0,006; laying: X^2=28,920, d.f.=3, P=0,00; ruminating: X^2=27,480, d.f.=3, P= 0,00). Scratching object was tested significantly different overall, but did not result in any pairwise significances (X^2=8,280, d.f.=3, P= 0,041).

Day-time effects on event-behaviour showed only a significant difference with grooming (X^2=11,400, d.f.=3, P=0,010).

The exact pairwise differences in day-times are as follows: Between noon and evening, the occurrence of foraging, walking, grooming and ruminating differed significantly (P =0,002; 0,034; 0,040; <0,001). The behaviours foraging, exploring, laying and ruminating occurred significantly different between noon and morning (P =<0,001; 0,015; 0,002; 0,019). Between afternoon and evening, foraging, walking, laying and ruminating differed significantly (P =0,019; 0,006; 0,006; 0,019). Between afternoon and morning, the occurrence of foraging and laying differed significantly (P =0,006; <0,001). Only in grooming a significant difference was shown between evening and morning (P =0,012).

5.4 Weather as an external factor

In the 34 days, only 6 days provided measurements of rain. Several degrees of radiation were measured at almost half the days with 16 days out of 34. Average day temperature ranged from -1,5 to 11 degrees Celsius with an overall mean temperature of 3,4 in the first 2 day periods and 4,6 degrees in the last 2 day periods. Daily averaged wind force ranged from 1,72 up to 24,84 km/h, with a mean of 11,15 km/h. Humidity varied with percentages ranging from 35 up to 96 as a daily average with a mean of 73 % humidity.

Most measured weather variables did not have a significant effect on frequency and duration of behaviours. Temperature, humidity, precipitation and wind force have not resulted in a significant increase, or decrease in any of the measured behaviours.
Radiation, when restructured into two classes (low rad. / high rad.), had a negative effect on frequency of horn scratching (GLM: F_1 =9,808, P =0,004) with a predictive value of over 25 %.

5.5 Active and resting related behaviour

2 main behaviours as representatives of each behaviour group are shown in this graph: Foraging and walking are the main active related behaviours and laying and ruminating are the main resting related behaviours. The total proportion of active and resting related main behaviours can be seen in figure 29: Of active related behaviours, foraging makes up about 62% and walking 13% of the total shown behaviour, while the representatives of resting related behaviours are only performed with about 16% of laying and 9% of ruminating.

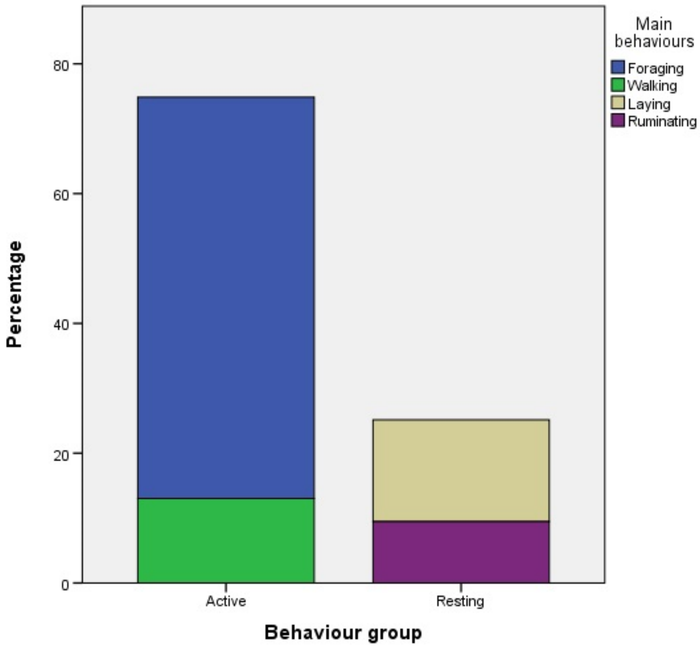

Figure 29 Mean percentage of occurrence per behaviour group.

In figure29 the proportion of active and resting related behaviours is shown with the mean percentage of occurrence of main behaviours. The occurrence of active related behaviours with about 75% is clearly higher than the occurrence of resting related behaviours with about 25%.

The 4 main behaviours foraging and walking, and laying and ruminating have been tested as representatives for active and resting related behaviours. A significant difference between the 2 behaviour groups was found (t(7)= 22,408, P=<0.001).

The distribution of active and resting related behaviours over the day (fig. 31) shows that the oxen are more active than in rest over the whole day. Only in the noon, 5 hours after sunrise, the percentage of resting related behaviour is higher than the one of active related behaviours.

A clear difference in proportion of activity and rest is seen between the congruous morning and evening period and the similar noon and afternoon periods. The first and the last day periods show a large difference in active and resting behaviour, with a pronounced active spectrum. Between the two mid-day periods, a less pronounced difference is shown; with activity and rest being similar in proportion.

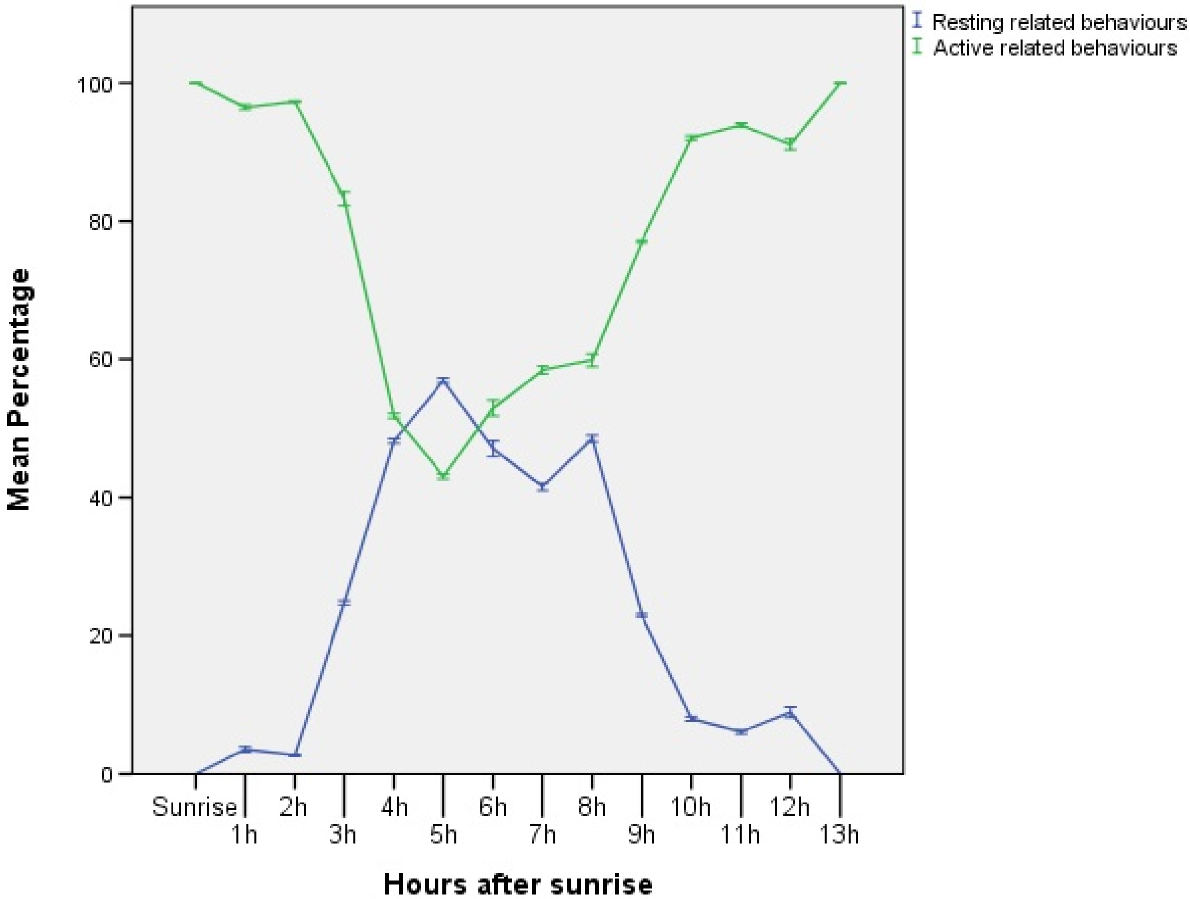

Figure 30 Mean percentages of both behaviour groups over the day. The standard errors show the deviation of the several days.

When looking at the activity variation over the 9 weeks, the mean percentage of active behaviour per week rises relatively congruous from about 70% in week one to almost 90% in week nine. Nevertheless, there is no significant difference in percentage of activity between the 9 study weeks. Neither a relation with week or temperature was found. The variable day-time was also tested for significant effects, but none were found, either.

6 Discussion

6.1 Approach of behaviours

The behaviours were divided into state and event behaviours. The state behaviours being: Foraging, Walking, Ruminating and Laying. These behaviours were also considered the main behaviours because over 90% of the scans consisted of these behaviours, whereas in other *Bos taurus* spec. studies these behaviours accounted for over 95% of total time spend (Herbel & Nelson, 1966; Zemo & Klemmedson, 1970; Kilgour et al., 2012). This 5% seems to be of small effect and could be explained by different group compositions. All three studies were performed on groups consisting of both, bulls and cows in semi-commercial conditions. Thus a wider palette of behaviours (e.g. social & mating) was apparent. Furthermore, when social behaviours are more pronounced, the enactment of these relative short term behaviours would be paired with events of walking. Walking was specified as the movement of at least all four limbs and no distinction was made between short events and longer distance travelling. The short events, mostly in between foraging bouts, were as such more likely to be missed with the 15 minute scan interval, although the focal results of walking showed a dismissible deviation from the scan results.

The other eight behaviours, which are represented by the remaining 10% of occurrence, are considered as event behaviours. These behaviours are instantaneous and are generally not executed over consecutive moments of time (Altmann, 1974; Martin & Bateson, 2007). These were pre-selected from experience and literature. During the field period however, apart from most behaviours which were performed as expected, the behaviour “scratching object” was performed at several occasions, over longer consecutive periods of time. Animals could be seen taking up to 20 minutes for a single act of scratching at an object. No other study engaged this behaviour as part of the well-known state behaviours, but the duration of the behaviour clearly classes it as a state behaviour. Next to that, most studies focus on grazing related issues, often studied at pastures at semi-commercial conditions, a smaller interest is then put into social behaviours, but the focus on “natural” behaviour has almost never been practised in listed scientific studies (Kilgour et al., 2012; Kilgour, in press)

If, in the context of “natural behaviour”, behaviour is studied with more focus and interest on event behaviours, the resulting sharper definitions and array of event behaviours, would allow for detailed comparisons between animals and/or populations.

6.2 Individual variation in behaviour

Of the 14 oxen eight were individually studied. As these eight oxen all belonged to the same age class and all were hormonally restricted, the assumption was made that individual behaviour would not greatly differ between conspecifics. In following the question was raised on this particular study group, if one individual could represent the whole group and as such could be representative for any group of oxen. Then also group behaviour can be representative for the behaviour of an individual. When looking at individual behaviour and at the intra-specific variation, a distinction could be made between the state and the event behaviours. In this study it was seen that two oxen significantly differed in the amount of walking. But other than this slight divergent movement specificity, no intra-specific deviations in state behaviours were observed. In comparison, the frequency of event behaviours differed greatly between the oxen. Only scratching object and scratching foot were shown on a similar basis, scratching horn differed overall and grooming differed between 4 animals. The other event behaviours were not taken into account because of their relative low frequencies. As the event behaviours are analysed from the focal sampled data, anomalies could have resulted from different spatial or temporal factors since the animals were not sampled simultaneously.

Oxen have been chosen as study species being able to collect standardised data and focus on individual behaviour. Now, that it is known that group behaviour is representative for an individual, it is of interest in what way the behavioural patterns differ from a naturally composed family herd.

In family herds a fixed rate in performance of state behaviours would be expected, while event behaviours might vary more strongly between the individuals. This would be caused by a higher occurrence of social (e.g. allogrooming or agonistic behaviour) and mating behaviour in mixed-sex groups.

6.3 Partial habitat use

Although meadow offers the second smallest range with about 11% of the total study area, the oxen spend over half of their time on this habitat type and thus suggest a preference. The remaining three habitat-types where visited in descending order: Forest, heathland, meadow-forest edge. Also in relation to its small area size, meadow-forest edge (1% of total area) has been visited often (10% of occurrences) and therefore suggests high preference by the oxen. Forest on the other hand is used relatively rare with 18% of time in an area making up 73% of the Prinsenbos. The Prinsenbos consists for 15% out of Heathland and has been used by the oxen for 15% of occurrences. This might be attributed to coincidence; however, considering that only 4 of the 11 heathland areas and therewith much less than 15% of the area, have been used, the usage of certain heathland areas seems to be purposive.

The usage of the relatively small meadow area could be caused by the temporal and energetic constrains, the animals underlie when foraging. (Sinervo 1997-2006) Meadow therewith seems to offer best conditions for optimal foraging, at least during the winter season. A change in habitat usage over time was expected in consequence of the over-season vegetation development. Eventually, no clear pattern was found in mean percentage of usage per habitat type over the 9 weeks. A reason for that might be the harsh and longer lasting winter-period, which resulted in a delayed vegetation development and growth.
Habitat selection might be caused by the offered vegetation alternatives that herbivores recognize making use of all their physical senses and consequences which they have associated with the particular habitat (Bailey et al., 1996; Launchbaugh et al., 2005). Already in 1938, Skinner coined the term 'operant conditioning' and described how animals choose habitats that offer optimal foraging opportunities (Kaufmann et al., 2013). In this line, experiential learning, genetic inheritance, interactions with the environment, and social dynamics, predestine habitat selection in herbivores (Bailey et al., 1989; Launchbaugh et al., 2005; Senft et al., 1983). This would suggest that the oxen's habitat selection is highly dependable on their vegetational demands.

Habitat related behaviour

All of the 4 main state-behaviours showed several significant differences in relative occurrence of behaviour per habitat type. Meadow is the most favoured habitat and in consequence shows the highest frequencies for all main behaviours. Relative to habitat-type usage, a clear distinction of execution of one of the main behaviours is shown per habitat. This would be explained by the offered biotic and a-biotic variations:

According to Ekesbo (2011) cattle preferably lay down in places protected from wind. Body care behaviours of the oxen frequented most before laying down. Tactile stimulation is known to lower the heart rate and therefore has a calming effect on several species (Uvnäs-Moberg & Petersson, 2005). It is thus expected that scratching on objects has a calming effect on the oxen.

Implementation for both behaviours, laying and scratching on objects, requires certain spatial elements. Trees and wood as wind protectors and scratching objects are numerously provided in meadow-forest-edge and forest. Therefore laying and scratching on objects were assumed to be the most occurring behaviours in these two habitat-types. In fact, only meadow-forest-edge was observed to have a profound large proportion of resting related behaviours, while forest, in contrast, was almost fully neglected in the resting aspect. An explanation for this could be cattle's avoidance of sticky ground for laying down (Sambraus, 1978) which is found in the forest. The oxen's laying preference could be induced by the edges' relative soft grass-ground. Next to meadow-forest edge, heathland was also observed being subject to a high proportion of laying behaviour. The explaining a-biotic quality of the heathland in question is probably the slight variation in elevation which offers solace from the wind.

In addition heathland was expected to support the higher variance in behaviour occurrence because of its vegetation- and relief-variation. This expectation has been confirmed, since, other than in the remaining habitat types, in heathland active- as well as resting-related behaviours occurred with a more or less even distribution. Forest instead, is used mostly for active related behaviours, mainly consisting out of walking and seemed to be used as a corridor to reach distant foraging patches. Meadow, also in the active spectrum, is mainly utilised for foraging.

The latter might be caused by the seasonal dependent food availability, assuming that forage quantity is higher at the meadow in winter than at the remaining habitat-types as cattle strive to maximize nutrient intake (Bailey, Et al., 1996 & Senft, Et al., 1987). Another study done by Miguel et al., (1991) proved that in autumn and winter, browsing was observed four times as much as in spring and summer. In consequence, grazing was significantly less observed in autumn and winter. Although the present study was planned to be carried out partly in spring months, the weather circumstances and therewith vegetational development, were at a winter period standard during the whole study period. The resulting behaviour of the oxen can therefore be compared to the results from Miguel et al. in 1991.

Habitat related behaviour should partly be caused by spatial factors; vegetation and relief, but is also dependent on season, as floral species and its developmental stages are also season dependent.

6.4 Day-time related habitat use

Cattle species kept on natural fields with different vegetation types, vary in their diet: After grazing on meadow, they move to an area with different flora. The regular diet can also be combined with buds from deciduous trees. Over all seasons, the average cow's diet is composed out of 72% grass, 15% herbs and 13% shrub. (Ekesbo, 2011) Since the study began in winter season, when not much herb and shrubs occur and meadow seemed to offer the most food availability, the expectation of meadow preference during the whole day was confirmed.

In the morning, the oxen were expected to be found in forest after spending the night in sheltered habitat. However, no clear pattern in habitat usage in the morning could be recorded. For that reason it sometimes took a time to finally find the oxen for observation. Therefore fewer observations took place within the morning periods. But other than forest in morning and afternoon, no significant differences are found between day-times. As a consequence no clear pattern was discovered in habitat use change over the nine weeks, either. This might be caused by the slow vegetation development due to the longer lasting and harsh winter during the study period. It is expected that the oxen forage for the above named food composition in the particular habitat types when it comes to flower.
Except from a variation in area usage, the oxen are still expected to be found in the forest in the morning. Improving the finding potential, one animal of the group could have been provided with telemetric transmitters.
Besides, the SH oxen have been observed while browsing on conifer trees and thus deviate from the above mentioned diet composition. Kaufmann et al. (2013) however, found that free-ranging cattle in Canada usually avoid conifer forests. Further studies are therefore advised to get insight if conifer trees belong to cattle's usual diet or if the oxen only foraged on it because there was just too little regular food available in this winter period.

The meadow was used most at every day period, which is probably caused by more excessive food availability and meadow might be considered as the preferred habitat.

6.5 Behavioural day-pattern

As expected, a diurnal pattern was expressed by the oxen when looking at the main behaviours: The day begins after sunrise with a high proportion of foraging interspersed with short events of walking. Then, in the noon, the animals slowly start to ruminate while standing and the proportion of foraging decreases. Later, around mid-day, the animals lie down and ruminate while laying, while still small margins of foraging and walking are executed. After mid-day the animals become more active again and foraging and locomotion increase to about the same peak they show during the early hours. Around sunset the animals start travelling, interspersed with short foraging events, to what is assumed their night habitat. As the animals were not observed during night, no light was shed on their activity during the dark hours of day. Corresponding day patterns are found in other studies of *Bos taurus* species and night time behaviour is less spend on grazing and more on ruminating and resting (Arnold, 1984; Kilgour et al., 2012; Linnane et al., 2001; Hafez & Schein, 1962; O'Connell et al., 1989). It is said that by spreading food intake, which is seen in this study with the two peaks of foraging, the rumen condition of the oxen stabilizes (Phillips & Hecheimi, 1989) and plant cellular substances are efficiently digested (Van Soest, 1994). The relative "tightness" of the oxen's daily program would then not be explained by an animal's "choice", or "anticipation" of best fit activity, which could contradict the small inter-ox and inter-day deviation, but would rather be dependent on more predictive and fixed external and internal factors. The increase and decrease of light intensity might be a proximate explaining factor for the onset of foraging behaviour (Phillips, 1993). Also, the diurnal variation of sward characteristics would make it nutritionally beneficial for the oxen to forage at the specified times (Provenza et al., 1998).
So what could be said is that the "fixed" behavioural day-pattern is closely related with digestive efficiency.

6.6 Weather effects on behaviour

Environmental factors have been reported as having an effect on diurnal behaviour of cattle (Linnane et al., 2001). The present study provides meagre results on this account. Solely scratching horn seemed dependable for a small amount on the intensity of radiation, which is not reported in any other study. Scratching horn respectively decreased significantly in frequency when radiation reached beyond 200 watt per square meter. It is questionable if the relation between radiation and scratching horn is an actual connection. Furthermore, as the circadian behaviour pattern of cattle is quite inflexible (O'Donnell & Walton, 1969; Stricklin et al., 1976; Ruckebusch & Bueno, 1978)(mostly based on grazing patterns), external factors would be of no significantly large effect. In addition, this study is based upon data which is collected in a short three months without a respectively large variation in weather conditions. A temporal wider database including weather conditions might prove of more extensive results on weather effects.

6.7 Active- and resting-related behaviour

The oxen's internal viability while being subject to changing environmental conditions is maintained through reaction and adaptation (Sterling & Eyer, 1988; McEwen, 1998a, 1998b; Schulkin, 2003). On this basis a distinction was made in active and resting related behaviours. Foraging and walking were counted as active- and laying and ruminating as resting-related behaviours. As expected due to literature research from Linnane et al.(2000) and De Miguel et al. (1991), the oxen are always more active than in rest in each day period. In fact the proportion in the present study was 3 to 1 overall, with a clear pattern over the day. Although the scratching behaviours with horn and foot were considered to be active related behaviours, scratching on an object is classified as resting related behaviour as tactile stimulation is known to lower the heart rate and therefore inducing a calm state in several species (Üvnas-Moberg & Petersson, 2005). Next to that, scratching on an object, in contrast to other body care behaviours, is shown for longer lasting and was mostly performed in coherence with laying and ruminating bouts.

The percentage of active related behaviour occurrence was expected to decline over the weeks in the observation period. The theory was based on the smaller food availability in the beginning of the observation period (begin February) and therefore the oxen had to move more to reach several foraging places. The explanation for the contrasting results could be the increasing day length: The diurnal frequency of active related behaviours of cattle kept under comparable conditions grows with increasing day length. Foraging, which was performed overnight in winter, is performed during day time in spring and summer. (Linnane et al., 2000)

The diurnal patterns of cattle can be influenced by weather conditions and access to shade. In warm weather for instance, cattle spend more time standing and less time laying. (Tucker et al., 2008) It is thought that cattle lose less heat while laying, because air can better circulate around their body when standing. (Tucker, 2009) This might be the reason why laying –and with it resting related behaviour- decreased over the 9 weeks. Moreover, decreased sapling lengths and abundance and increased consumption of material of lesser digestibility as the growing season draws to a close, can increase rumination time (Phillips and Leaver, 1986) A decreasing occurrence of foraging is therefore performed in winter (Stricklin et al., 1976) strengthening the same findings in the present study. Therefore the diurnal proportion of active- and resting- related behaviour is dependent on forage quality and availability, the foraging pattern as well as on day length.

6.8 Effects on environment

As gregarious animals, the oxen make use of the same locations simultaneously. Since little individual behavioural difference is apparent, the environmental impact of an individual is representative for the whole group. The oxen have a higher nutrient intake at the meadow than in the other habitat-types. Through excretion, the oxen distribute the meadow nutrients to the other habitat-types. With the resulting nutrient displacement the oxen would have a high impact on the meadow which would otherwise be subject to a more rapid succession. The displacement of the oxen's feces in forest or heathland favors insect species, which in turn are foraged upon by several bird and rodent species. Next to that, the openness of forest areas, kept open by the oxen, is profitable for predation of several raptor and owl species. (Forestry Commission Scotland, 2013) It is also assumed that the lowest impact by nutrient-output is effective in the forest since this habitat-type is in comparison, rarely used for foraging. Physical impact is expected to be highest in forest and meadow-forest-edge. Twigs and bark could get damaged when trees are used for scratching or are merely passed by, which are common behaviours when the oxen use these particular habitat-types. In result trees can be assumed to flower on a higher level of tree-height over long-term periods. The forage possibilities on buds and flowers by the oxen and other browsers would as such be prevented. However, only particular areas of each habitat type have been occupied. The remaining areas were neglected during the observations. It is possible that the habitat selection might be caused by the offered vegetation alternatives. These areas are likely to be unhindered by any physical or nutritional impact by the oxen.

However, the creation of microhabitat which provides for higher insect-diversity and the aim of the DFW-management to keep the area open, is likely to be seen on only the particular areas of Prinsenbos.

6.9 Study limitations

The study is based on 9 weeks of observation from February until April 2013. This period has been chosen to attend the seasonal dependent development in vegetation and therewith presumably record changes in behaviours over time. However, the winter of this year has been a very harsh and long lasting period, so that data's should have been collected over a longer period to receive significant results of behavioural changes over time, but also to select more weather related data. Much time could have been saved in tagging the animals with telemetric measurement. In this way the oxen were faster to find and more data could have been recorded and give more information on their spatial distribution as well.

To get more sound insight in event behaviours, several methodologically aspects have to be considered: The focal sampling method could be standardised in a more accurate way by observing each of the 8 oxen simultaneously. This method would consequently include the work of 8 observers, since only one individual can be focal sampled by each observer. Implementation of that method was not possible with the given 2 observers.

Nevertheless, to receive significant results of behavioural changes over time and the effects of changing weather conditions, data's should have been collected over a longer time span than the 9 weeks.

Main discussion points

- If, in the context of “natural behaviour”, behaviour is studied with more focus and interest on event behaviours, the resulting sharper definitions and array of event behaviours, would allow for detailed comparisons between animals and/or populations.
- In family herds a fixed rate in performance of state behaviours would be expected, while event behaviours might vary more strongly between the individuals. This would be caused by a higher occurrence of social (e.g. allogrooming or agonistic behaviour) and mating behaviour in mixed-sex groups.
- The patchy usage per habitat type might be caused by the vegetational demands.
- Habitat related behaviour should partly be caused by spatial factors; vegetation and relief, but is also dependent on season, as floral species and its developmental stages are also season dependent.
- The meadow was used most at every day period, which is probably caused by more excessive food availability and meadow might be considered as the preferred habitat.
- The “fixed” behavioural day-pattern could be closely related with digestive efficiency.
- The diurnal proportion of active- and resting- related behaviour is dependent on forage quality and availability, the foraging pattern as well as on day length.
- The creation of microhabitat which provides for higher insect-diversity and the aim of the DFW-management to keep the area open, is likely to be seen on only the particular areas of Prinsenbos.
- To receive significant results of behavioural changes over time and the effects of changing weather conditions, data’s should have been collected over a longer time span than the 9 weeks.

7 Conclusion & Recommendations

7.1 Diurnal behaviour pattern

90 % of behaviour observed in the oxen consists out of four different state behaviours, namely: foraging, walking, laying and ruminating. The remaining 10%, for the larger part, consisted out of the event behaviours: running, scratching horn, scratching foot, grooming, exploring, agonistic behaviour and excretion. Scratching object, with almost 4% is counted as a state behaviour, because of longer duration. When looking at state behaviour, a single ox proved representative for the whole group. With event behaviours this conformity proved less apparent. The oxen have an almost fixed diurnal pattern considering behaviour, which is neither affected by weather, nor habitat choice. The oxen start their diurnal pattern with foraging interspersed with walking, followed by ruminating while standing right before 12 a.m. and then lie down to end their day with another foraging bout. As the oxen spend most of their time in the meadow the behaviours were all mostly performed at the meadow, but when the oxen were in the other three habitats, they showed habitat related preferences in behaviour: Meadow was mainly used for foraging, heathland for laying, meadow-forest edge for ruminating and forest for walking.

7.2 Active and resting related behaviours

No listed literature describes the classification of active and resting related behaviour in the context of the semi-wild conditions. As such with the lack of the proven physiological relation to this behaviour classification no certainty is obtained of its representative quality. Activity and rest of the oxen remained proportionally static over the days and weeks and was clear with a three to one ratio of activity. Considering the lack of human interference and the freedom the oxen had to exert control in themselves and over the environment, the behaviour exhibited could represent naturalness. This clearly defined ratio can be implemented as comparison for other studies, both under commercial and under wild conditions, possibly proving a future fundament for studies on naturalness.

7.3 Effects on environment

The oxen prevent succession at meadow and at the forest edge and in part in the heathland. Their faecal displacement in forest and heathland provide for insect populations, which in turn provide for insectivores. They maintain open areas by eating tree buds and saplings and through the trampling of undergrowth.

7.4 Recommendations

- The 3/1 proportion of active and resting related behaviour can be applied as a guideline for naturalness in behaviour in comparable studies. For achieving a natural stability in husbandry systems, this proportion can be compared as a model for adaption.
- Physiological research is required to establish the possible relation between active and resting related behaviours and the autonomic nervous system.
- To achieve the goals of the park management, also a mixed sex group of SHC could replace the oxen to give the animals the opportunity to perform behaviour, which is closer to its origin.
- When insight in specified event behaviours is required in accordance with scan sampling, it is advised to implement all occurrence, or ad libitum sampling.

8 Literature

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Appendix

I. Ethogram

	Function	Action	Acronym	Description	State or event behaviour
Resting related	Resting	Laying	L	The body is in direct contact with the ground; legs are bended; head is positioned above ground/ laid on ground/ leaned sideward against the own body	s
	Digestion	Ruminating	r	Chewing without taking new food into mouth; >5x chewed; while standing or laying	s
		Excretion	Ex	Defecation and Urination: Excrete dung and urine while standing or being mobile	e
	Body care	Scratching object	SO	Scratching own body at an object (e.g. a tree)	s
Active related	Foraging	Foraging	F	Eating and drinking: Imbibing grass, leave, bark from bushes or trees or water	s
	Mobility	Walk	W	Walking for > 1 step with each foot	s
		Run	R	Making > 1 step with each foot, faster than walking: Trot or canter	s

Active related

Bodycare	Scratching Horn, Scratching Food	SH SF	Scratching own body with horn or foot	e
	Autogrooming	G	Cleaning own fur with tongue or teeth	e
Focusing	Exploration	E	Smelling at a group-member or object; Sniffing in the air; Holding the head still; Standing still; Focusing a group member, or an (undefined) object	e
Agonistic	Agonistic Action	AA	Physical : Aggression or playing behaviour against a group member/ another creature/ object by contacting with own head (Attack); Moving another conspecific /pushing it with the body; Non-physical: Chase another cow away; Impressing by showing off one's size and horns; Threatening	s
	Agonistic Reaction	AR	Dodging; Leave from a social conflict or play situation, giving way for another group member	e
Nor active, nor resting related behaviour	Other	O	Behaviour not mentioned above; observed animal not visible	

II. Check sheet Focal sampling

Worksheet: Behaviour Scottish Highland Oxen

Focal animal instantanious sampling method

Temp, C°: ________

Humidity: ________

Name: ____________________ Wind direction: ________

Animal: ____________________ Date: ____________________ Wind force ________

Location: ____________________ Day time: ____________________ Rain, mm: ________

Start time: ____________________ Sun,watt/m²: ________

Interval	Behaviour	Comment	Interval	Behaviour	Comment
1			**43**		
2			**44**		
3			**45**		
4			**46**		
5			**47**		
6			**48**		
7			**49**		
8			**50**		
9			**51**		
10			**52**		
11			**53**		
12			**54**		
13			**55**		
14			**56**		
15			**57**		
16			**58**		
17			**59**		
18			**60**		
19			**61**		
20			**62**		
21			**63**		
22			**64**		
23			**65**		
24			**66**		
25			**67**		
26			**68**		
27			**69**		
28			**70**		
29			**71**		
30			**72**		
31			**73**		
32			**74**		
33			**75**		
34			**76**		
35			**77**		
36			**78**		
37			**79**		
38			**80**		
39			**81**		
40			**82**		
41			**83**		
42			**84**		
			85		
			86		
			87		

Behaviours	Acronym	Code
Foraging	F	1
Walk	W	2
Run	R	3
Scratching Horn	SH	4
Scratching Foot	SF	5
Scratching Object	SO	6
Grooming	G	7
Exploring	E	8
Agonistic Action	AA	9
Agonistic Reaction	AR	10
Laying	L	11
Ruminating	r	12
Excretion	Ex	13
Missing	O	14

III. Check sheet Scan sampling

Worksheet: Behaviour Scottish Highland Oxen

Scan sampling method

Ethogram

Behaviour categorie	Active behaviours						Resting behaviours			
Behaviour	*Foraging*	*Walk*	*Running*	*scratching*	*Exploring*	*Social*	*Laying*	*ruminating*	*excretion*	*Other*
Code	F	W	R	Sh/Sf/So	E	S&ox(1-14)	L	r	Ex	O

Temp, C°: ________

Humidity: ________

Name: ________________ Wind direction: ________

Location: ________________ Date: ________________ Wind force ________

Day time: ________________ Rain, mm: ________

Start time: ________________ Sun, watt/m²: ________

	OS nr.													
	F/W/R/So,Sh,Sf/E/S(1-14)/L/r/Ex/O													
Interval	1	2	3	4	5	6	7	8	9	10	11	12	13	14
(___min)														
1														
2														
3														
4														
5														
6														
7														
8														

IV. Time planning Focal sampling

				Day-time	
Date:	***Day:***	**Morning** 8:15-10:35	**Noon** 10:35-12:50	**Afternoon** 12:50-15:10	**Evening** 15:10-17:30
Feb. 11th	**Monday**	*1,5,2,3*	*6,4,8,7*		
	Tuesday			*5,3,8,4*	*7,2,1,6*
	Wednesday			*3,7,8,1*	*4,5,6,2*
	Thursday	*8,5,6,7*	*2,3,4,1*		
Feb. 18th	**Monday**			*1,5,4 ,3*	*6,2,7,8*
	Tuesday	*1,5,3,8*	*6,4,2,7*		
	Wednesday	*8,3,7,2*	*1,4,6,5*		
	Thursday			*2,1,4,7*	*8,3,6,5*
Feb. 25th	**Monday**	*6,7,8 ,2*	*3, 1,5,4*		
	Tuesday	*8,4 ,5,7*	*1,2,3,6*		
	Wednesday			*4,8,5,1*	*2,6,7,3*
	Thursday			*8,7,2,5*	*1,4,3,6*
March 4th	**Monday**	*7,5,1,2*	*4,8,6,3*		
	Tuesday	*6,1,5,2*	*8,4,7,3*		
	Wednesday			*3,1,2,6*	*4,8,7,5*
	Thursday			*4,7,8,3*	*6,1,5,2*
March 11th	**Monday**	*1,2,7,6*	*8,5,3,4*		
	Tuesday	*1,7,3,4*	*6,5,8,2*		
	Wednesday			*5,6,2,4*	*1,8,7,3*
	Thursday			*6,5,4,8*	*2,3,7,1*
March 18th	**Monday**	*4,7,5,2*	*6,8,3,1*		
	Tuesday	*1,7,4,6*	*8,2,5,3*		
	Wednesday			*3,6 ,7,8*	*5,4,2,1*
	Thursday			*2,6,1,8*	*3,4,7,5*
March 25th	**Monday**	*2,3,7,6*	*5,4,8,1*		
	Tuesday	*1,3,2,4*	*7,8,5,6*		
	Wednesday			*5,8,2,4*	*6,1,7,3*
	Thursday			*4,6,2,7*	*1,8,5,3*
April 1st	**Monday**	*8,4,1,3*	*5,2,7,6*		
	Tuesday	*1,2,6,3*	*4,8,5,7*		
	Wednesday			*7,5,3,6*	*1,8,4 ,2*
	Thursday			*5,4,1,6*	*7,8,2,3*
April 8th	**Monday**	*3,6,7,8*	*1,4,2,5*		
	Tuesday	*5,8,3,4*	*7,2,6,1*		
	Wednesday			*6,2,5,4*	*1,8,7 ,3*
	Thursday			*3,6 ,1,8*	*2,7,4,5*

V. Term definitions

Allogrooming:	Licking another conspecific ´s fur or scratching it with the teeth.
Allostasis:	The stability through change, predicting that both hyper stimulation and hypo stimulation have adverse effects on animal welfare.
Autogrooming:	Licking the own fur or scratching it with the teeth.
Behaviour patterns:	A subsequent order of physical acts composing behaviour.
Dairy husbandry:	The husbandry achieving the production of milk and milk-products.
Event-behaviour:	Behaviours with a short duration and can be noticed as points in a time period.
External Variable:	A variable which cannot be influenced. (In the present study it is weather & day time)
Homeostasis:	The maintenance of balance within a self-regulating dynamic system.(In the present study this system is based on the active and resting related behaviours related to the autonomic nervous system)
Internal Variable:	A variable which is (indirectly) influenced by the oxen´s preference. (In the present study it is habitat usage & behaviour)
Loose housing:	A husbandry system in which cows can move around freely within the barn.
Motivation:	In the context of auto motivational decisions: The process within the brain controlling which behaviours and physiological changes occur and when.
State-behaviour:	Behaviours which are frequent and performed over longer consecutive periods of time.

VI. Number of Scan-samples

Number of scans per week

Week	Scan-counts
1	39
2	53
3	40
4	59
5	59
6	49
7	53
8	45
9	42

Number of scans per day-period

Day-period	Scan-counts
Morning	110
Noon	114
Afternoon	104
Evening	111

VII. Number of Focal-samples

Number of Focal-samples per week per animal

Week	Animal	Focal-counts
1	1	2
	2	5
	3	5
	4	7
	5	3
	6	5
	7	0
	8	1
2	1	5
	2	3
	3	4
	4	5
	5	3
	6	3
	7	3
	8	4
3	1	1
	2	1
	3	1
	4	1
	5	1
	6	2
	7	1
	8	0
4	1	5
	2	3
	3	5
	4	6
	5	3
	6	4
	7	6
	8	6
5	1	5
	2	6
	3	5
	4	4
	5	5
	6	6
	7	5
	8	4

Week	Animal	Focal-counts
6	1	4
	2	2
	3	5
	4	3
	5	4
	6	5
	7	4
	8	4
7	1	6
	2	5
	3	6
	4	6
	5	6
	6	5
	7	7
	8	5
8	1	4
	2	4
	3	3
	4	3
	5	3
	6	2
	7	5
	8	6
9	1	2
	2	2
	3	4
	4	3
	5	8
	6	5
	7	3
	8	6

VIII. Method-comparison: Scan vs. Focal

For the comparison of the methods, both databases, of focal and scan sampling have been standardised and merged into one file. The comparisons are calculated with N=8, which is based on the 8 identifiable oxen.

Table 11 Occurrence of behaviour per method (mean percentages & S.E.)
The mean occurrence of behaviour results of both simultaneous methods with standard error illustrate the proficiency of each method. The difference in percentages show the margins and the measure of standard error shows possible overlap.

State-behaviours	**Focal sampling N=8**	**Scan sampling N=8**
Foraging	53,8 ± 2,5	56,1 ± 1,3
Walking	11,6 ± 0,6	11,8 ± 0,9
Laying	16,4 ± 1,2	14,3 ± 0,7
Ruminating	8,5 ± 1,5	8,6 ± 0,4
Event behaviours		
Running	0,2 ± 0,1	0,1 ± 0,1
Scratching horn	1,4 ± 0,2	1,8 ± 0,4
Scratching foot	0,2 ± <0,1	0,4 ± 0,1
Scratching object	4,1 ± 0,4	3,87 ± 0,4
Grooming	1,5 ± 0,2	0,7 ± 0,2
Exploring	1,5 ± 0,3	1,3 ± 0,1
Agonistic action	0,6 ± 0,2	0,9 ± 0,1
Agonistic reaction	0,1 ± <0,1	<0,1 ± <0,1
Excretion	0,1 ± <0,1	<0,1 ± <0,1

After comparing both sampling methods (table 11), for none of the state behaviours a significant difference was found. In the event behaviours, significant differences were proven in grooming (t(7)= 3,079, P =,018), agonistic action (t(7)= -2,450, P =,044) and excretion (t(7)= 2,401, P =,047).

For none of the state behaviours a significant difference between the results of both sampling methods was found (foraging*:* t(71)=-1,516,*P*=0,134; walking*:* t(71)=-0,298, P =0,767; laying*:* t(71)=1,443, P=0,145; ruminating*:* t(71)=0,687, P =0,495) (fig. 17).

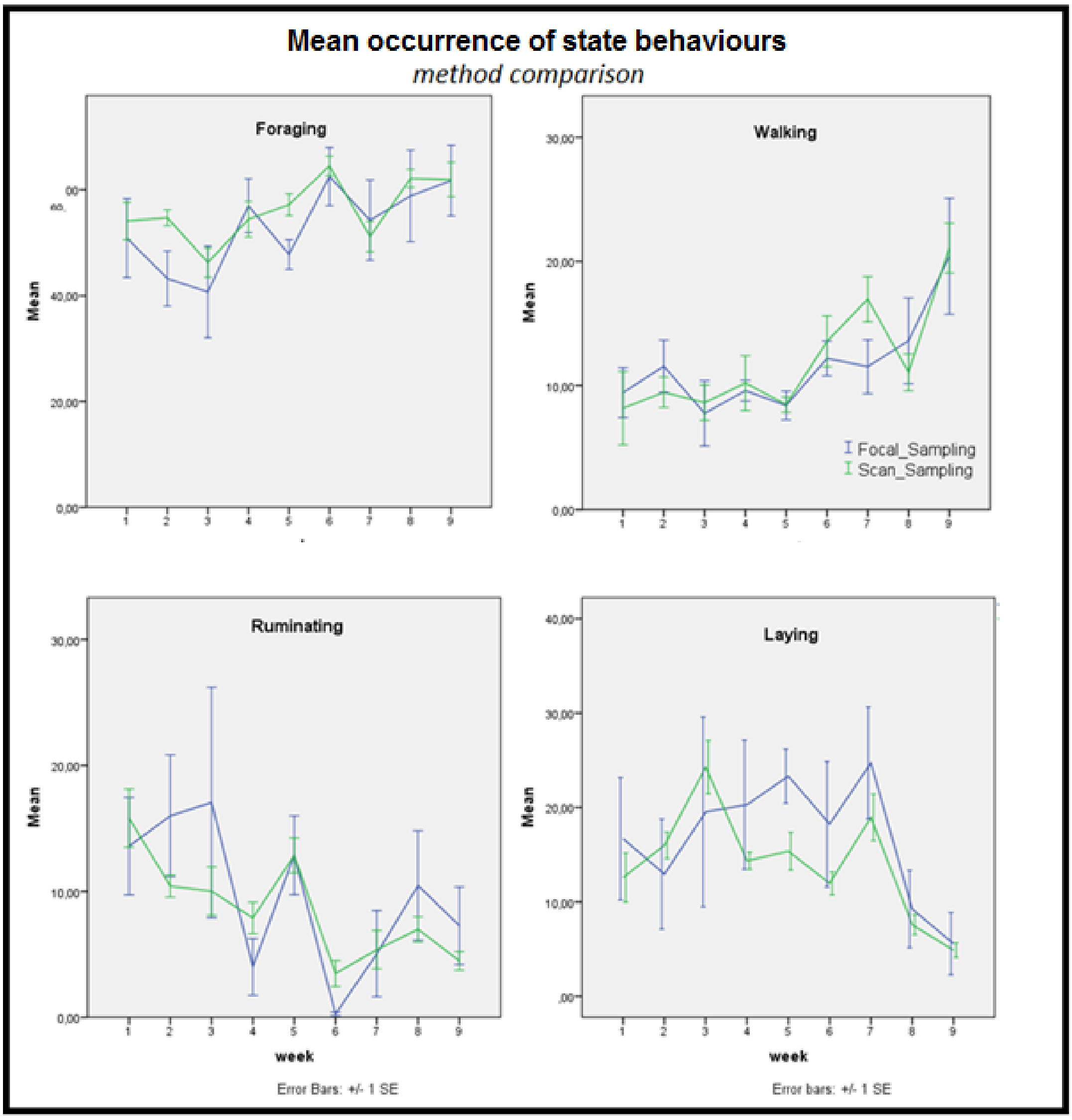

Figure 17. State behaviours, method result comparison
The four main and state behaviours, which are measured with both focal and scan sampling are methodologically compared and illustrated in the line graphs, where mean occurrence is set out through time in weeks. Both methods show similar results. The standard error overall is higher for the focal sampling method.

The event behaviours, grooming and excretion proved significantly different between both sampling methods (t(71)=3,509, P =0,001; t(71)=2,734, P =0,008). The behaviours were not executed by the animals in several weeks during scan sampling (fig. 18). The behaviours running, scratching horn, scratching foot, scratching object, exploring, agonistic action and reaction were proven statistically similar.

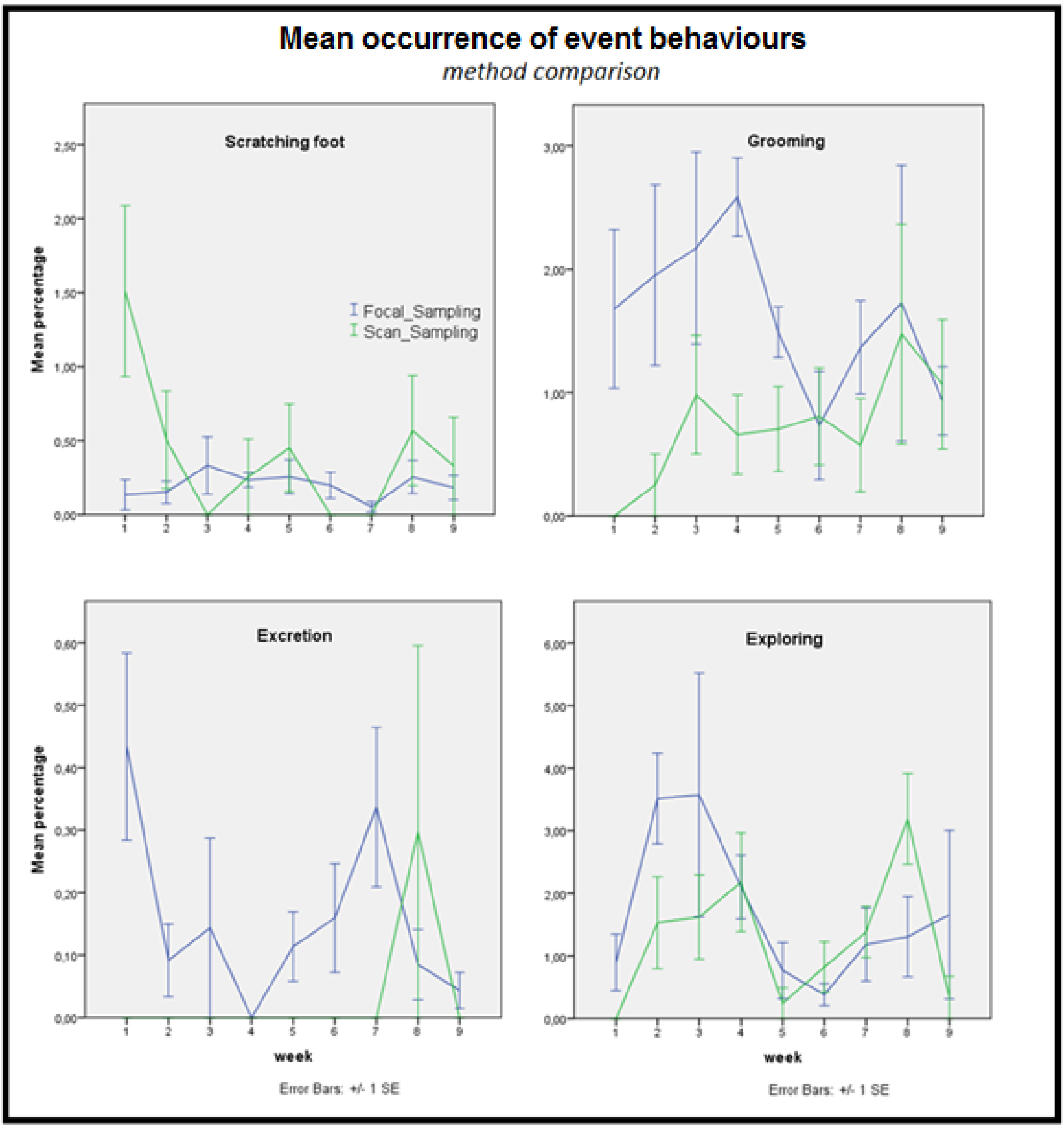

Figure 18. Event behaviours measured with scan- and focal sampling, diverging results.
The four behaviours which are illustrated through time here are event behaviours. The mean percentages of occurrence are shown per week. The behaviours grooming and excretion show significant divergent results per method. Scratching foot and exploring are less divergent and the method results are not significantly different although both behaviours are missed several weeks with the scan method. The standard error is consequently higher with scan sampling.

As the assumption was made in the proposal that scan sampling ought to be used for the state behaviours and focal sampling for the event behaviours, based on these results this assumption is ratified.

Discussion: Method-comparison Scan vs. Focal

2 sampling-methods were used simultaneously as described in the method section: Scan and focal sampling. Both methods were compared for the total data and per week to get insight in diverging results: As was expected, both results differed in behaviour occurrences and relative behaviour occurrences. More data of event behaviours was collected using the focal sampling method and thus is more accurate in measuring infrequent behaviour. The state behaviours were not proven significantly different in relative occurrence from both results, but the standard error from the focal data was higher in almost every state behaviour. The scan method is more standardized as it samples all animals every time, at the same time, whilst with focal samples only one animal is sampled at a time and in consequence these samples are less related and more biased (Altman, 1974), which might result in a higher variance. Scan sampling is practically only used for state behaviours. The irregular and short occurring event behaviours are easily missed in such instantaneous methods. (Altman, 1974) This explains the number of missed event behaviours.
When comparing both methods for event behaviours, grooming and excretion proved significantly different between both methods. Both behaviours have not been recorded with scan sampling during several weeks. Scratching foot and exploring are less divergent and the method results are not significantly different although both behaviours are missed in several weeks with the scan method. During the pilot the interval time of 20 seconds for focal sampling was established ensuring no event behaviours would be missed because they normally take minimally 20 seconds to execute. If state behaviours were not taken into account during focal sampling, and a relatively small number of event behaviours are wanted to be measured, all occurrence, or ad libitum sampling could be used quite accurately instead and would provide a definite result of event behaviours (Altman, 1974).

This data reveals that focal was best suited for event behaviours. Next to that scan sampling was best suited for state behaviours because of efficiency (more simultaneous with longer intervals). Both databases were apart from some small differences respectively similar.

Conclusion: Method-comparison Scan vs. Focal

Focal sampling is the best method of the two to observe event behaviours, because these events prove more likely to be missed when using scan sampling. Scan sampling in contrast, is best used for state behaviours because with this method all animals are observed simultaneously thus decreasing bias caused by temporal factors.

IX. Further Discussion

Auto motivational behaviour

Although the diurnal behaviour pattern of the oxen remained reasonably static over the nine weeks, the oxen were given the opportunity to react and adjust to environmental factors. As opposed to most husbandry systems, under the current study conditions, the oxen are able to control their environment and make their own choices. The natural environment is invariably more complex than the environment in husbandry systems (Chamove& Anderson, 1989; Buchanan-Smith, 1997) and is as such associated with less predictability. Control is exercised by the oxen to actively react to unpredictable aversive situations and to prepare for predictable situations (Weinberg & Levine, 1980). Aversive situations in the DFW are rather limited due to a fence, the lack of natural predators and temperate weather conditions making the environment less capricious. As the oxen's environment is lacking in aversive factors, predictability is increased. And as it is said that with predictability comes controllability (Overmier et al., 1980).

Control is exerted by the oxen in actively reacting to stimuli. Foraging at the onset of daylight, or being vigilant when approached by humans is then promoting the sympathetic system. Promotion of the parasympathetic system is controlled by the oxen's choice to lie down at the heathland, avoiding wind and human disturbance.

It remains questionable if the behaviour- and active/resting pattern is induced by a measure of control or by innate systems, but the diurnal behavioural pattern in terms of active and resting related behaviours seems a viable reflection of homeostasis.

In general it is questionable whether the preference in areas and expressed behaviours are a result of conscious decisions by the oxen which seems a logical consequence affected by environmental circumstances. Regarding food availability, the oxen have an actual choice as on what to forage on (e.g. shrub, grass, fiolage). Under the given circumstances, it is justified to speak of auto-motivational decisions by the oxen when looking at their forage preferences. These decisions cannot be made by dairy cattle in kept circumstances. Their behaviour and spatial usage is influenced by the system, rhythm and management of the barn (Sambraus, 1978).

Further naturalness in behaviour: To discover naturalness in behaviour, the study environment has to be natural and as such promoting natural responses. Given the fact that *Bostaurus* species are no natural occurring, but bred bovine, origin circumstances had to be chosen. The current study is done on semi-wild *Bostaurus*, meaning the animals roam a fenced area, where no natural predators occur. It is questionable whether these animals show their natural vigilance.

Vigilance: Any explore- and/or flight-reactions shown during observation, have been caused by human interference. In contrast, in presence of construction machines, jet fighters or cars, the cattle showed almost no alertness and kept a small flight-distance of only about 5-10m. Cattle´s flight distances can vary greatly: Feedlot *Bostaurus* species may move away from people at 1.5m, while less handled range *Bostaurus* species keep a flight distance of 30m (Blackshaw, 1986). The flight distance of the SH oxen depended on movement of observer or cattle, and habitat type: The more sheltered the habitat, the greater the flight distance: It was not possible to get closer than 50m to the group. If the researchers stayed sitting at the observation-point and the cattle moved towards the observers of their own choice, the oxen-observer-distance could reach a minimum of 10m. Still they expressed their natural alertness towards humans, what is clearly slighter in kept animals (Blackshaw, 1986), which complements naturalness in their behaviour.

Group composition: When being older than 2 years, bulls live solitaire. But until that age the pubescent bulls leave the herd and build a group together with two or four other young bulls (Sambraus, 1978). The 14 studied castrated bulls correspond quite accurately to this composition. The similarity mitigates as such any controversies in lack of naturalness aimed at group composition.

Horn related behaviours: Considering the fact that much *Bostaurus* species are hornless breed or get the horns removed (Brem et al., 1982), a further natural factor is that the SH oxen are able to act out the original function of horns. In cattle species, horns are used for various functions: Fighting, divided into wrestling and ramming behaviours, is not only used to define the hierarchical order, but also – resulting from the latter- to state the privilege of reproduction. (Caro et al., 2003) Hierarchical position can also simply be demonstrated by repeatedly ramming the horns into the ground. Playing with horns on the opposite, does not determine hierarchical order but is actually classified as play behaviour. Moreover horn playing is mainly performed in oxen. Another function is body care by using the horns for scratching parts of their own body. Cattle species would reach every part of their body caudal from the line between withers and elbow except from the anus. (Sambraus, 1978) The SH oxen in contrast are also able to reach the anus due to their greater horn length. Due to the higher flexibility in relation to most other cattle species, the welfare rate is assumed to be higher in the SH oxen.