YOU CAN LEAD A HORSE TO WATER, BUT YOU CANNOT MAKE IT DRINK

The Ecology and Social Context of the Reintroduction of Semi-wild Horses in the Eastern Rhodopi Mountains: An Exploratory Study

Student Thesis
Van Hall – Larenstein, the Netherlands

Willem van Hoesel
Stefan van der Werff

Arnhem, June, 2011

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“A little misunderstanding? Galileo and the Pope had a little misunderstanding!”

Dr. S. L. Cooper PhD in ‘The Nerdvana Annihilation’ (fictional), 2008

“You can lead a horse to water but you cannot make it drink.”

English proverb, 1175

PREFACE

This Bachelor thesis has been written in the context of our study program Forest and Nature conservation at Van Hall – Larenstein, University of Applied Sciences. We worked with a lot of pleasure on this project and we have both experienced it as very educational. This is the first study in a first pilot project and a long term nature conservation project. That is why the intention of this thesis is more orientating than conclusive.

We would like to thank both Ad Olsthoorn and Frank Zanderink, our supervisor at Van Hall-Larenstein and sponsor and supervisor of Ark foundation, for their advice, guidance, time and effort they spent for us. When we needed advice or counsel, we could reach them at any moment.

Also crucial people and friends in this project are Desi Kostadinova, Hristo Hristov and Tim Jenkins. We lived at Desi's and Hristo's apartment for the whole time and without them as caretakers, guides and information sources, this thesis would be less complete. All the GIS information we got thanks to Hristo, and historical information was provided by Desi. We could also always borrow Hristo's old army helmet if we had a quarrel with some feral shepherd dogs, however we believe that Tim needed the helmet more than us.

We would like to thank Tim for his sophisticated discussions, guided tours and information of the area, animals and people. Also the day that we were close to smoke poisoning during the preparation of a well-deserved meal on a terrible stove in Chernichino, that made moving to his 'Furgon' legendary.

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Their names:

Rene Boesten	Environmental engineer
Hristine Eterska	Caretaker and researcher
Muciee Ivanova	Student and member of eco-club
Daniela Jenkins	Teacher
Hrista Kadieva	Student and member of eco-club
Kamburcha family	Caretakers and local cow keepers
Michaela Kircheva	Ecotourism, New Thracian Gold
Sofia Kodjamanova	Student and member of eco-club
Krimenna	Pub owner and cook
Freek Rensen	Teacher/study advisor at our University
Iva Tontcheva	PR manager for New Thracian Gold
The Eco-club	A group of young volunteers dedicated to ecology

And a big thanks to everybody whose name we forgot to mention!

Willem & Stefan, Arnhem, June, 2011

ABSTRACT

The rural areas of South Eastern Bulgaria are being abandoned as people are moving to the cities. The practice of small scale livestock grazing is disappearing as well. The extensive character of animal husbandry is considered an analogy with disappeared large herbivores, whose influence can be observed in the mosaic landscape they created by their typical ways of grazing. In order to recreate and preserve the typical mosaic landscape with all its biological diversity and natural processes, semi-wild horses have recently been reintroduced.

In the area near Madzharovo and Chernichino, SE-Bulgaria, a mixed herd of local breed horses (Karakachan) has been introduced. In March 2011, two of the horses were collared with a GPS-collar, for this study the data of the leading mare was used. The goals were to examine in what way the herd used the landscape they were placed in, and if they preferred a certain land use type. Initially field observations were planned, but this method was discarded due to time and logistical limitations. With the use of GIS and GPS data, it was possible to study their habitat and home range use for the spring period (March and April).

For this spring period, the home range (Kernel estimator) is 32,4 km^2, of which 66% consists of broadleaved forest and 15% is occupied by land use types with a high grassy content. The horses show indeed a significant preference for certain grassy land use types, such as natural grasslands, pastures and non-irrigated arable lands. There are a lot of artificial water sources available and small streams are abundant, and it is proven that natural watercourses might play an important role in the presence of the horses. Asphalted roads are mainly used as means of transportation and they will move away from these in order to reach their preferred land use types.

Social support during reintroductions is an important factor that can help or frustrate a project or process. Handling the affection of local people for nature should be done carefully. Currently, local people are optimistic about the reintroduction of species and understand their role in natural ecosystems. In reintroductions, local people are to be involved and local authorities should be well informed. A good planning can avoid conflict situations when problems will be handled adequately, and thus enhance the sustainability of the project. This report ends with recommendations for research in the near future.

Keywords:

Grazing, Large Herbivores, Horse, Reintroduction, Bulgaria, Ark Foundation, Rhodopi, Madzharovo, Chernichino, GPS

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OVERVIEW FIGURES, TABLES & APPENDIX

▲ *View towards Madzharovo (hard to see down in the valley), terrain with hills and mostly covered in forest (dark patches are planted pine forests).*

▼ *View towards Chernichino with characteristic mosaic landscape around it, especially near the village one can find grassy vegetations.*

1| INTRODUCTION

In this introduction, one will find all the background information needed to understand the reason for this study. This chapter includes the frame and motivation for the thesis subject, the use of large herbivores in nature management (especially horses) and the fundaments of Ark Foundation's project in the Eastern Rhodopi Mountains in South Eastern Bulgaria – concluding with the main question and sub questions of this student thesis.

1.1 Frame for the Thesis Subject

1.1.1 Grazing in nature management

Nowadays, grazing by large herbivores is a common used practice in nature management to restore natural processes. For centuries, the present original large herbivores were looked upon as competitors with the held cattle and seen as destroyers of the forests. It is because of these reasons that they were expelled from nature, so to speak. As a result of the absence of large herbivores, certain types of vegetation would diminish to unviable sizes and would have to be maintained by intensive human effort – in many cases that would not be satisfying and special vegetation types disappeared totally. Today's misconception about the use of large grazing herbivores lies in the fact that is seen as only a way to restore natural processes, but they are actually part of the restoring nature (Ark Foundation, 1998).

1.1.2 Large herbivores as a part of (restoring) nature

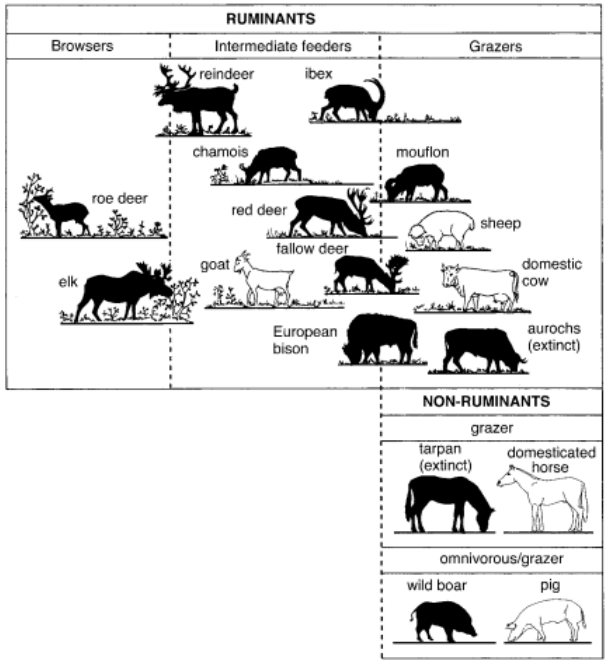


Figure 1.1. Large herbivores indigenous to Europe, classified according to their feeding strategy (Vera, 2000).

The relationship between herbivores and plant species is an evolutionary process that took millions of years. Every species of herbivore is different, and the relationship between species each evolved in a different way – as a result many feeding strategies exist. Plants developed mechanisms to repel browsing, or developed seeds that used the animal's fur as a way for distribution. Other kinds of animals, such as predators, would even adapt their way of life to the migrating movements of herbivores. Complicated ecosystems developed – with sophisticated relationships between species. With a multitude of relations, a huge biological diversity evolved in both plant and animal species – each to a lesser or greater extent dependent on the large herbivores (Ark Foundation, 1998). It is often the large mammalian herbivores which can have a permanent effect on their environment – as can be seen in the composition of the vegetation.

Each mammalian herbivore species has its own properties and feeding preferences, and they are roughly divided into three groups: concentrate feeders or browsers (eaters of buds, leaves and twigs of shrubs and trees), intermediate feeders (eaters which alternate between grass and herbs, or bark, leaves and twigs of shrubs and trees) and grazers (specialized grass eaters) (see Figure 1.1).

1.1.3 Ecological function (wild) horses

In this bachelor thesis, the main emphasis is orientation on the ecological function of horses in the current landscape. Horses, like wild boars, are non-ruminant grazers. The food they ingest is directly digested; and as a result horses are always on the lookout for new protein rich food. They mainly take the growing parts, because of the high nutritional value. This is noticeable in the landscape as short grazed horse meadows, versus the rougher parts where the horses do not come (Ark Foundation, 1998). However, when the food quality for the horses is getting worse, they will eat more and will manage to get the nutrients they needed. The nutrients that are not needed, such as not easily digestible parts, will move faster trough their system. Because of this, one can use horses in areas with poorer conditions, in which most cases the use of cattle (cows and bulls) is not even acceptable anymore (Poortinga & Van der Lans, 1986).

1.1.4 Rewilding Europe

The concept of the project 'rewilding Europe', initiated by Ark Foundation, is well expressed on their website – an attempt to make it even more concise will be in vain and will make it less clear:

"As more and more people leave rural areas for an urban life, large parts of the European countryside are currently being abandoned. It is a large-scale process affecting particularly the more remote regions of the continent. Until now, such areas served as the principle home for a large proportion of the European fauna and flora associated with mosaic landscapes. These semi-natural areas have their roots in pre-historic Europe, where large mammals once roamed freely, and are today maintained through extensive land use with grazing animals.

However, with the guardians of these treasures leaving, the conservation of the European natural heritage is subsequently facing a tremendous challenge. If nothing is done, we run the risk of ending up with a "digital" Europe – intensive farming on fertile soils or forests dominating the less productive regions. And with that we will lose many animals and plants as well as landscapes valued by our citizens. It is clear that we must act now!

To address this challenge, the Rewilding Europe *programme has been created. It was first presented at the "Conference on Wilderness and Large Natural Habitat Areas" hosted by the Czech European Union Presidency and the European Commission in May 2009.*
The overall aim of the programme is to re-wild at least one million hectares of Europe by 2020 consisting of ten areas, each of at least 100,000 ha. Every area should host complete and naturally functional ecosystems specific to the region, the new land use should be economically viable and competitive with other alternatives, and the area should be embedded in the social and cultural fabric of their respective region.*" (Rewildingeurope.eu, 2010)*

At this moment five pilot areas have been appointed, of which areas in East-Europe have the highest priority. Among the twenty entries at the beginning of the project, an area in Southeast Bulgaria was also submitted: the Eastern Rhodopi Mountains (see **FIGURE 1.2.**).

FIGURE 1.2. Project locations of 'Rewilding Europe' initiated by Ark Foundation in Europe (ARK.eu, 2010)

1.1.5 Bulgaria

The rural areas of Bulgaria are currently emptying from people; this urbanization is at full blast. Mainly because of economic reasons, people move away from the countryside and into the bigger cities. Small scale livestock farmers with their grazers had created a mosaic of different landscape types over time; everything between forests and open (grassy) areas. Large grazers are 'key species' needed to create a complete ecosystem with the full extent of natural processes. They are able to create a wide variety of landscapes with their typical behaviour. Without these animals, the biological diversity specific to this area is threatened. This process of areas losing its typical biodiversity, due to the loss of large herbivores, is also a current problem in the Eastern Rhodopi Mountains, in South-eastern-Bulgaria (see **FIGURE 1.3.**).

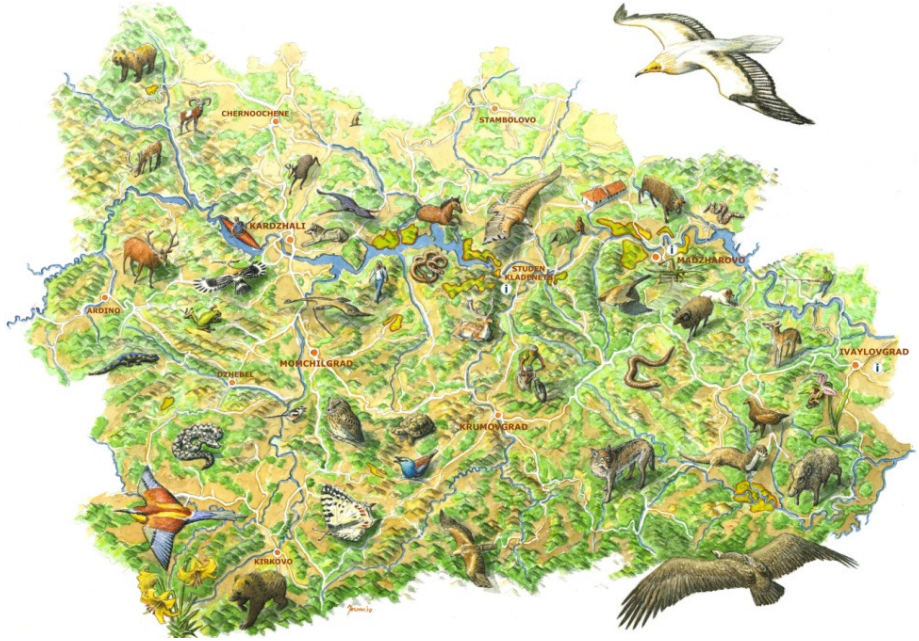


FIGURE 1.3. Potential of biodiversity in Eastern Rhodopi Mountains, Bulgaria according to Ark Foundation (ARK.eu, 2010)

1.1.6 New Thracian Gold

In the Eastern Rhodopi Mountains, the Dutch organizations Ark Foundation and Avalon are working together to enhance the economic situation by 2014. In this project organic agriculture, nature management and preservation, and ecotourism are the three most important issues. Ark Foundation is committed to the preservation and management of large scale natural areas. The main priority is to attract local people and to "create economic levers to support the natural processes in the regional economy." Avalon focuses on ecological agriculture, and "on familiarizing people with the possibilities of organic farming, caring for nature with good agricultural practices and sustainable rural development." (Newthraciangold.eu, 2011) *(The name New Thracian Gold is probably chosen because the realm of Thracia included North-eastern Greece, Southern Bulgaria and the European part of Turkey, and existed between 4000 BCE until about 300 CE. It is famous for its wealth of golden hordes that have been buried in graves.)*

1.1.7 Use of large grazers and social understanding

In a (forest) landscape without a healthy population of grazing animals, succession leads to a forest with a closed canopy. However, with a population of herbivore mammals too big for its carrying capacity (e.g. overgrazing), rejuvenation or regeneration of the forest will fail, in which case the open areas in the forest will even grow bigger. In nature management one has to search for the right equilibrium between the amount of animals and the natural carrying capacity of a given area. Without the intervention of humans and with all its processes present (such as wildfires and predation) this will happen naturally. Although having one type of grazing animal is better than to have none; a forest with only roe deer or merely bovines, will less likely evolve into a complete and varied (forest) landscape than a (forest) landscape with a wide variety of large herbivores (Van der Lans & Poortinga, 1986).

The goal of the project 'New Thracian Gold' in the Eastern Rhodopi Mountains is to reintroduce the aboriginal grazing animals into the landscape. The underlying idea is to recreate and preserve the typical mosaic landscape with all its biological diversity - with the help of large ungulates, such as horses, distinctive cattle breeds and different deer species (Cervidae). Which will be able to stay in the landscape the whole year round. Local nature (management) organizations will be approached to help with the management of the large grazers and to preserve the nature and its biodiversity (Newthracian-gold.eu, 2011).

Another very important aspect of reintroducing species is the understanding and support of local people for this kind of measure. Without understanding or support, reintroducing (new) species will be not successful. It is interesting to find out what the local people think about this, and if they understand the decision of placing (former pet-) animals in the nature in order to complete the natural processes of the landscape.

1.1.8 Ultimate goals for reintroduction according to Ark Foundation

The most important goal of reintroducing (extinct) species is to create a sustainable way of nature conservation and development. The species being reintroduced have always played an important role in local ecosystems. The herds will be small, but complete with all its social structure. Because of this, the presence of those key species is presumed to be continuous (sustainable). On the short term it is expected that by creating complete ecosystems, it will trigger (eco)tourism and give an impulse in the economy of the local community. On the long term other locally extinct herbivorous species can also be introduced, and will in turn create even more attraction for local tourism. From the animals point of view; as they are regarded as wild living species (especially the former domestic animals), they will in a way de-domesticate and will fit in the local circumstances and environment even better.

1.2 Motive for the Thesis Subject

The College Forest and Nature Management has its aim for forest management in a wide context. The Bachelor program 'Urban Forestry' is focussed on the current forest management methods (and the social impact of this because of the expanding urban areas). After following the minor programme 'Nordic Forestry and Wildlife Management' in Norway, both of us got inspired by the key role that large fauna has in nature management. Not only in Norway, but all over the world many conflicts, discussions, and questions are rising. A good example is the Netherlands, where the discussion still continues about reintroducing certain species and the expected comeback of large carnivores (but that aside). Bringing back large herbivores in an area is an attempt to complete a natural ecosystem and its processes.
Ark Foundation recently started a pilot project in Bulgaria by reintroducing semi-wild horses into natural areas. There are a lot of (management) questions concerning ecology that are calling for answers. With this assignment Ark Foundation wants to get an idea about the complexity of the reintroduction of the horses in South-Eastern Bulgaria.

With this assignment we expect to extend and improve our knowledge about grazing and the role of large grazing species (horses in this case) in nature management. This assignment offers us a unique chance to get to know more about the ecology of these animals (and the role they fulfil in large scale nature development), but also the social context will be very interesting. And because the project is situated in Bulgaria, our view of nature management will be broadened, whereby we can apply the (newly) gained ideas and working methods in the field of expertise in which we will later work. The project offers us the possibility to witness an exclusive development in this area: the reintroducing of semi-wild horses and tracking them by means of a geographical positioning system (GPS). We see it as a pioneer's job to follow these animals and to describe their ecology and specific behaviour.

1.3 Problem Description and Analysis

The restoring of the ecosystem by bringing back large herbivores, with local bovine and horse races, serves to enhance the variety of landscapes and to preserve the original biodiversity. It is important that the large herbivores will be a part of the ecosystem itself as well. Horses are being reintroduced into the landscape by means of 'herd fund', in which locals are being incorporated.

It is expected that by introducing wild living large grazers, the animals will take over the role of the now disappeared small agricultural practices, such as the keeping of small herds. To make an expectation or an idea really valid, one needs data and information about the real habitat use of this kind of horses. The horses are only recently reintroduced (October-December, 2010), so this gathering of data is in its initial stages. There are, of course, a lot of reports and books published about the use of the landscape by

(wild) horses. This information can not be blindly used to describe to habitat use of the horses in the specific area of the Eastern Rhodopi Mountains in Bulgaria. To get a better understanding of the specific (local) ecology of these horses, further research of the habitat use is needed.

Ecology of wild animals can be divided into different fields of study. This includes subjects as intra- and inter specific relations (respectively between individuals of a species and between different kinds of species), but also typical habitat behaviour. It includes the use of vegetation as food or shelter, and how the terrain determines the occurrence of the herd and individual animals. In the context of this bachelor thesis the main accent lies on the landscape use in the specific location in which the animals are being reintroduced: the Eastern Rhodopi Mountains.

The impact the animals have on its surroundings are relatively good noticeable and controllable, by means of fieldwork and monitoring. Following the animals regularly, one can get a good representation on the landscape use of the horses. Simultaneously, data can be gathered on topics such as group structure and composition, or on the behaviour of animals of the same species – or interactions with other animal species. This bachelor thesis is because of its short duration only an orientating first start in the long-term monitoring the ecology of the horses and their environment, and in this case focus lies on their habitat use.

Besides research in the ecology of the horses, we also put out a small social research in the understanding and support by the local people of introducing of horses. The reason is that currently people regard these animals as former cattle or pets, in which the animals are not supposed to wander off into the wilderness and live on their own without care. Bringing back these important animals to become a part of the ecosystem themselves even finds resistance in the minds of people in Netherlands. We expect that this will cause a similar reaction within local peoples' view in Bulgaria. It is important to know on what subject knowledge or understanding is missing, in order to work on this matter in the future. Better knowledge and understanding of the important processes of the 'wild' nature are very important in the development of nature at a large scale.

1.4 Research Question and Sub Questions

Main question:

What determines the habitat use of the re-introduced horses, and how can human influence help to restore the semi-natural ecosystems?

Sub questions:

Part I Traditional land use

1. Which large herbivore species were indigenous to the Eastern Rhodopi Mountains and what influence did they have?
2. How can the traditional (small scale) livestock raising, with focus on horses, in the Eastern Rhodopi Mountains be described as regarding to grazing pressure?
3. What were the effects on the landscape and the biodiversity of small scale livestock breeding?

Part II Horse habitat use and horse ecology

4. What is the home range of the horses within the spring period?
5. How can the landscape be described within their home range?
6. Which elements form natural boundaries in the presence of the horses?
7. What are the potential feeding grounds for horses within their home range?
8. Is there a relationship between the distribution of the horses and potential feeding grounds?

Part III Restoring nature in a social context

9. What purpose has understanding/support of local people in the process of reintroducing or recolonizing species?
10. What was the reason for disappearance of the small scale livestock raising in the rural areas (of Southern Bulgaria)?
11. What is the current understanding of local people on the matter of re-introducing herbivorous species in general?
12. In which way can ARK Foundation interact to positively influence the (local) understanding in semi-natural ecosystems?

▲ *The herd described in this research, in some sort of defensive or alert stance, when the new male was reintroduced to this herd.*

▼ *A photograph showing the landscape of the surroundings of Madzharovo (lower left corner).*

2| MATERIALS AND METHODS

For the reader of an article or thesis, the description of the used method is a crucial part to imagine how the writers executed their research. Described in this chapter are the study area and animals because it/they had a major influence on the method. The methods used for measuring vegetation and (grazing) preferences and the analysis of GPS and field data will be explained as well (Modus operandi). Because the terrain and the animals influenced the initial method in a way we had to change it, there is a chapter Justification of change.

2.1 Study Area and Study Animals

The study area is located in southeast Bulgaria (see **p.9**), about 10 kilometres south from Madzharovo, right on the intersection of the municipalities of Krumovgrad, Ivaylovgrad and Madzharovo. It includes the small villages of Chernichino and Malko Popovo. The elevation of the area ranges from 150 meters up to 800 meters and is mostly covered by oak forest (*Quercus spp.*). The forests are interspersed with open (grassy) areas. Most of these open places are used by local people as grazing grounds for their cattle and sheep. For an overview of the distribution and classification of respectively land use types and height classes: see **APPENDIX I** & **APPENDIX II**.

The Eastern Rhodopi Mountains are situated in the Continental Mediterranean Climate region. Characteristics of this regions climate are the mild winters, often occurring heavy precipitations, and the hot, dry and sunny summers. Annual precipitation values of 1700 – 2200 are measured along the south-eastern borders (Gerassimov, 1997).

The herd in this study consists of 17 horses in total (of Karakachan and mixed breeds), of which 9 are mares and 8 are stallions. The age of the mares is between 1-8 years old, and 4.4 years on average; for the stallions this is between 0.25 – 5 years and an average of 1.9 years **[APPENDIX III – Overview Herd]**. The herd does not have a leading stallion and is led by a leading mare (called Penelope). The previous leading stallion was killed by wolves (pers. comm. T. Jenkins & H. Hristov, 2011) in December, 2010. A new stallion (Karakachan breed, from Pernik) was introduced to the herd on April 21st, 2011. According to plan, this should become the new leading stallion. Together with the leading mare, this horse was collared (Iridium collar, Vectronics) on the same day of reintroduction. The few attempts to connect him with the rest of the herd have been unsuccessful because of varying reasons. However, the latest GPS-data (beginning of May, 2011) shows that the horses are at the same place (meadows near Malko Popovo).

The herd started with the horses of Tim Jenkins and companion, and were used as natural grazing for completing the ecosystem. Only recently the herd is owned by Mr. Tzigov, who has an agreement with the Ark Foundation 'herd fund' and lives in the area around Chernichino. The horses should stay in this area for the purpose of natural grazing, but horses (as most wild animals) do not always stick to artificial borders. In five years, the offspring of the horses should have created the amount for a new herd. By then the original herd is in Mr. Tzigov's ownership, the rest (new horses) will go back into the 'herd fund' and will be used again for the same or another area where horses will be reintroduced. This will be after five years. After the duration period of the contract, the owner is allowed to handle the herd as he wishes. This is the approach of Ark Foundation to increase the number of grazing herds in an area by using natural processes, and to complete ecosystems on the long term.

2.2 Modus Operandi

2.2.1 In general

With the development of our main question '*what determines the habitat use...*' we assumed that the presence of animals is determined by the features of the landscape or area where they are living. Also Vera (1997) confirmed this, and showed that large mammalian herbivores were actually able to alter their own habitat, but not alter it permanently.

Describing the habitat of an animal contains many features and variables, unfortunately too many to analyze in the short time of period for our Bachelor thesis. In our initial project plan we stated that we would follow the horses on foot. This proved to be impossible. Now the main method to follow the horses was the use of GPS.

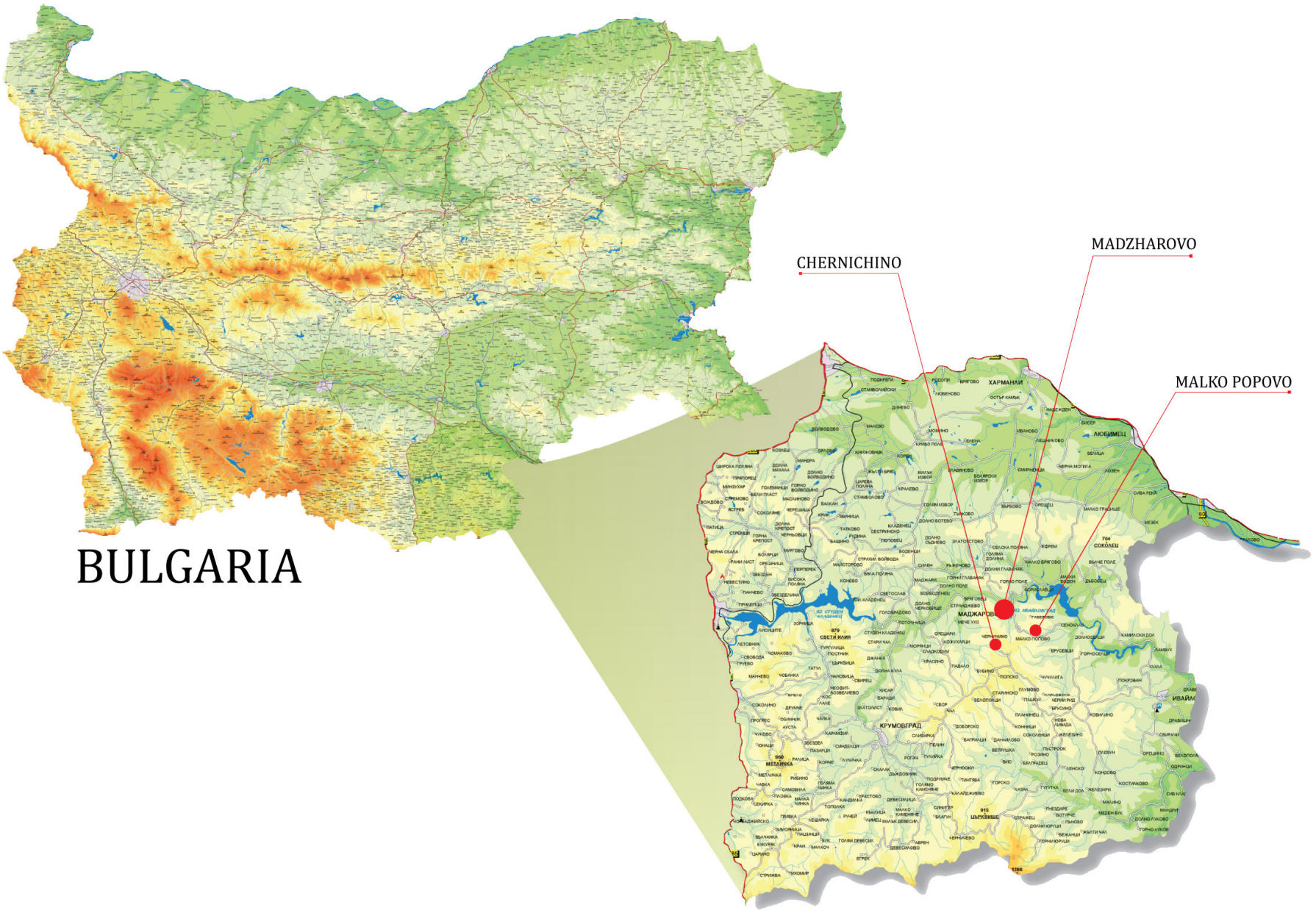
One third of the time spent on this thesis was used for planning and set up, one third for acquiring data and the last third analyzing and writing (in total 4 months). The data collection of GPS fixes on the horses started on 21st of March and ended on the 2nd of May.

2.2.2 Use-availability & site-attribute design

To describe the habitat use of an animal, there are several designs (Boitani & Fuller, 2000). The first one, use-availability design, "compares the proportion of time that an animal spends in each available habitat type to the relative area of each type". A second one, the site-attribute design, "compares habitat characteristics of sites used by an animal to unused or random sites". They both generate measures of selection for various habitats or habitat attributes. The importance for a given habitat is deduced from the time spent there.

For both the *use-availability design* as the *site-attribute design* we needed GPS data. The *use-availability design* can be analyzed using GPS and GIS data, to look for significant differences in the use of the landscape. This design allows us to consider use and habitat availability data, collected only on individuals (radio collared animals), to be the same for all the individuals (thus all the animals in the herd are pooled for analysis) (Boitani & Fuller, 2000).

For the use of the *use-availability design* we included a formula used by King (2002) that calculates the grazing preference index for each land use type. The formula used is: $PI = \frac{Ui}{Ai}$, in which *PI* indicating the grazing preference, where *Ui* is the use of the area, and *Ai* is the availability of the land use type (given in percentages of the whole).


CHERNICHINO
MADZHAROVO
MALKO POPOVO
BULGARIA

For both the *site-attribute design* and the description of the habitat itself, in means of habitat characteristics, we conducted fieldwork. We focussed the fieldwork on landscape features, because this coincides with the sub questions stated in the initial project plan. To make a better analysis according to the *site-attribute design*, we analysed GPS location clusters to see at which location the animals spent most of their time. In other words, we made a description of the areas that are mostly being used by the horses (according to the GPS-fixes) and the areas which they do not use, or random sites.

We based the animal's behaviour in certain vegetation types on reports about Przewalski horses (*Equus przewalski*) and other feral horses, and we also used personal communication with local people to complete this part of the study. In most reports, researchers could study the horses for a longer period (often a few years) to come to a well-balanced conclusion about the behaviour connected to the use of the landscape.

2.2.3 Transects

The actual carried out fieldwork for the *site-attribute design* deviates from the initial plan. The reason can be read in **2.4 Justification of change** (**p.11**). We want to measure the vertical and horizontal structure of the eight land use types as can be distinguished in the GIS map: Discontinuous urban fabric, complex cultivation patterns, Non-irrigated arable lands, Pastures, Land principally occupied by agriculture with significant areas of natural vegetation, Natural grasslands, Transitional woodland, and Forest.

Because one description is not representative the area we would choose at least 2 locations (at random) to measure the structure. After the data on locations of the horses was obtained, we would pick 2 other locations of the same land use type which are used most (according to the number of GPS-fixes). This would give us a total of 32 (8x2x2) transect lines over eight land use types.

For the type of transect line we used the so called 'gradsect' line, which is short for gradient-directed transects. The length of our transect line was always 30 meters and the width was 4 meters, a variation on the method described by Atkinson (1975), who used different widths and lengths. Using a transect line for measuring vegetation can allow more productive sampling in sparse vegetation (such as grasslands), and can be more practical in tall vegetation. In either case, sampling will be faster than quadrate sampling (Sutherland, 2006).

We selected the areas for the transect lines from the GIS vegetation map, and tried to find the most central point of the area. We then went into this area and decided again on the location whether this area was in the centre, and if it is representative for the whole land use type. When positioning a transect, we took the edge effect into consideration. Putting a transect line too close to another type of vegetation may affect both the composition and structure of the vegetation, and is thus not representative anymore. We took a distance of at least 20 meters (if possible).

The actual amount of transect lines executed are in total 14 lines in 6 different land use types, lacking only transects in Discontinuous urban fabric and Complex Cultivation Patterns. Eight transect lines we did in random sites categorized as Land principally occupied by agriculture with significant areas of natural vegetation, Natural Grasslands, Transitional woodland and Forest. We did six transects in used sites categorized as Non-irrigated arable lands and Pastures.

Within the transect we measured the height, diameter of the projection of its leaves and determined the species if we were able to identify it during this time of the season. We assumed this will be easy for oak (*Quercus spp.*) and juniper (*Juniperus spp.*). Other types of plants and trees will be categorized according to thorny bushes, evergreen forbs, and herbaceous species whose parts above the ground died off but are still present.

2.2.4 Visual obstruction measurement

We assume vegetation structure will affect the animal's presence at one place or another. It is most likely that horses will not stand or graze in areas where there is little sight, mostly because the potential harm of predators, such as wolves and jackals found in this area (pers. comm. T. Jenkins, 2011). To measure this visual obstruction used the Robel Pole for visual obstruction, as described by Robel (1970).

The pole itself is 1.50 m long, and approximately 3 cm in diameter. It is held at a sample location, in which one observer moved 4 m from the pole in a direction perpendicular to a transect. A second pole of 1 m (sighting pole), held by the observer, will set the eye height of the observer. From this point, the observer recorded the highest band on the Robel Pole that is completely covered or obscured by vegetation. We did two readings (in opposite direction) at every $1/7^{th}$ part of the transect line in order to have more different positions.

2.2.5 Carried out fieldwork

The fieldwork was executed in the area of Chernichino and Malko Popovo. Regularly we worked in the field for 3 days. Then we went back to Madzharovo to digitalise the data.

The fieldwork we conducted for the *site attribute design* was done in 6 different land use types, in total 14 transect lines. We sampled the most of the lines on foot; a car was only used on the last day.

The data from social study was acquired with a self-developed questionnaire with 18 questions. We had no specific target group; our aim was to sample a random part of the population in Madzharovo. We had no target number of questionnaires to be done, and we did as much as the limited time allowed us to do (in total 43 local people were questionned). The most of the questionnaires were done with translations of Bulgarian students, members of the eco-club of Kardzhali.

Especially in the first weeks, information by word of mouth proved to be very helpful to prepare the fieldwork.

2.3 Analysing GPS and Field Data

For the analysis of the GPS data, acquired from the collars, we mainly used the ESRI ArcGIS 9, together with new GIS Tools, named Home Range Extension (Rodgers & Carr, 2001) and Hawth's Tools (Beyer, 2004). We also used Google Earth (see **p.19**) to check the location of the horses regularly. The amount of data we got from the fieldwork we digitalised this in Microsoft Office Excel 2007 and in the same programme we made the statistical calculations and analysis. The plan we wrote in Microsoft Office Word 2007.

2.4 Justification of Change

The method chosen to answer the research questions in this thesis are deviating of the one written in the project proposal. On site, it was clear that there were too much variables and uncertainties to continue with these methods. Before we started this research, we had no experience of any kind with horse ecology and research.

In articles written by researchers that have done research to Przewalski horses in Mongolia it was not a problem to follow the horses. In the area of Madzharovo (Bulgaria) however, it became clear to us that the horses were hard to follow. A car was not an option in this terrain and following by foot, or horseback was pointless seeing that the horses were much faster than we were.

This was unexpected for the reason that we did not anticipate that the horses are regularly disturbed by shepherd dogs, humans and wolves. For as far was we know the wolves, did not form a problem, because they are nocturnal hunters. We would not monitor the horses in the night.

This made us change our method and strategy. We discarded the behaviour and habit use scan sampling method and changed it into an extended landscape description. To get a good insight of the habitat use of the horses we combined this description with the GPS data we got from the collars.

The quick movement of the horses was not the only variable that made us change our method. To locate the horses and not to be reliant on local trackers we needed the GPS collars, which were equipped with a VHF beacon. This beacon makes it possible to locate the horses quick and thus time efficiently. The GPS collars were planned to arrive on site the 28th of February. This has been delayed for almost 2 weeks. The collars were fixed on the horses 3 weeks later, on April, 21st. We could not justify doing nothing towards our sponsor during this period.

This radical change made us do assumptions based on former research done in Mongolia on Przewalski horses and personal communications of local experts. We planned to observe the habitat use of the horses ourselves. With our planned observations we could determine if, for example, they grazed in shrubs or pastures, why and when. We could also observe what they did in other land use types. Now these assumptions are based on former research done in other countries on different horses. However, we are sure that, there must be overlap in their usage of resources, but there are also differences. This again confirms why this thesis can be commonly considered as orientating for further research.

The newly selected method, as described in the chapters above, made it possible to continue even without the collars placed. As soon as the collars were in place and running for a certain amount of time, we could continue with working in the field. Although the method is aiming for other data, we will be able draw the same conclusions with it.

In the last three weeks another setback was given. Urgent family matters made one of us leave 2 weeks earlier, making the help of the Ecoclub and use of a car crucial. Only with this help it was possible to finish the most important part of the transect lines in one day. We chose to finish at least the used grazing grounds and set aside the probably less used land use types.

Questions Unanswered:

We were not able to answer the following questions (initially stated in the project plan) due to time limits and a change of methods. In the future, these questions can possibly be answered as the project and study continues.

Which interaction between individual animals/herds can be distinguished during the research period?

Has there been a change in the people's view after a workshop about reintroducing of locally extinct herbivorous species?

Is there a change of group composition during the research period? If yes, what determines the group composition?

To which extend does the natural predation determine the use of the landscape by the horses?

Are there landscape elements to distinguish which are used as cover, and is there a difference in function (for example predation, weather influences)?

▲ *A formerly buried horse in an ancient Thracian grave excavation. It was buried with about 10 horses in the 2nd century BCE, Mikri Doxipara – Zoni, Greece.*

▲ *The current herd of horses in Ark's herd fund.*

Small scale animal husbandry in Chernichino, kept by a 70-year old woman. ▼

3| RESULTS

This chapter includes the results needed to answer the questions in this thesis. It uses the same division as the questions, starting with traditional land use (part I). Most of this part consists of literature study. The history of animal husbandry is described elaborately because the details found here are crucial in understanding the past, and necessary for the future of the project and other projects in Bulgaria. Part II covers the results obtained for the description of the habitat use of the studied horses, and includes grazing preferences, the relation to site attributes of preferred grazing grounds, and concludes with a description of the sampled transects. Part III describes the results obtained from a questionnaire answered by 43 local people, in order to see what their knowledge about nature and the project is.

PART I: TRADITIONAL LAND USE

3.1 Indigenous Herbivorous Mammals

The indigenous (large) herbivorous mammals (*Macromammalia*) in the Eastern Rhodopi Mountains (Bulgaria) include wild boar (*Sus scrofa*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and chamois. About the mouflon (*Ovis mussimon*) little is known. The fallow deer "has been practically reintroduced, it occurred in the Balkans until the Middle Ages" (Spassov & Illiev, 1994 – in Spassov & Markov, 2004). But since the climatic and environmental conditions are good for these species, the fallow deer has been increasing in numbers (Sheremetiev, 2000 – in Spassov & Markov, 2004) The total ungulate population is not too abundant, probably because of bad game planning and for some species environmental conditions (especially red deer). The chamois is long absent from the Eastern Rhodopi Mountains due to non-regulated hunting in the past (Spassov & Markov, 2004).

3.2 The Importance of Animal Husbandry in (Pre-)Bulgarian Society

BCE: "Before the Common Era" i.e. before Christ
CE: "Common Era" i.e. after Christ

9th MILLENIUM BCE – transition from hunting towards farming

The Neolithic Revolution in the 9th millennium BCE marked the transition between hunter-gatherer societies to agricultural societies. The transition took gradually place from south to north; towards the areas that were suitable for agriculture, as can be seen in found ceramics and stone tools.

South-East Europe offers good circumstances for the cultivation of different crop species. The landscape in this region of Europe is diverse and the 'Neolithic Man' had rivers full of water, vast forest, mineral deposits, fertile grounds and pastures at their disposal. Most of the settlements were situated in the foothills of the Central Balkans, the Rhodopi Mountains, and the valleys of the Rivers Mesta, Varder and at the coastal areas (Dimitrov, 1981).

END OF 2nd MILLENIUM BCE – Thracian period

The Thracian period is estimated to have lasted from the beginning of the Iron Age (1.200 BCE – 100 CE) until the rule the of the Roman emperor Claudius. Horses were mainly used as means of transportation and status. This is visible in the majority of Thracian and early Roman graves were horses of the deceased were slaughtered on the burial site and buried with their masters. Also other 'belongings'; such as women, slaves, dogs, chariots, wine and a lot of food were buried in order to help them in the afterlife (Pers. comm. D. Kostadinova, 2011).

5th CENTURY BCE – the Slavic community

The tribes of the Slavs lived during the 5th century BCE, and sedentary agriculture was their central way of life. In this time, people started to use iron ploughs along with wooden ones. Amongst cultivated crops were wheat, barley, flax, hemp and different legume species. Hunting and fishing were still practiced, even when people already domesticated animals. The products from agriculture were stocked in pits close to the settlements, which in turn were situated at rivers, lakes and wetlands. All the members of the community took care for the grazing pastures, forests, rivers, hunting and fishing grounds. The farmlands were divided evenly amongst the people (Dimitrov, 1981).

4-7th CENTURY CE – the Protobulgarians

The first *Protobulgarian* (Bulgars) tribe originated from West Siberia, and was of a Turkish or Altaic family of peoples. They lived from nomadic animal husbandry on the steppes, and used both small and large animals, such as cows, horses, sheep, pigs and goats. Especially the breeding of horses experienced an uprising. Horses were used as means of transport during wanderings, campaigns and raids. The *Protobulgarians* also ate the meat and drank the milk of horses.

Agriculture played only a minor role in their way of life, and developed slowly – as did hunting and fishing. The settlements were placed on the riverbanks, within the vast forests and on the steppes. The nomadic settlements consisted of two building types: tents and above ground huts made of soil and stones (for a more sedentary way of life).

The social basis was consisted of a patriarchal nomadic community, in which accommodation, pastures and meadows, animal herds etc., were managed on a collective basis. Within the Protobulgarian tribes, the army consisted mostly of cavalry; therefore the breeding of horses was highly developed. During peace time, the horses were put into grazing areas (meadows) for resting, and anyone who would ride a horse was punished by death (Dimitrov, 1981).

12th CENTURY CE – increase of urban areas

During the 12th century CE, the main sources of income were agriculture and animal husbandry because of the favourable geographical and meteorological conditions. In certain regions the growth of grapes and vegetables was even possible. The techniques used in agriculture were improved and the use of the chopping tools and plough were widespread. This progress of techniques of both agriculture and the tilling of soil led to an increase of urban areas - hunting and fishing, as means feeding, were only incidental. Whilst using a two-course rotation method, agriculture could still be categorized as non-intensive. Especially in the mountainous areas animal husbandry was well developed – this included the keeping of cows, domesticated buffalo, sheep, pigs, horses and poultry. The larger animals were used as draft and transport animals (Dimitrov, 1981).

14th CENTURY CE – 2nd Bulgarian empire

A couple of centuries later, during the 2nd Bulgarian Empire, the main reasons for economic growth were still agriculture and animal husbandry. The abundance of mountains, meadows and rivers were good conditions for the development of animal husbandry. According to Byzantine writers, cattle breeding were the main source of income. The communities were dominated by the peasantry (farmers) and the village and towns were the fundamental economic and social unit. In this age, the cultivation of cereals (wheat, barley, oats and rye) knew a strong development, probably because of the use of a three-course rotation method. The relatively intensive nature of agricultural practices highly contributed to the development of trading (Dimitrov, 1981).

15th – 18th CENTURY CE – Ottoman Empire

During the Ottoman Empire (15th – 18th century), Bulgaria was a country with old fashioned agriculture where wooden ploughs were still used. It was a country without real industries or modern means of communication, without ports and ship transport – a big contrast with the more industrialized parts elsewhere in Europe (Dimitrov, 1981). Horses were an important export product for a lot of Bulgarians. The Ottoman army was large and therefore needed a lot of horses for transport. The horses bred and used for this, were mainly imported from countries on the Balkans, because of their tough and hardened nature (pers. comm. D. Kostadinova, 2011). The capitalistic free market developed as late as the 19th century. Most of the inhabitants were still farmers, and as always the main income was from agriculture and cattle breeding (Dimitrov, 1981).

3.3 Tradition and Horses

The shape of the country of Bulgaria as we know it today is of recent origin. When one goes back long enough in history, one can find many different tribes living within its boundaries. Most of the tribes had their own traditions, mixed with others, or developed their own over time. One important cultural, and in a way natural feature was the breeding of horses.

The very distinct breeds of horses were a typical feature for some of the tribes. In all of the cases, these horses were adapted to the terrain they lived and worked in of course. This paragraph will give a concise overview of the main breeds of horses found in Bulgaria and their characteristics, their use and their history. The reason why this is included is because the so called 'Karakachan' horse is one of those typical breeds, and it is in both Ark Foundation's and future members of the project's interest to know more about this special breed of horse.

Five breeds of horses are to be distinguished, and among them are the following: Deliorman, Karakachan, Staroplaninski, Rilaplaninski and the Kamche horse. All of them originate in different parts of Bulgaria and their existence is disputed to be of wild horse (*Equus ferus ferus*) origin (Petrov).

Figure 3.1. Karakachan people, 1937 (lostbulgaria.com, 2011)

Deliorman

The Deliorman horse was the traditional horse of North East Bulgaria, intentionally a wild horse, but domesticated by local people. The horses' genes has probably gone extinct late 19th century because of a large scale ethnical movement. When the local people (originally Turkish) moved, the horses mixed with other breeds and the genes were lost. (Petrov, pers. comm. D. Kostadinova).

Karakachan

The Karakachan horse was used for the transport of a tribe of a nomadic existence, and were called Karakachan (hence the name of the horse). The tribe was known for its traditional way of life, and the horses they used were of pure breed. They used to travel along the whole Balkans, but their existence is limited to the eastern parts of the Balkans, and most of them speak, or have spoken, Greek.

During summer, the people moved higher up in the mountains on places where their horses did not get any additional food. The horses could only eat grass and because of this they were smaller than normal (modern) horses. The people used the horses as means of transport (Petrov, 1941). At young age they were already used for the transport of heavy loads, and that is the main reason for their bended spines. They were bred without any additional food, and were confined to natural grasslands and meadows. The horses were even able to defend themselves against wolves and other potential predators, they did not have any protection from guarding dogs. In the months February until March they would get new foals, just before they moved to the higher grounds. When a horse owner saw one of his mares was about to give birth, he would take her into his tent for a safe place to give birth. The foal is taken away from the mother at an age of one, used for work at age of three, and males will be castrated at age four (when the horse is fully grown). The Karakachan horse had an average withers height of 126.1 cm, and a length of 129.1 cm (Petrov, 1941).

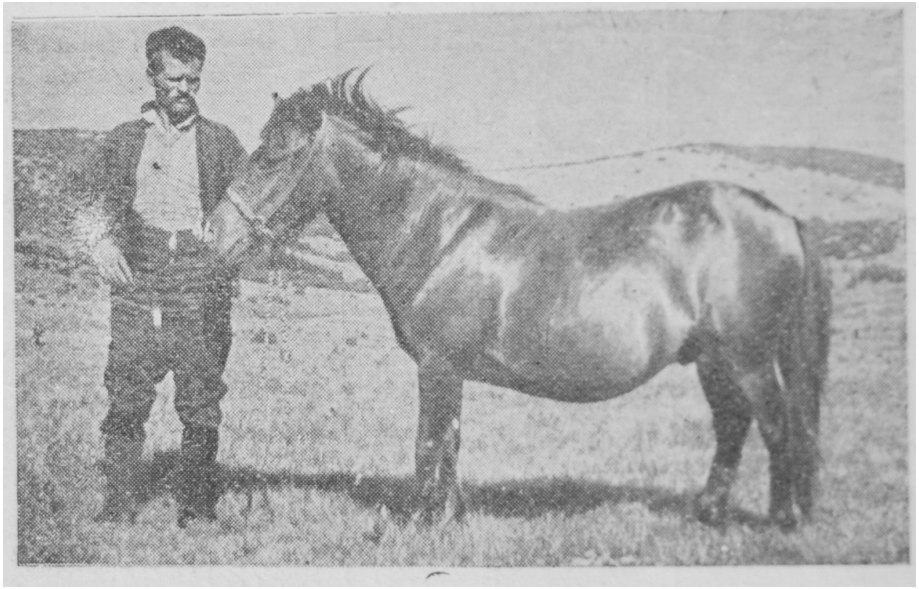


Figure 3.2. Karakachan horse, Petrov

Staraplaninski

The horse of the Central Balkan Mountains was the so called Staraplaninski horse (named after the region). This horse was used as a draft-horse in mountainous areas where there were no roads. In some literature, this horse was also called Karakachan. On these remote places, little agriculture existed and life was more concentrated on animal husbandry and timber production (before the communistic period). The horses were small and few ever got sick, and on top of that they were outside the whole year round. They lived of what nature offered them on natural grasslands, and receive only a little bit of additional food when they are of young age. At age three, they were already used as working horses and by the age of six they were able to move loads of up to 150 kilograms. That is also the main reason why they got sick, by carrying heavy loads and not because of other (modern) sicknesses. This breed of horses were the smallest ones around, their withers reached an average of 123.9 cm (mares 122.5 cm, castrated stallions 124.9 cm), and weighed only 250-300 kilograms.

Rilaplaninski

The Rilaplaninski horse originated from the alpine areas of the mountains, were a lot of forest is present. Also in these regions they were used as draft-horses to pull away the trees and timber. In the northern parts of the Rila Mountains, there were fields present for the horses to graze upon. The local people were relatively rich because of the money they earned with the cutting of wood. Only some of the draft-horses would receive additional food (often castrated stallions). The mares only received some during winter. During summertime the horses moved higher up into the mountains for food.

When the mares were about to give birth, they were take into the villages (for safety reasons) and would receive additional food. It is already after 10 days that the horses will have to get back with the others, out in the nature. The foals stay with their mothers until they reach an age of two. The stallions were used as working horses at the age of three, and castrated at four. This breed of horses was not as pure as the others, because the owners were not as traditional, or conservative, as other tribes – in which case the horses were sometimes mixed with other breeds. The horses which were not used as draft horses stayed up in the mountains during summer, and were put into a shed with other animals during winter (Petrov). They were known to have fairly long heads (50.1 cm) and their withers reached an average of 124.1 cm, and their length about 125.1 cm.

Kamche

The Kamche horse originated from the eastern parts of the Central Balkans (Stara Planinski). Bichev (1930) suggests that this horse is of Thracian heritage, although he is not sure. The horses survived mostly by grazing on grass and eating leaves of the tress, and they only received little additional food such as hey. This type of horse was still being bred until the beginning of the 20th century. The animals were used only 10-15 days a year to thresh, or flail, after the harvest of cereals. In fact, they were not even used for transport, pulling carts or any other kind of work. This is not typical Bulgarian, which can be related to the fact that most of the people living there were of Turkish origin, which would use cattle for transport instead of horses. Only few of the horses owned were used for riding or were sold. Each horse owner owned between (on average) 4-5 and 20-30 female horses (mares) and only one male (for the socials structure of the herd). In situations where one owner did not have enough horses to make an actual herd, the horses of several owners where put into one herd.

This horse could be regarded as a semi-wild mountain horse, as they stayed outside the whole year and also the climate (tempered climate because of the sea, no harsh winters) was in their favour. When a harsh winter occurred, the horses were gathered an put into the village and received additional food. Their heads measured an average length of 52 cm, their withers 133 cm and their length about 133 cm as well.

3.4 Communism and the End of Breeding

Petrov writes about the disappearance of the Deliorman horse, but it was until 1995 that this breed of horses was officially regarded as extinct. Amongst the causes is the destruction of habitat by turning natural grazing areas in areas for agriculture by 'cleaning' the areas of trees and bushes. After the second Balkan war (1913), the total area of Bulgaria increased and more people resulted in a higher demand for food. Also during communistic times more and more areas were turned into (more productive) lands for agriculture. During the 19th century, the Turkish people had to move because of ethnic clearance, with them the tradition of breeding horses disappeared as well. A change of nationality also meant a change in biodiversity. This was because the people who took their place had other traditions and other ways of managing the land.

After the Second World War (1945), the borders of Bulgaria were definite and the nomadic way of life of, amongst others, the Karakachan people ended, while the people still lived on. Shortly after WWII communism entered the way of life, and since then it was impossible to own horses privately. The state took everything from the people and distributed it evenly, in that way (according to the principles of communism) there were no differences. The herdsmen of the Karakachan tribes turned into shepherds in which they did not own the sheep, but only took care of them and received wages for this. The animals and their products were owned by the state. Only in some places high up in the mountains people could live the way they have always done, because the state took no interest in those inhabitable places. Also, these places could not be reached by modern agriculture machinery and were of low productive value, so horses were still needed. In areas such as the Pirin Mountains and the Eastern Rhodopi Mountains still horses were used, but their genetically purity is unclear.

During the 1960s, Bulgaria experienced an uprising of industrialism. The inhabitants were not forced to move to the cities, but life was easier there since everything is owned by the state. Towards the 1970s, the main focus shifted from agricultural products towards products made in the industries – which had nothing to anymore with the traditional way people managed the land. Every single part of the communistic 'empire' was appointed on having its own role to fulfil, and in the southeast (Madzharovo region) this meant mining because of the natural resources (e.g. vanadium). In the meanwhile almost all of the animals were confiscated by the state, except for the poor people who lived in the mountains who were able to keep their animals. Those regions could be found in the Pirin and Central Balkans, where local breeds were still kept for breeding.

This stayed for a while, until communism ended in 1989. In the beginning of the 1990s the state returned the ownership of the land, according to the national archives that were written when everything was confiscated. It was a hard transition for the people, to cope with the private ownership of goods, land and animals. In most cases where the people received animals from the state, the animals went directly to the slaughterhouses because of the simple reason that people did not have the space (in the cities) or the knowledge to take care for them.

Nowadays, the European and Bulgarian laws describe that pet animals (also farm animals) should be kept strictly in a prescribed way. The owners are obliged to have a place with a roof and to be provided with decent food, there are rules concerning the amount of days they can stay outside and about giving birth. Only for some of the local rare breeds (such as the Karakachan horse) there are exceptions. They are allowed to stay the whole year outside, which is better for the animals because of the nature of the animals.

The so called national clearance occurred in the whole Balkan district. There were several waves of national purification / ethnic cleansing, starting in the beginning of the 20th century. It became worse after the 2nd Balkan war (1913). The last occurred shortly after the First World War (1918). For example, most of the population near the Black Sea was of Turkish origin and they all were forced to move to Greece. The Bulgarians who came in their place, were not interested in the breeding of horses which could only be used for the thrashing of corn – they also wanted horses which they could use for other kind of work. At this moment, only the Karakachan horse is recognized as rare breed of horses.

In recent time, more and more people try to save local breeds of cows, sheep and horses. In the area of Madzharovo there are projects (e.g. the Friends of Rhodopi Cow Foundation), in cooperation with local farmers, to show that primitive races can be used more

effectively and sustainable than modern breeds. This is with great success; now several cow and sheep farmers practice animal husbandry successfully with just primitive races (pers. comm. H. Hristov, 2011).

3.5 Primeval Landscape

In what way the primeval landscape of the Netherlands, but also the rest of lowland Europe, looked like – is still a matter of discussion. For centuries, people envisioned the primeval wilderness of Europe as vast areas covered with dense forests, in which every animal and plant species known today would have had its own place. Nobody ever challenged this view on a scientific basis. Even species bound to open areas (small gaps in the canopy, which would differ in size) would have survived in those vast primeval forests. Local extinction happened every now and then, but on the larger scale each species would be able to survive on the long term. In this concept, large herbivores would not have any influence on the succession and rejuvenation of the forest system (Vera, 1997, 2000).

3.5.1 A variety of landscape types

The Dutch Frans Vera (1997, 2000) actually managed to make a scientific breach in the way people thought about the primeval wilderness of Europe. He wrote his dissertation, and called it 'Metaphors for the Wilderness', but the idea is probably older (later his work is published in English, 'Grazing Ecology and Forest History', 2000). In his doctorate dissertation he shows that the primeval landscape of lowland Europe did not consist of vast dense forests – but it proved to consist from a variety of landscape types. This so called park like landscape consisted of groups of trees with meadow and pasture-like areas in between (Buissink & Vera, 2004). In this wilderness, the succession of species is actually being directed by the behaviour of large herbivores and even several bird species. Grazing by specialized grass eaters, such as bovine and horse species, will result in meadows with thickets of thorny bushes. Those thickets could be potential locations for seedlings of every kind of tree or bush. The thorny bushes will protect the small seedlings from being browsed upon. Tree species which are dependent on the distribution by birds like Eurasian jay (*Garralus glandarius*) or nuthatch (*Sitta europaea*), such as oak (*Quercus sp.*) or common hazel (*Corylus avellana*), will have a chance to establish themselves within those thickets. In this way even forests with a closed canopy could be originated.

3.5.2 The theory of the cyclic turnover of vegetation types

The predominant shadow of the forest canopy, along with the trampling hooves and feet of large herbivores will prohibit the rejuvenation of light-dependent species. The failure of new regeneration of the forest will lead to a natural degeneration, in which case the forest will transform into a meadow. This process can be accelerated by natural catastrophes, such as storm, through which even larger areas of closed forest can turn into grassland. From this moment on, the whole cycle starts over again. Every stage of the succession of vegetation types (succession) will be permanently present, and when seen at a big scale – the only thing that changes over time will be the location (Vera, 1997, 2000). He calls his new concept of the pristine vegetation in Central and West Europe: the theory of the cyclic turnover of vegetation types.

3.5.3 Analogy with large herbivores

As a result of the constant change in the landscape, the primeval wilderness was characterized by a wide variety of plant and animal species. A big number of the animal and plant species were able to survive in the forest meadows, even after the disappearance of the original large herbivores. The way cattle were kept during former times was a modern analogy of the way large herbivores affected their environment – it was in comparison with the aurochs and the tarpan almost the same. In Central and West Europe this analogy could be made up until the 18th century, even after the aurochs and tarpan had been displaced by modern cattle and horses. New technologies to optimize agriculture and livestock breeding, developed less analogical to the natural processes (Vera, 1997, 2000).

PART II: HORSE HABITAT USE AND HORSE ECOLOGY

3.6 Collar Statistics

For the collar statistics of Penelope (F) see **TABLE 3.1.**

*N.A.: not available – no fix

**2D: a 2D fix means that the GPS used signals from less than 4 satellites to estimate a position.

***3D: a 3D fix means that the GPS used signals from at least 4 satellites to estimate a position (Brundberg, 2004).

TABLE 3.1. Collar statistics of Penelope (F), March 21st – May 2nd 2011 (spring)

Collar statistics (Penelope, ♀)	
Date of collaring horse	March 21st, 2011
Start date GPS-collar	16h00 – March 21st, 2011
End date location acquisition for thesis	22h00 –May 2nd, 2011
Total amount of days	±42 days
Frequency of fixes	1 fix / 0,5 hour
Amount of fixes (obtained)	2029
% N.A.* / %2D** / %3D***	0,05% / 0,20% / 99,75%
Amount of fixes usable (without human interv.)	1902
% N.A. / %2D / %3D	0% / 0,16% / 99,84%
Amount of fixes within 'Kernel 95'	1880
Difference in amount of fixes (obtained and usable)	127

3.7 Home Range

FIGURE 3.3.: shows the Kernel 50% and Minimum Convex Polygon 50% (called hereafter MCP) 2011 spring home range estimations (March and April), using Home Range Tools and Hawth's Tools in ArcGIS. It also shows that the MCP has sharp boundaries; however Kernel has a buffer zone around the fixes. This shows the cognitive map of the animal. The animal may not be present in the area around the fixes but it is certainly aware of it and its contents. The ranges show some overlap but the area size is significantly different in both methods.

TABLE 3.2.: shows that the Kernel 50% area is almost 4 times as small as the MCP 50%. The Kernel 50% is 5,71 km² and the MCP 50% is 22,87 km².

FIGURE 3.4.: shows the Kernel 95% and MCP 95% spring home range estimations (March and April), using Home Range Tools and Hawth's Tools in ArcGIS. The ranges show a lot of overlap but here again it is very well visible that the MCP has sharp boundaries and takes not into account the cognitive map of the animal.

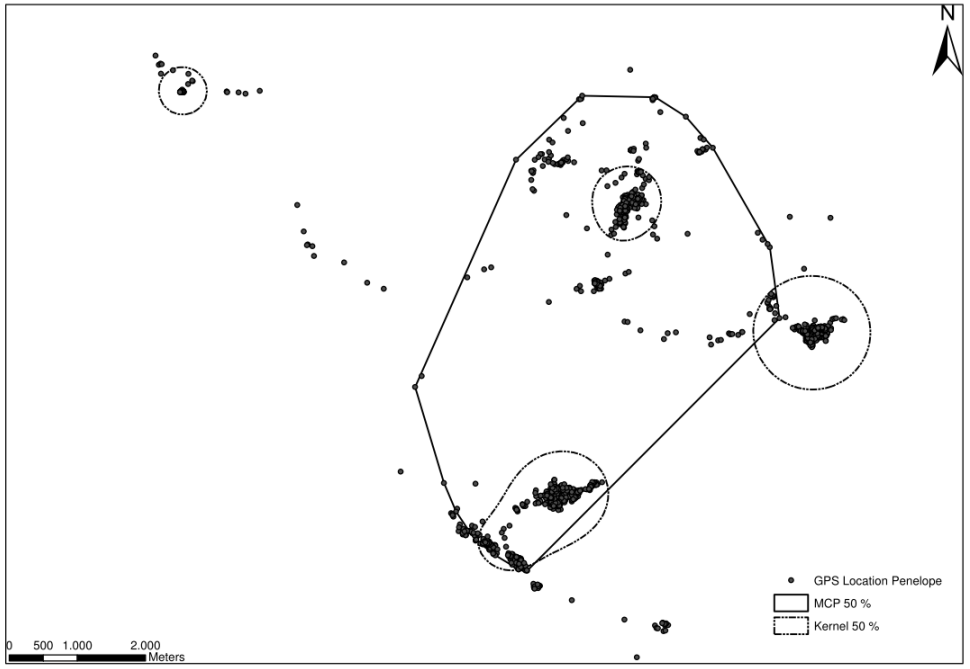
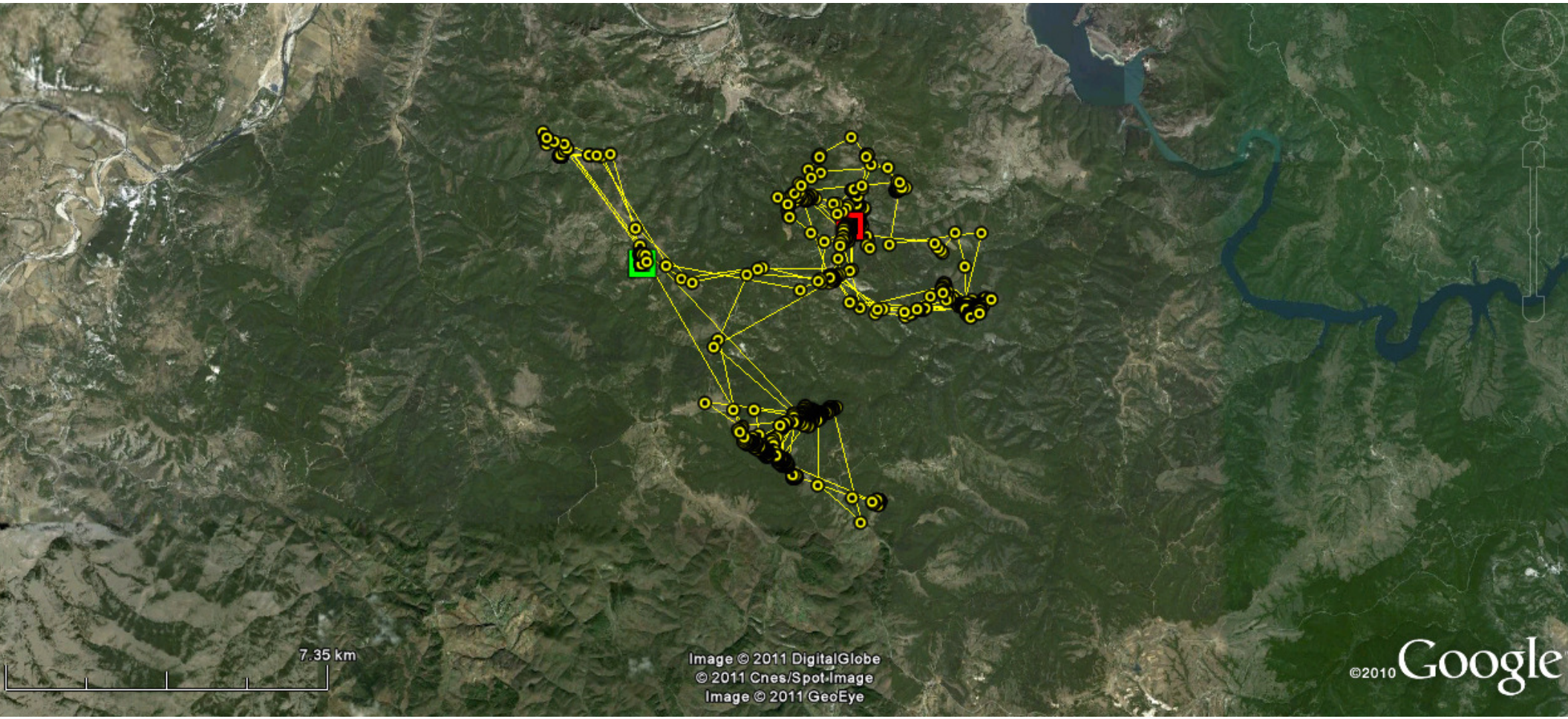


FIGURE 3.3. Comparison home range estimators MCP (50%) and Kernel (50%) in spring 2011 (March & April)



▲ *The fixes (of Penelope's collar) plotted in Google Earth, showing spatial distribution in the period March 21st to May 2nd. The squares showing the first (green, Chernichino)and the last position (red, Malko Popovo).*

TABLE 3.2.
Home range area in Kernel and MCP - 50% and 95%

Home range	Area ($km^{2)}$
MCP 50%	22,87
MCP 95%	50,57
Kernel 50%	5,71
Kernel 95%	32,36

TABLE 3.2.: shows again that the MCP 95% has a larger area size but the Kernel 95% is not even half the size. The Kernel 95% area is now 32,36km^2 and the MCP 95% area is now 50,57km^2.

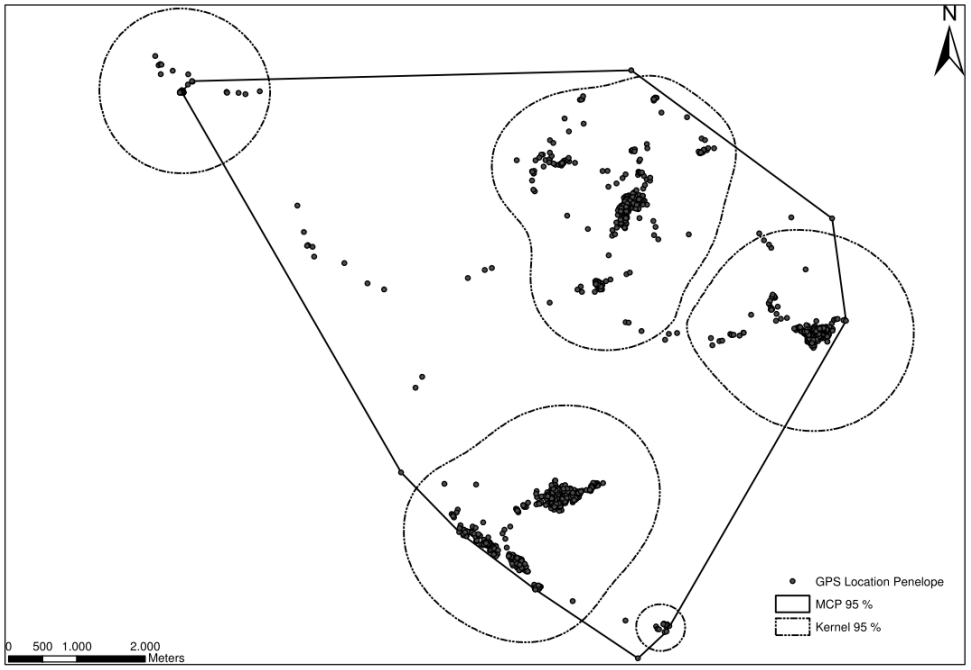


FIGURE 3.4. Comparison home range estimators MCP (95%) and Kernel (95%) in spring 2011 (March & April)

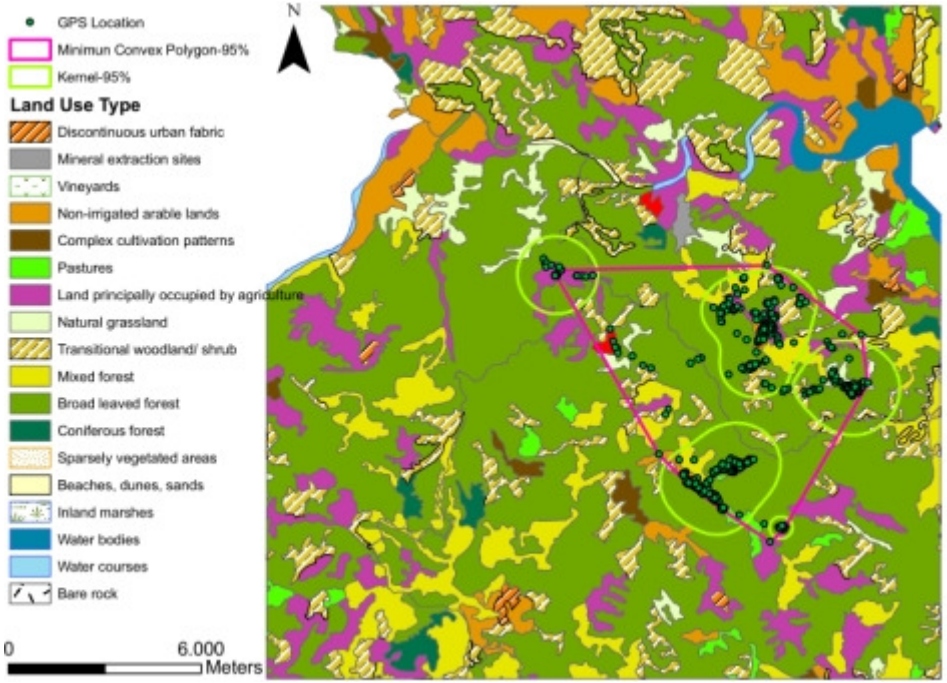


Figure 3.5. Land use types including GPS fixes Penelope within 20x20 km square, March & April, 2011

3.8 Habitat Use

FIGURE 3.5.: shows a spatial overview of the positions of the horses. It shows that the fixes are not equally distributed over the area. The horses are the most in natural grassland and in non-irrigated arable land (for larger version: **APPENDIX IV –Map Land Use Types**). Upper red area is Madzharovo, lower is Chernichino.

TABLE 3.3.: shows the preference index (PI) when MCP 50% and MCP 95% are used. The preference index is for both in pastures the highest (PI=22,40 and 13,27 relatively), but it has with the MCP 50% a significant larger difference with the second preferred land use type (non-irrigated arable land, PI=11,07).

PI = preference for a land use type (0 = total avoidance, 1 = no preference, 1 + increased degrees of preference). U = use (percent of grazing observations in that land use type). A = area (percent of home range preference). U = use (percent of grazing observations in that land use type). A = area (percent of home range covered by that land use type).

TABLE 3.3.
Grazing preference index (PI) used by Penelope's herd, March – April, 2011. MCP 50% and 95% estimates

Land use type	Home range					
	MCP 50%	22,87	km^2	MCP 95%	50,57	km^2
	U	A	PI (=U/A)	U	A	PI (=U/A)
Broad leaved forest	11,65	63,18	0,18	8,95	65,84	0,14
Land principally occupied by agriculture, with significant areas of natural vegetation	6,93	5,32	1,30	9,99	4,95	2,02
Mixed forest	1,61	13,51	0,12	0,99	11,15	0,09
Natural grassland	1,51	0,89	1,69	33,08	2,57	12,89
Non-irrigated arable lands	38,96	3,52	11,07	23,03	2,26	10,21
Pastures	33,03	1,47	**22,40**	18,66	1,41	**13,27**
Transitional woodland/ shrub	6,33	12,11	0,52	3,70	11,12	0,33
Discontinuous urban fabric	0	0	0	1,60	0,70	2,28

TABLE 3.4.: shows the preference index when Kernel 50% and Kernel 95% are used. The Preference index is for Kernel50% is for pastures the PI=3,47 in and has a small difference with the second preferred land use type, natural grassland 3,26. When Kernel 95% is used there is a preference for natural grasslands (PI=10,82).

PI = preference for a land use type (0 = total avoidance, 1 = no preference, 1 + increased degrees of preference). U = use (percent of grazing observations in that land use type). A = area (percent of home range preference). U = use (percent of grazing observations in that land use type). A = area (percent of home range covered by that land use type).

TABLE 3.4.
Grazing preference index (PI) used by Penelope's herd, 2011 March - April. Kernel 50% and 95% estimates

Land use type	Home range					
	Kernel 50%	5,71	km^2	Kernel 95%	32,36	km^2
	U	A	PI (=U/A)	U	A	PI (=U/A)
Broad leaved forest	5,72	56,22	0,10	8,36	65,72	0,13
Land principally occupied by agriculture, with significant areas of natural vegetation	13,12	11,21	1,17	15,06	7,44	2,03
Mixed forest	0,19	2,04	0,09	0,90	9,40	0,10
Natural grassland	37,25	11,41	3,26	31,93	2,95	**10,82**
Non-irrigated arable lands	23,26	12,02	1,93	22,30	3,32	6,71
Pastures	20,46	5,90	**3,47**	17,99	2,02	8,90
Transitional woodland/ shrub	0	1,20	0	3,46	9,16	0,38
Discontinuous urban fabric	0	0	0	0	0	0

3.9 Natural Boundaries

There is little to say in our results about natural boundaries. Because of our changed method we could not observe the horses in their habitat, thus we were not able to discover any abiotic boundaries. In **4 | Discussion** more explanation is given about possible natural boundaries.

3.10 Potential Feeding Grounds

On forehand, we determined for the potential feeding sites four different classes (**FIGURE 3.6.** Potential Feeding site map): '*First choice*', '*Second choice*', '*Forest*' and '*Other*'. We based this on our only available data for land use types; a GIS map. For the distribution of the different classes we manually decided the preferred sequence, based on attractiveness according to literature research (see **4 | Discussion**).

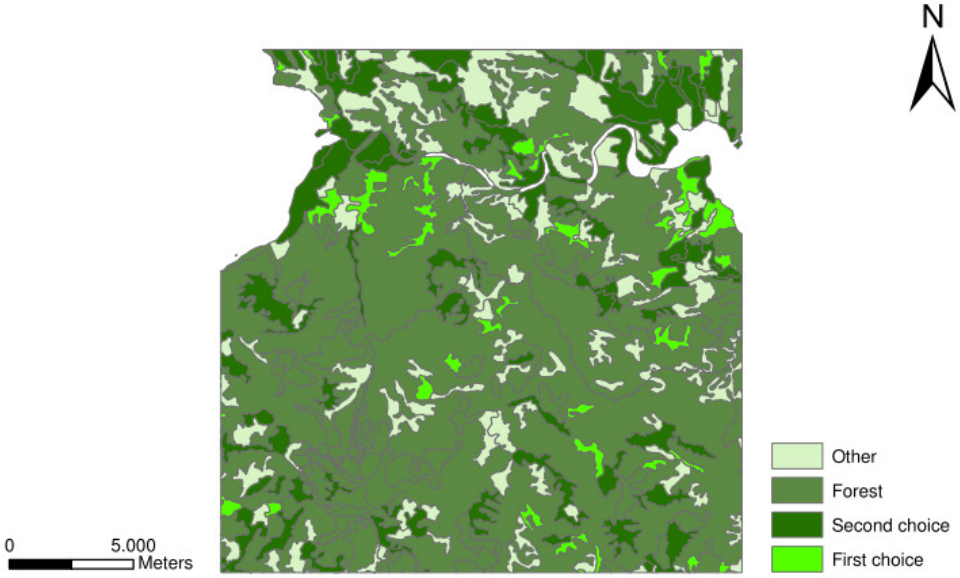


FIGURE 3.6. Potential feeding site map within 20x20 km square

The land use types included in the 'First choice' are; *natural grassland* and *pastures*. In 'Second Choice' those are: *land principally occupied by agriculture* and *non-irrigated arable land*. '*Forest'* consists of all the forest types (broadleaved, mixed and coniferous). And in 'Other' those are: *transitional woodland, complex cultivation patterns* and *discontinuous urban fabric.*

3.10.1 Feeding sites vs. actual habitat use

When these categories are to be compared with the actual preference index (P.I.) (**TABLE 3.3. & 3.4.**), one can see that the assumption of the different classes was well according to the actual habitat use (**TABLE 3.5.**). As can be seen in the value of the PI's of the potential choices.

TABLE 3.5.
Grazing preference (PI) in potential feeding grounds by Penelope's herd, March – April, 2011

Potential choices	Potential		
	U	A	PI
First choice	48,70	4,33	11,25
Second choice	36,55	16,72	2,19
Forest	9,66	62,80	0,15
Other	5,09	16,15	0,32

3.11 Characteristics Preferred Sites

3.11.1 Distance to roads

This graph (**FIGURE 3.7.**) shows the amount of GPS location (fix) in a given distance (in meters) from the roads. There is a big gap in between the two extremes. Either most of the points are situated within 200 meters from a road, or 1 kilometre or further. In between there are relatively few fixes.

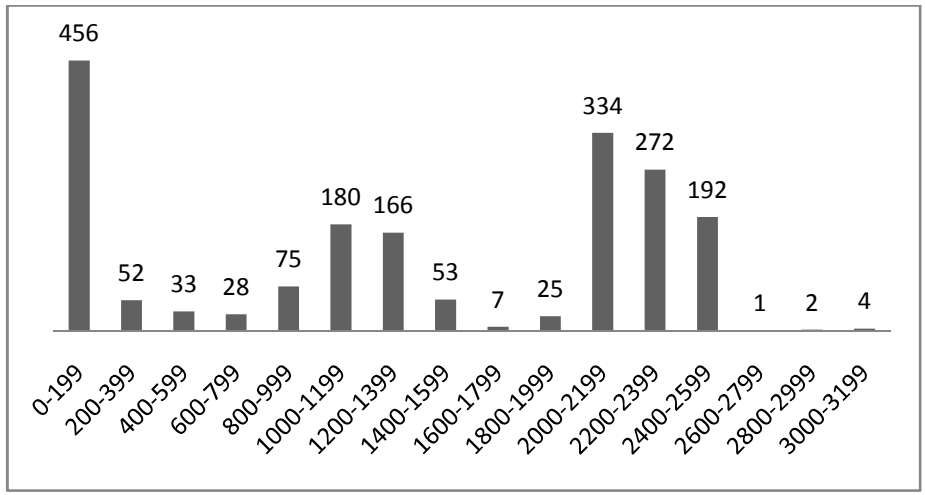


FIGURE 3.7. Number of fixes in relation to distance (m) from a (main) road

3.11.2 Distance to (broadleaved) forest

This graph (**FIGURE 3.8.**) shows the closest distance (in meters) from the fixes to the border of the land use type categorized as 'broadleaved forest', in the available GIS data. Broadleaved forest is the most abundant type of forest (65,7%, see table of home range kernel 95). It shows that most of the locations are really close to the border, the majority of them within 200 meters. There are no fixes further away than 500 meters.

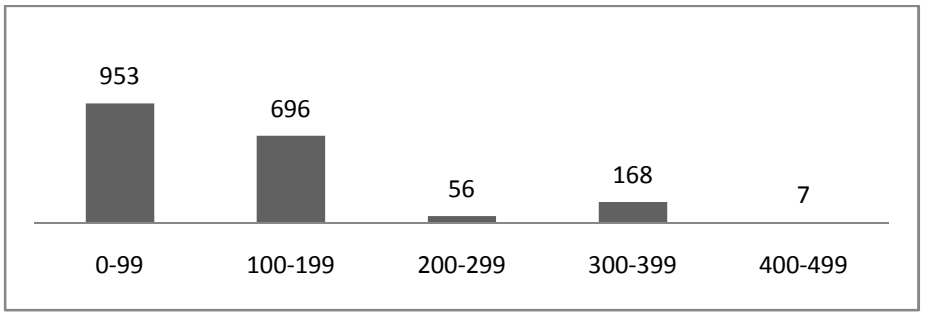


FIGURE 3.8. Number of fixes in relation to distance (m) from border of broadleaved forest

3.11.3 Distance to natural water sources

The available GIS-data contained the Strahler-values of the different natural water-courses. For each GPS location the relative distance (in meters) to a watercourse with a different Strahler-value is given. In this thesis the values of 1, 2, 3 and 4 are recognized. A high Strahler-value means that the stream has not been diverged much from its initial source. A watercourse ends in a stream with the Strahler-value of 1.

In the tables found in **APPENDIX V – Distance to Natural Watercourses**, the land use types are categorized according to the preference index (PI), which has been taken from the table of the grazing preference within Kernel 95% home range estimation of the horses (see: **TABLE 3.4.**). The next step is the amount of fixes within different distances (meters) from a watercourse with differing Strahler-values.

The (relative) high amounts of fixes are moving away from the watercourses as the Strahler-value gets bigger, in other words; the bigger the Strahler-value of a watercourse, the bigger the (average) distance gets. This is noticeably of the fixes within the preferred (PI>1) land use types. Only the amount of fixes located within natural grasslands (PI= 10,82), does not show this movement of a bigger distance when the Strahler-value gets bigger.

3.12 Vegetation vs. Height (Altitude)

3.12.1 Preference Index for given land use type, per height class

This table (**TABLE 3.6.**) shows the preference index (P.I. > 1 shows preference, no data is a 0) of a given land use type within a certain height class. This makes clear when the horses are at a certain height class, to which extent they will use or prefer a certain land use type. With other words, when they are at 400-500 meters they prefer natural grass-lands the most (according to the highest P.I.). (This takes into account the fixes within the Kernel-95% home range estimation.)

In elevations between 300-400 meters natural grasslands are (P.I.=9,14) mostly pre-ferred, secondly non-irrigated arable lands (P.I.=5,25). On elevations between 400-500 meters they also prefer natural grasslands the most (P.I.=15,38), while non-irrigated arable lands is a good second (P.I.=5,86). On the heights between 500-600 they mostly use pastures (P.I.=14.09) and to some degree they prefer transitional woodland and shrub (P.I.=1,09). For the height classes 600-700 they prefer non-irrigated arable lands and land principally occupied by agriculture (P.I.=2,18).

TABLE 3.6.
Preference Index (P.I.>1 = preference) for given land use type, per height class for Penelope's herd, March-April, 2011

Height class	Land use type						
	Broad leaved forest	LPOBA	Mixed forest	Natural grassland	Non-irrigated arable lands	Pastures	Transitional wood-land/ shrub
200-300							
300-400	0,07	0,29		**9,14**	**5,25**		
400-500	0,05	2,60	0,06	**15,38**	**5,86**	0,88	0,10
500-600	0,29	0,66	0,18			**14,90**	**1,09**
600-700	0,04	**2,18**	0,15		**8,63**	0,14	0,12
700-800							

3.12.2 Preference Index for given height class, per land use type

This table (**TABLE 3.7.**) shows the P.I. of a land use type for a given height class (P.I. > 1 shows preference, no data is a 0). With other words, this table shows any preference for the same land use type but then at a different height. To make the distinction between the previous more clear: they might (in general) prefer natural grasslands (according to their Preference Index), this table shows then that they (from all the natural grasslands present) prefer those at elevations between 400-500 meters the most (compared to the natural grasslands at other height classes). So this table shows a comparison of land use types among the height classes. (This takes into account the fixes within the Kernel-95% home range estimation.)

Broadleaved forest is only preferred at elevations between 500-600 meters (P.I.=2,13). Land principally occupied by agriculture is preferred only at heights of 400-500 meters (P.I.=1,85). The land use type mixed forest is preferred in the two height classes covering 500-700 meters (with an average P.I. of 1,39). Natural grassland is preferred at heights 400-500 (P.I.=2,05). Non-irrigated arable lands is most preferred at heights between 400-500 meters (P.I.=1,25). Both pastures and transitional woodland or shrub are only preferred at heights 500-600 meters (P.I.=1,55 and 2,66 respectively).

TABLE 3.7.
Preference Index (PI>1 = preference) for given height class, per land use type for Penelope's herd, April – March, 2011

Land use type	Height class					
	200-300	300-400	400-500	500-600	600-700	700-800
Broad leaved forest		0,53	0,59	**2,13**	0,19	
LPOBA		0,13	**1,85**	0,30	0,75	
Mixed forest			0,88	**1,71**	**1,07**	
Natural grassland		0,79	**2,05**			
Non-irrigated arable lands		0,73	**1,25**		0,89	
Pastures			0,14	**1,55**	0,01	
Transitional woodland/ shrub			0,37	**2,66**	0,22	

3.13 Used Land-use Type vs. Temperature

FIGURE 3.9.: shows the average temperature within given land use type (measured temperature in degrees Celsius, at the GPS collar). It shows that there is not much difference in preference (according to the amount of fixes) in a certain land use type with changing temperature.

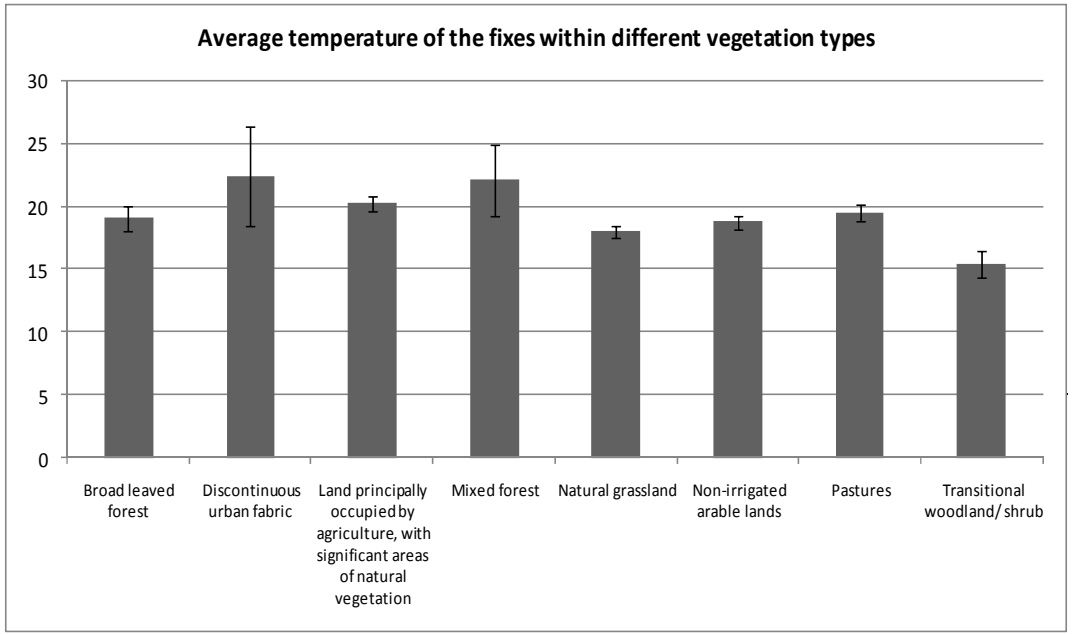


FIGURE 3.9. Average temperature of the fixes within different vegetation types (with 2 x Standard Error)

3.14 Transects

The fieldwork included a total of 14 transects, of which 8 are random and 6 are placed within a land use type that, according to GPS data, has been used intensively. The 8 randomly chosen transects are situated in four different land use types, while the other 6 are placed in only two different types. In total, transects have been placed within 6 different land use types. We have tried to distinguish as many species as possible, but this was due to the season not always easy.

The first table in **APPENDIX VI** shows the total count of measured plants/trees, the average height per species, and the average height per vegetation type (of the measured plants, in most transects grass was dominant and not measured, only on average) and the standard deviation of the height. This table gives an overview of the distribution of measured species within the transects. More data has been acquired resulting in a horizontal and vertical structure display of the transects taken. Also the visual obstruction (see **2 | Materials and methods**) has been visualised. These visualizations can be found in the **APPENDIX VI – Vegetation Transects**.

3.14.1 Random transects

The transects in transitional woodland / shrubs (1 and 4) shows that the plants are scattered across the landscape. The height can be categorized as quite low, on average 0,60 and 1,84 meters. Also the visual obstruction (see **APPENDIX VI**) varies from almost none (in transect 1) to a lot (transect 4, see **APPENDIX VI**). The species composition consists mostly of herbaceous plant species or low deciduous (probably grazed) tree species. Some juniper (*Juniperus spp.*) is present. Besides the measured plants, grass and other small low herbs are dominant with an average height of: 27,5 cm (transect 1).These two examples show the diversity of this land use type.

The transects in forest (transects 2 and 3, see **APPENDIX VI**) are, based on the data available, totally different. One is measured in a (planted) piece of pine forest (*Pinus spp.*) (transect 2), the other in a more open forested area (transect 3). This is directly noticeable in the distribution, the amount of plants, and the species composition of the whole. The more natural forest type (transect 3) contains a lot of oak (*Quercus spp.*) and juniper and other light-requiring species. Also the difference in the average height of the transects is huge; 8,69 meters in the pine forest (transect 2) and 0,96 meters in the other one (transect 3). Visual obstruction is on average higher in the forest dominated by light-requiring species, while there is almost none visual obstruction in the pine forest (because of the absence of species in the undergrowth).

The transects (5 & 8) recorded in LPOBA (land principally occupied by agriculture but with significant areas of natural vegetation) have an average height of 0,95 and 0,64 meters. Their species composition consists mostly of (low) deciduous tree species and herbs; with transect 8 having a bigger share of Christ's thorn (*Paliurus spina-christi*). The individual plants are regularly scattered along the transect (see horizontal structure, **APPENDIX VI**). Most of the small herbs are found below the taller plant species as can be noticed in the visualisation of the vertical structure. Because of the high amount of low deciduous tree species, the visual obstruction is quite high. Especially noticeable in transect 8 where the obstruction is caused by the tall juniper trees. Besides the measured plants, grass and other small low herbs are dominant with an average height of: 27,75 cm (transect 5).

Both transects in natural grassland (6 & 9) are dominated by herbaceous species (almost two thirds of the recorded amount of species) and in some degree by (low) deciduous and juniper species. The average heights are 0,56 and 0,65 meter. The horizontal structure of the transects are quite comparable, showing clustered groups of plants with some space in between (see **APPENDIX VI**). The amount of visual obstruction is on average on the medium level, it varies a lot, which is due to the clustering of plants. Besides the measured plants, grass and other small low herbs are dominant with an average height of 16,44 cm (transect 6).

3.14.2 Used transects

The three transects in pastures (X1, X2, X3) show that the plants are more widely scattered, but still show a clear variation in the way and the distances bothered (compared to the transects taken in grassy vegetations, above). They have in common that the plants are also clustered at some points along the transect, and in between nothing exceptional grows. All three of them are dominated by herbaceous species, and in some low growing deciduous tree species are present. The majority of the measured plants have a small diameter. The visual obstruction measures low to high, but low in general – only the visual obstruction measures from transect 3 are an exception.

The transect which has been taken in an area categorized as non-irrigated arable lands (X4, X5, X6) are very similar to each other. They are mostly dominated by grass with an average height of 2,3 (X4), 2,5 (X5) centimetres, but only the exceptions are taken into account here. There is no visual obstruction and the herbs are small in diameter and small in number (only 24 are measured on three transects) and most of them are herbs (see **APPENDIX VI**).

PART III: SOCIAL STUDY

3.15 Social Study

To almost all the questions (**APPENDIX VII – QUESTIONNAIRE**) people could give multiple answers. This makes that sometimes the sum of all percentages in one question is more than 100%. All the tables are included in **APPENDIX VIII – RESULTS QUESTIONNAIRE**.

Of all the people we questioned, in total local 43 individuals (±10% of the population of Madzharovo) with an average age of 44,8 years, 74% is male and 26% is female. We grouped the hobbies in classes, which can be categorized as following: sports (12%), fishing (35%), hunting (16%), nature (26%), miscellaneous (23%), animal husbandry (9%). The professions of the questioned people were differentiating. 12% was farmer, 14% engineer, 26% unemployed or retired, 5% teacher, 5% student, 9% entrepreneur and 30% had other jobs.

3.15.1 Knowledge of nature (questions 1, 2 and 3)

There is significant amount of people that give nature a positive aesthetical value (61%) in question one. Negative aesthetical values were never given. On the other hand more than 50% gives nature a functional label, for example; for people to work in. What people think about wilderness is clear. 40% says that is not a place where no human goes or is able to go. 28% thinks that it is right here in Bulgaria and 26% thinks that it is were the wild things are (broad definition).

A significant amount (61%), of people also thinks that the role of man in nature is the one of a manager that natural processes should be controlled. Only a small percentage (9%) thinks that nature is only for hunters.

3.15.2 The importance of nature (questions 4 and 5)

The majority of the people gave a higher value to the function of recreation (147, is not a percentage) than ecology and economy. Ecology follows close with 121 points awarded by the people. A significant high amount of people says that they experience the nature / environment of the Eastern Rhodopi Mountains as very good (67%).

3.15.3 History of local animal husbandry (q*uestions 6, 7 and 8)*

The questioned people do see progress and future in animal husbandry, 42% says it will use more rare breeds and 35% thinks that it will get bigger. Just a small percentage sees no progress in this business. The overall opinion about reintroducing local species/breeds is positive. People do see that it is important to breed more local breeds, but for a variety of reasons. The most supported view is that people know that those breeds are more self-reliant in nature on their own (49%). Second is that those breeds do give better milk and meat because they are living freely (37%). The third but not less important is that they find it important to save local species (28%).

3.15.4 Wild animals (questions 9 and 10)

Significant here is that the majority either thinks no animals have disappeared or have no idea (42%). Just a few percent do see that the animals that suppose to live there are actually missing. In question 10, the majority admits that people are to blame for the disappearance of the lost animals. The destruction of their habitat as number one reason (37%), poaching has been noted as second (30%). Significant to see is that nobody thinks that the wolf or jackal is the blame for this.

3.15.5 Project 'New Thracian Gold' (questions 11 – 16)

Significant here is that a small difference between people that know the project 'New Thracian Gold' and do not know the project (only 11%). People that do know the project tend to know what it is about and what is going on. The majority of the people that know the project know this from a (rare breeds or tourist) fair (23%) or from friends (19%). A smaller percentage knows this through workshops or information gatherings (14%). The percentage of people that know the project from flyers/folders (2%) is very low. What people think of this project varies from 'not my favourite' to 'very good'. The highest percentage is good with 33% in respect to 16% for very good. Neutral is ranked third with 11.6%.

The reintroduction of lost species, a large part of the New Thracian Gold project, is favoured by the majority (74%). 19% says it is of no importance for them and 2% says it will actually bother them.

3.15.6 Wilderness, eco-tourism and economics (questions 17 and 18)

Ecotourism is thought well off by the people in general: 67% do think is it good for the region. 21% thinks it is very good. Only one person does not like it.

The majority also thinks that the Eastern Rhodopi Mountains are ready for ecotourism. However in some cases they also checked the box where negative opinions could be expressed, we also took this into consideration because we find this important to know.

▲ *Relative fresh prints of horses' hooves in the moist soil of a forest road somewhere in the surroundings of Chernichino.*

▼ *The steep and hilly landscape north of Chernichino, characterized by forest interspersed with open grassy areas containing thorny shrubs (such as Christ's thorn).*

4 | DISCUSSION

Discussing the results gives an overview of the factors that might control or affect the results. Besides this overview, it is the place to look critically to the results and to compare it with findings from other research, in order to see differences or similarities. All the results are discussed in the same sequence as in the previous chapter.

PART I: TRADITIONAL LAND USE

4.1 Indigenous Herbivorous Mammals

One can question if the list of animals, mentioned in results, is complete without the cattle breeds (Karakachan sheep, goat, horse, and several cow breeds). According to H. Hristov (pers. comm., March 2011) these are rare breeds descending from older (if not ancient) times. Assuming that they are used for such a long time, and are self-reliant (breeding and feeding) in the wild without the help of man, some could consider them as indigenous.

Our biological definition of the word indigenous includes; spontaneous establishment and without human influence. When using the word indigenous like that, cattle species are not to be included in the list of indigenous herbivorous animals. There is too much that can be discussed and it seems that there is no consensus for the definition of indigenous. There is no timescale that says when an animal, or plant, becomes indigenous. Therefore, for this research, we do not assume that cattle species and breeds are indigenous.

One can perhaps also consider the brown bear (*Ursus arctos*) as a grazer (although it is an indigenous omnivore), as its diet consists for three quarters of green plant matter as showed by Cicnjak *et al.* (1987) and Paralikidis *et al*. (2010). Recently, there are only a few occurrences, regarded as dispersal attempts of young males. Their self-dispersal is hindered by poaching and bad reputation (Spassov & Markov, 2004). When taking into account that herbivores have an influence on the landscape (perhaps because of herd behaviour) , the bear can not be regarded as a substantial grazer.

4.2 Historical Land Use

Most of the information in the chapters **3.2, 3.3, 3.4**, was available in an unfinished report of Hristina Eterska, where she wrote about the genetic diversity of the local breeds of horses in Bulgaria. Currently her work is finished, but still only available in Bulgarian. Please forgive us for any erroneous information; this information was handed down by word of mouth (pers. comm. with D. Kostadinova). In our list of references one can find an overview of works in Bulgarian used in Hristina's work. In some cases the source (in Bulgarian) is known, mostly by Petrov (Петров), but not all the times the date of the publication is known. Some of the information is without source, because it was not possible for us to discover which writer stated exactly what. We hope that, by giving this overview, one interested in the matter can find his or her way.

4.3 Primeval Landscape

Vera's theory (1997, 2000) is focused on the natural landscapes of lowland Central and Western Europe. In his conclusions and his syntheses he clearly writes that the accepted theory concerning vast forests is based on observations made in the last primeval forests in the mountainous areas of the Balkans – then regarded as the last natural forests of Europe. In these areas, closed forests, the wild animals were found in low concentrations. In other words, low concentrations meant that (because of the closed forest) the animals did not have a determining influence on the natural vegetation. According to Vera (2000), the starting point of this argumentation is that "the wild animals must have existed in low concentrations because they would have had an influence on the forest if they had existed in higher concentrations".

Later, he rejects the made assumption of an analogy of the mountain forests in the Balkan and the original primeval forest landscape of Central and Western Europe – immediately disregarding the relation between a low herbivore density and the absent influence they could have. Also, because of the different altitudes and the fact that some of the natural herbivores were not present in the mountain forests of the Balkans (but were in the lowland forests), he states that the analogy is invalid (and thus concluding with his own hypothesis that in natural circumstances the herbivores did have an influence).

In this research we assume the analogy can actually be made, but with a certain degree of caution. Some ecological processes can be valid in different systems, others can not. The horses are reintroduced to make the ecosystem more complete (see: **1 | INTRODUCTION**), we assume that also Ark Foundation made these choices partly based on Vera's theory. When applying a theory one should be careful regarding to different altitudes, species composition and climate – along with many other differing factors.

Another factor in applying this theory in the area of South East Bulgaria – is that is only valid when there are sufficient wild animals or the amount of animals used in small scale – extensive – livestock breeding is on the same level with natural circumstances. The large scale industrialization of the 1960s resulted in a substantial internal migration (most intensive in the 1950s and 1960s) from the villages to the cities. Mainly old people remained in the countryside (Rangelova, 2003), and in due course small scale livestock breeding (with all its effects on the landscape) will disappear as well. In combination with the fact that ungulate abundance is relatively small (Spassov & Markov, 2004) – the effect these animals have on the landscape will disappear as well – including the variety of landscapes. Therefore reintroduction or management is needed.

PART II: HORSE HABITAT USE AND HORSE ECOLOGY

4.4 Collar Statistics

With showing the collar statistics we want to show that there is need to assess the acquired data on falsification to prevent the results from getting mixed up with non-natural movement of the horses. From the period that we used the GPS data, the horses have regularly been transported or tied up (connected to the reintroduction of a new stallion). More than a hundred fixes were removed from the total dataset. With those points included, it could easily be that the grazing preference would change towards another land use type than our research now would point out. Also the collars did arrive late, not due to somebody's fault, but if they had arrived on time we would have got more data and our conclusions could be more precise.

4.5 Home Range

There is no precise definition of a home range; at least there is no consensus within animal sciences. The closest definition might be: "that area traversed by the individual in its normal activities of food gathering, mating and caring for young" (Burt, 1943). The definition of a home range is not to be mistaken with the one of a territory. A territory, however, is an exclusive area where the animal will fight for and will have no overlap; the animal has exclusive use of it. In home ranges sometimes overlap can be accepted by the animal (Boitani & Fuller, 2000).In some studies there were never exclusive ranges seen when multiple harems lived next to each other, there was always some overlap (King & Gurnell, 2005).

Home ranges do contain parts that must be more important to the animal; areas within the home range with a greater density of critical resources ought to be more important. So objectively, biologists tell that the most important area, thus the most used, is a home range core. We can not apply this thought – because the horses do have needs for extra minerals, and they might not often visit these places. So in this case the area where they find the minerals is very important, but might not be as often visited as grazing grounds. We also do not know where they find their necessary minerals, for this we leave the estimation of the size of the core area out of consideration.

Knowing an animal's home range may give researchers a good insight into social organisation, forage and food choice and more. However, there may never be a completely objective statistical method based on location data that yields biological important data information about an animal's home range (Boitani & Fuller, 2000)

The current spring home range is large when compared with those shown by different harems Przewalski horses in Mongolia. Recorded home ranges of those Przewalski horses (also called 'Takhi') were varying from 75 ha to 1.158 ha, depending on year and season (King, 2002). This in respect to 5,71 km^2 to 50,57 km^2 in Bulgaria depending on what home range estimator is used (**TABLE 3.2.**). This is not completely abnormal, seen that other feral horses in areas, for example in Mid-West America, have even larger home range sizes, varying from 73 km^2 up to 303 km^2 (King 2002). In other studies concerning Takhi in Mongolia, however, home ranges were estimated from 1,6 km^2 up to 24 km^2 (King & Gurnell, 2005). "In general, differences in home range size are related to vegetation quality and distribution of resources such as water and shelter." (Leuthold, 1977 – in King & Gurnell, 2005).

The home range estimator used by King (2002) is the Minimum Convex Polygon. Although this method is widely used, it is regarded as a less suitable home range estimator (Boitani & Fuller, 2000). The Minimum Convex Polygon (MCP) can incorporate large areas that are never used by the animal and emphasizes unstable boundary properties by assuming that occasional sallies are also part of the home range. This makes the method highly sensitive to those extreme data points. The MCP assumes that animals use their home range evenly and ignores stable internal structures. It also does not take into account the cognitive map an animal has of its home range. In other words, the MCP assumes that animals know the area within all extreme data points (extremes of their movement) but are not familiar with any area, no matter how close, outside the extremes of their movement (Boitani & Fuller, 2000) as projected in such a polygon.

Burgman & Fox (2003) wrote that there is little to recommend the MCP for home range estimation, also Boitani & Fuller (2000) noted that multiple sources (Powell *et al.,* 1997; Seaman 1993; Seaman *et al*. 1999; Seaman and Powell 1996; Worton 1989) wrote that kernel is the best available home range estimator.

The Kernel home range estimator produces an unbiased density estimate. It estimates the probability that an animal will be in any part of its home range, but does not show how important that part is. This is a problem for researchers interested in underlying importance of the observation. It also takes the cognitive map the animal has of its home range into account. An animal, even when it is observed at one point, is aware of what is

around in that specific area (Boitani & Fuller, 2000). The Kernel estimation was also used by King & Gurnell (2005) and those estimated area sizes are more similar to our findings.

We assume that the Kernel 95% (**FIGURE 3.4.**) comes closest to a realistic home range estimate and is appropriate for researching the habitat use in our thesis. No strong biological logic supports the choice of the 95% method, only that occasional sallies will be excluded using this probability level (Powel, 2000.).

In our research we showed the Minimum Convex Polygon (MCP) to show what the consequences are when using different methods, for the project employees and next researchers in this project.

4.6 Habitat Use

Habitat use of horses within their home range is mostly determined by factors like; fly abundance, temperature, time and season (King & Gurnell, 2005). This study's observations were mostly made in the field, a luxury we did not have. For our fieldwork and analysis, we were dependent on only GIS-data. Also the time of the year was not suitable to record abundance of flies and the horses' reactions on this. This is why we can not tell anything about the use of our animals' habitat in respect to fly abundance and time of the day.

4.6.1 Vegetation use

This was the first year that our study animals had not been fed throughout winter. Though they had a considerable amount of body fat compared to the previous years, and they were in a very good physical condition (pers. comm. T. Jenkins, March 2011). This suggests that they know their area well and have a considerable amount of food in their home range. Lamoot (2004) wrote that: "free-ranging herbivores have to make many foraging decisions at different resolution levels (Senft *et al.*, 1987; Stuth, 1991), resulting in a foraging strategy that meets the large herbivores' nutrient and energy requirements. These decisions are primarily made in relation to forage availability and quality, which are in turn determined by environmental conditions."

During spring, the herd had a preference for more grassy vegetation and more or less avoided forested areas, though observations (fixes) were seen on all land use types. The same is seen at studies in Mongolia (King & Gurnell, 2005). Plants change in nutrition throughout the seasons (Novellie and Winkler, 1993 – in King & Gurnell, 2005), so there could be a change of preference during the change of seasons. One should take into account that the GIS data used is probably based on aerial photography (remote sensing), and that the boundaries of the given land use types are not always according to the reality.

The Karakachan horses clearly preferred natural grasslands (P.I. = 10,82), pastures (P.I. = 8,90), and non-irrigated arable lands (P.I. = 6,71) above any other land use type, when using Kernel95% (**TABLE 3.4.**)**.** The difference between these three might be explained in relation to the difference in fibre or crude protein content (Dierendonck & Wallis de Vries, 1993 – in King & Gurnell, 2005). But horses also graze or browse on young willow and birch growth, so preventing the forest from overtaking on the open field (Colijn, 2006). For the Karakachan horses we can not say when or where they do this, because we did not observe them in the field.

When the grazing preference is calculated with the area size of both home range estimators (MCP95%, **TABLE 3.3.** and Kernel 95% **TABLE 3.4.**) there are differences in preference of land use type. The MCP has relatively high P.I. over all three the just mentioned land use types; the difference between them is less than when Kernel 95% is used. This shows that MCP uses extreme data points and assumes the evenly use of the animals' habitat. When Kernel 95% is used the difference between the P.I's is higher indicating a stronger preference for one land use type.

When using Kernel 50% there is a slight change of preference but the same land use types stay preferred. Some studies take a lower Kernel (for example 80% or 50%) estimate as home range core (King, 2002 and King & Gurnell, 2005). We do not want to talk about the home range core-use by the horses, because there is too little known and the definitions are too wide to make a Kernel 50% or 80%-core estimation of this. But if 50% should represent the core area, does this tell us that the animals have another preference in their core area? The change is so minimal that we can not draw a conclusion like that now. The project should monitor this for a longer period to draw a conclusion on that.

4.7 Natural Boundaries

In our research, natural boundaries formed an important sub question. However, when analyzing the data in ESRI ArcGIS it became clear that it is hard to analyze in if our study animals have certain natural boundaries. The only thing we can hypothesize is that large continuous forested areas could be a natural boundary for the horses. We hypothesize this because the horses do have so little fixes in forests.
That they have so little fixes in forest in spring could be determined by factors like food abundance, safety or just the time of the year and no effective shelter because of the lack of leaves. Horses in Mongolia show movement into forested area when the abundance of flies and temperature is getting higher in summer (King, 2002 and King & Gurnell, 2005). It could just be that our horses will spent a lot of time in the forest during summer. For this the project should monitor this over a longer stretch of time.

4.8 Potential Feeding Grounds

Most available research papers and reports are focused on Przewalski and Konik horses, or domesticated horses. For our research, we assumed that the diet and behaviour (ethology) is comparable with those of the Karakachan horses involved in this study. No comparative study, as far as we know, is available on this topic. We made assumptions for the estimation of potential feeding grounds based on literature available on the habitat use of horses.

A study on the area use of Konik horses in Vitinu Plavas, Latvia (Colijn, 2006), showed that horses used the open grasslands very frequently – the data showed that they even preferred it. Half of the time they were observed in only a quarter of the reserve, which consisted of grasslands. Besides reed and sedge fields (21-18% respectively), they only visited the other vegetation types less than 3% of the observation time.

According to Ark Foundation (1998), the horses digest the grass directly and therefore need the most nutritious parts. They take advantage of the new growth of recently grazed grass, which has a higher protein value than ungrazed grasslands. As a result, the meadows where the horses are will often be short grazed – resulting in 'horse meadows'. Ark Foundation also states that 'horses sometimes eat bark or twigs as well', which could suggest the preference of the presence of woody shrubs in the feeding grounds.

A study on Konik horses in a wetland area in the Netherlands (Haarsma, 2007) showed that the horses ate some of the tree species mostly in January (5-16% of their diet), during winter. In all other periods they ate mostly grasses (48-99% of their diet), and to some extent herbs as well (5-47%). It is remarkable that the intake of woody shrubs is higher during winter months, while at the same time they eat fewer herbs. Also, the horses visited grasslands the most in the months February until May. The horses foraged mostly on grasslands.

Therefore we assumed that horses in the first place prefer grasslands and secondly, they will probably visit already grazed areas (by either cows or sheep) because of the higher nutritional value of the grass. Also, the presence of woody shrubs might be preferred (winter diet). With these facts in mind we produced the map as can be seen in **3 | RESULTS**.

4.9 Characteristics Preferred Sites

With this part we have tried to distinguish if the preferred sites have certain spatial determined relationships in relationship with the presence of roads, forests or watercourses.

4.9.1 Distance to roads

FIGURE 3.7. shows that most of the locations are either close to the main roads or further away; there are three peaks in the amount of fixes at distances 0-199, 1.000-1.399 and 2.000-2.599 meters away. This means that the main areas they preferred are at least either really close to the main roads (within 200 meters), or at least 1.000 meters away. At this point we are not able to distinguish preference or avoidance from any main roads.

With our data we can confirm that there are three main places of interest for the animals (as shown with the Kernel home range estimator, see also **FIGURE 4.1.**), of which two places are near to the road explaining the first peak (both in a land use type described as *non-irrigated arable lands*). There is another at a distance between 1.000-1.399 meters (in *pasture*) and the last one is where the last peaks are (in *natural grassland*, which is in total the highest amount of fixes also the grazing P.I. is highest there, see **TABLE 3.4.** and **FIGURE 3.7.**).

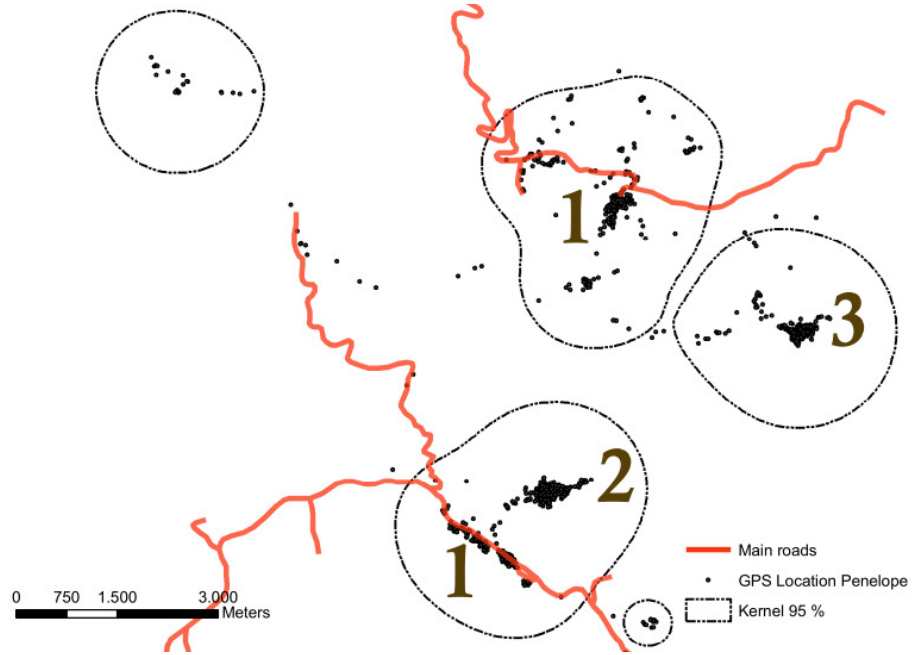


FIGURE 4.1. Clustered fixes (main places of interest for the horses), categorized according to maximum distance to a main (asphalted) road. Number indicating the peak (1=first) in FIGURE 3.7.

One flaw in the analysis of the date available is that only main roads are known. Most of the dirt roads used for forestry or local transport are not available in a digital format. Those roads however could be of great use as main ways for movement for the horses.

Also our own experience tells this, in which case the horses used hiking or off road trails for movement through the forests. This would be in accordance with the findings of Theuerkauf & Rouys (2008) that showed that ungulates avoided main roads actively in (found in wild boar and European bison population, but not found in roe deer and red deer population). Because there is no data on forest roads, it is therefore hard to analyse this characteristic with only data on main (asphalted) roads.

We find it peculiar that there is such a big gap between the peaks. This could mean two things. Either they use the main roads only sporadically to cover big distances, because there are so few fixes close to the roads. Another explanation is that they do use the road, but as soon as they do not need it anymore, they move with high speed further away from the roads (to their preferred sites). This could also imply that the horses will, in between the peaks, use easy-accessible terrain and it is interesting to know then what kind of vegetation this is. Future research should invest effort in mapping the dirt roads, because these might be very important migration / escape (for potential danger) routes for the horses. As with every animal, they try to optimize energy use and will probably use the already available roads.

4.9.2 Distance to (broadleaved) forest

The reason to show only the distance to broadleaved forest, is because this is the most widely distributed type of forest (65,7% within the 20 x 20 km square). Most of the other types of forest are to be found within the masses of this type of forest. Compared to the fixes of the horses this is not relevant because most of them are found in grassy areas.

FIGURE 3.8. can also be explained on two ways. The first one can be that the horses prefer to be in the presence (not further away than 400 meters) of the forest for some sort of shelter (wind). This could indicate that the Karakachan horses do the same as the Konik horses, grazing or browsing young trees in the transitional zone from forest to grassy areas (Colijn, 2006).

On the other hand, this can prove that although most of the fixes are on grassy areas – the areas are not wider than 1 kilometre each, which can be related to the huge total area covered by forest. The landscape is very fragmented and makes this also a possibility.

4.9.3 Distance to natural watercourses

In the first place we observed a bigger distance when the Strahler-value gets bigger. Only with the most preferred (according to our Kernel 95% analysis) land use type *natural grasslands* this is not the case. This could mean that the presence of watercourse of a Strahler-value of 1 does not have an influence of the presence of the horses in natural grasslands. On the other hand, it means that the presence of smaller watercourses could be an estimator for the presence of the horses in other preferred land use types (a prerequisite to be on a place).

As with any other land use type this sequence, of a bigger distance when bigger Strahler-value, can be explained by the distribution of the watercourses within the 20 x 20 kilometres square. As can be seen in the **TABLE 4.1.** below (proportion), the amount (total length) of watercourses with a Strahler-value of 1 is three times as much as that of those with a value of 2. The increasing of the distances of the fixes in the preferred sites can be explained by the fact that the higher the Strahler-value gets, the fewer the total length is of watercourses within this class.

TABLE 4.1
Proportion of length (scale) of Strahler-values within 20x20 km square

Strahler Value:	1	2	3	4	7
	12,58	4,22	2,24	0,98	**1,00**
	12,77	4,29	2,28	**1,00**	1,02
	5,61	1,88	**1,00**	0,44	0,45
	2,98	**1,00**	0,53	0,23	0,24
	1,00	0,34	0,18	0,08	0,08
Total length (km)	315,80	105,97	56,28	24,72	25,10

Also the near presence of grassy areas close to water can be explained by the fact that there is a significant human influence. The richest grounds are to be found near watercourses and will be exploited earlier than all the other, because those are the best for harvesting potential forage or to graze their animals. On the other hand, in nature the richest places will develop near the streams and such.

According to King (2002) the most nutritious feeding grounds are located in the valleys near to streams or rivers. King's study animals established a home range near to these sites suggesting that "the horses select these for the nutritional grazing". However, King does not give a spatial definition of the distance to what this is valid for. Also, she suggested that the horses select these grounds for possible sight lines and ease of travel.

Both harems studied by King covered a variety of vegetation types, but showed preferences in the most nutritious vegetation in their home range. She states that also other studies have showed this kind of selection (Salter and Hudson, 1979 – in King, 2002). Very important is the fact, that "the best predictor of their habitat use was the abundance of food, particularly green plant matter" (Duncan, 1983 – in King, 2002). The horses in King's (2000) study were found most often where the best food occurred: in the valleys with the greenest vegetation.

In a later study King (2005) also writes that the characteristics of all harems (Przewalski horses, Mongolia) included a permanent water source, and places for resting by rocks (ridges) and patches of forest used in summer (shelter from the sun). The horses selected vegetation classes dominated by grasses (van Dierendonck & Wallis de Vries, 1993

– in King, 2005). Also, "home range sizes are related to vegetation quality and the distribution of resources such as water and shelter." (Leuthold, 1977 – in King, 2005).

This underwrites our found relation between the presence of a water source and their preferred land use type. Only the fixes in natural grassland do not confirm this.

The best way to test if there is a spatial relationship (i.e. a minimum distance to a watercourse), is to research their preference in an (fairly) untouched landscape. In this case, the occurrence of grassy vegetations is natural and in not mainly influenced by human activity. This is, however, almost impossible in the western world. Future research should also take notice of other natural watercourses, such as ponds, but also the use of manually made water sources which are present in this part of Bulgaria.

4.10 Vegetation vs. Height (Altitude)

In King & Gurnell (2005) the Przewalski horses altitudinal movement was affected by the vegetation available through the year. This is because plants change in nutrition and palatability through the year (Novellie & Winkler, 1993 – in King & Gurnell, 2005) and the horses even preferred some species in their early development stages and avoided others after they have flowered (King & Gurnell, 2005).

The use of a certain vegetation type is also based on the fact that it can serve as shelter, as observed by horses using low and mid elevations in Hustai National Park, Mongolia. The clear difference in nutritional value (Salter & Hudson, 1978 – in King & Gurnell, 2005) affected their movements (more nutritional content in the valleys). Also the season of the year affects their altitudinal movement, whereas horses will use higher altitudes during summer (perhaps because of the lower temperature) than in spring or autumn (King, 2005). Even the time of day affects their movement – this makes analyzing data even harder.

Another important fact was showed by King & Gurnell (2005), that harems selected more vegetation classes in spring and autumn than in summer. In spring the horses used the classes at mid to low elevations the most, this makes any distinction in our time of study even harder to distinguish, because less distinct preference will be shown.

In this research we wanted to show if there is a relation between the animal's occurrence and the preference for a certain land use type – according to the height class - but also the other way around (**APPENDIX I & II**). For every fix available we assumed that this means that they used the site in one way or another, every fix is therefore independent and unique (also an assumption made in the home range Kernel method) (Boitani & Fuller, 2000).

We showed that the animals' preferred height class for natural grassland is 400-500, this also coincides with the fact that when the animals are within the 400-500 height class they will prefer natural grassland above all other land use types present. The same accounts for pastures, but then at height class 500-600 meters. Both are grassy vegetations and therefore preferred more than any other. To some degree this is also true for the animals' major preference for non-irrigated arable lands (in height class 400-500), while they are second in preference when the animals can choose among every type of land use type within this height class. This can also be said of transitional woodland/shrub within the height class of 500-600 meters.

With this we showed that they also mainly used the mid elevations, the lowest and the highest they do not use or to a lesser degree, which is also shown in King & Gurnell's study (2005). On the other hand, the animals are only reintroduced recently which could imply that the horses are still orientating in the area, and stick to a certain height class. At this moment, we do not have the data to compare this spring data with other times of the year. In the future, the expanding of data can indicate more significant differences or similarities in the relationship of an animal's preference for land use types and height.

4.11 Used Land-Use Type vs. Temperature

The study conducted by King (2002) in Mongolia, concerned several harems of Przewalksi horses. And their grazing pattern was significantly different over the day. In the mornings and evenings they grazed, and they rested during the middle of the day. According to King (2002), this is reflected in their temporal use of their habitat, and is likely to be related to vegetation, temperature, and abundance of flies.
FIGURE 3.9. shows the used land use type in relation to the measured temperature (°C measured at the GPS collar). There is no real preference in land use type at certain temperature. This is similar what King (2002, 2005) found in her research during spring. The pattern of using different land use types on different heights and temperatures for those Przewalski horses was less marked in spring and autumn, and more in summer.

4.12 Transects

Transects in this research were recorded somewhat too early, because nothing actually flowered (except for the early spring flowers) or had leaves. We were forced (due to time limitations) to carry out transects before the leaves were growing, which resulted in an incomplete record of the measured plant species. Because we had a limited amount of time (and data, see below), we had to spend a long time in considering in what way we wanted/were able to use the (in fact, incomplete) data.

The data available in the GIS considers only a few land use types, which is good enough when looking at the landscape on a large scale – to give a general view of the landscape. However, this classification neglects a lot of important characteristics for the given vege-

tation types. When one analyzes the GIS data alongside an aerial photograph (e.g. Google Earth), one immediately notices the difference between sites categorized as the same land use type. In most cases, there is no common homogeneity within the predetermined land use types, and the same accounts within an area of a land use type itself. This makes choosing representative locations for transects, both from a map and in the field, really hard.

As described, the land use types are within themselves so diverse, as the heterogeneity on smaller scales is amazingly high. It therefore requires a lot of transects, and thus data, to be able to distinguish significant differences. We were limited in time (**2.4 Justification of change**), and we did not succeed in the amount of data forethought. Even with the forethought amount of transects, we think it will be hard to conclude anything (**6 | FUTURE RESEARCH TOPICS & RECOMMENDATIONS**).

The main goal for measuring the vegetation structure was to give a representative overview of the different land use types in order to outline the main differences. The data collected will give only a broad and general view of the differences between the land use types. We must emphasize that collected data can not be used solely in describing the different land use types regarding their vegetation structure. For that, many more transects are needed.

PART III: SOCIAL STUDY

4.13 Social Study

The majority of the people that were questioned at the bar: the social hart of the town. We also conducted the questionnaire in the streets and went to the municipality house. The major and some aldermen were questioned as well.

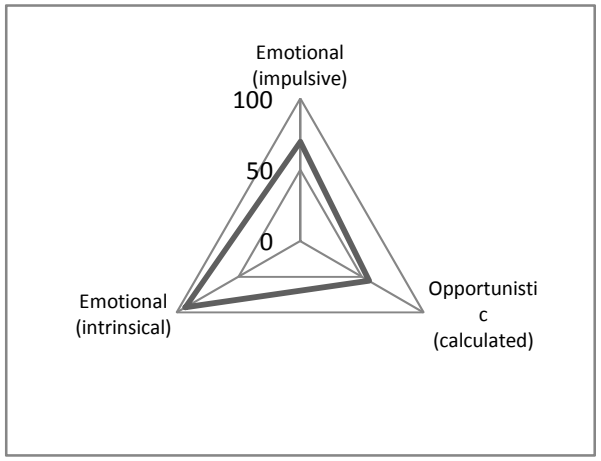


FIGURE 4.2. Index according to the typology of De Bakker & Overbeek (2005) - in Elands & Turnhout (2009).

The average age is quite high, about 45. The reason for this is that we conducted the fieldwork for the questionnaire during working hours. Most of the young people, when finished with primary school, study or work in surrounding cities like Kardzhali and Haskovo. This makes that during working days not all age classes are present in Madzharovo. One influential factor is that the questionnaires are taken with the help of a Bulgarian translator and that specific details will be lost in the translation process. It would be good to have a more direct way of questioning the people.

The hobbies are quite differentiating and a lot of people do see or use nature for their hobby, fishing, hunting, and nature (resp. 35%, 26%, and 16%). This assumes that those people find nature quite important. At least their activities do mostly take place in nature, so according to Elands & Turnhout (2009) it is fair to draw this conclusion.

4.13.1 Knowledge of nature (questions 1, 2 and 3)

When discussing the answers given in the questionnaire, starting with the people's knowledge of nature; 93% gives an aesthetical value to nature, or it is beautiful and it is everything around us. This is a wide definition, and is probably based on emotions and results out of intrinsic satisfaction. Nearly 70% gives an emotional answer, more based on impulsive reaction. 50% though, gives an opportunistic or calculated value. This is mostly based on economical motives (De Bakker & Overbeek, 2005 – in Elands & Turnhout, 2009). For an overview see **FIGURE 4.2.** However, only 12% (profession: farmer) had to work in and with nature, more people though see the economical value of nature. Probably the hunters also see nature like this.

When we started the questionnaire, it was made clear to us that there is not a real difference between the definition of nature and wilderness in the Bulgarian language. This is probably the reason why the answers in question 2 have a wide range.

4.13.2 The importance of nature (questions 4 and 5)

When the importance of nature was asked to people, clearly recreation got a higher score than the economy. This is corresponding with the high amount of people who use nature for recreation. But ecology had the second highest value. This indicates that people do know that ecology is also important.

4.13.3 History and future of local animal (questions 6, 7 and 8)

In general, people do not think badly about the future of animal husbandry. A large amount of people think that rare breeds (Karakachan horses, sheep and dogs) will become more popular. This was also the opinion of local experts (pers. comm. H. Hirstov, April 2011). If this coincides with the opinion of people about the size of animal husbandry is unsure. Mostly when farming becomes bigger, local breeds are not used, as seen in the history of Bulgaria. Species that are more productive are used then.

What people say about the history is very diverse; there used to be camels (now extinct) and more goats and cows. It is then fair to say that small scale local husbandry sector was much larger than it is now. This is also confirmed in the historical literature study. About reintroducing local cattle species like horses, cows and sheep, the overall opinion is positive. Perhaps people see that breeding those, more self-reliant, breeds their work

might become a lot easier, plus they get a higher quality of milk and meat. The people do find it important to save rare local species, perhaps it is pride, and perhaps it is the realisation of the information written above. It is very hard to establish the rationale of the people in a situation like this. The language barrier played a major role in this.

4.13.4 Wild animals (questions 9 and 10)

It seems that a large amount of people either does not know anything about disappeared animals or have no idea. Just a few percent only see that some species are missing. We know from literature (Spassov & Markov, 2004) and personal communication (H. Hristov, April, 2011) that some species like ibex (*Capra spp.*), chamois (*Rupicapra rupicapra*), red deer (*Cervus elaphus*), fallow deer (*Dama dama*), wild goats (e.g mouflon, *Ovis aries orientalis*), and brown bear (*Ursus arctos*) have existed. This might indicate that the education about nature in this region is not optimal.

4.13.5 Project 'New Thracian Gold' (questions 11 – 16)

People who know about the 'New Thracian Gold' project, tend to know what it is about, and the most do know this from a fair or from friends. However, as we regarded Madzharovo as the centre of the project (because of all the surrounding successful projects with rare breeds of cow and sheep), only 55% of the questioned people know of this project. This suggests that the publicity was not well handled in the beginning, personal communication also confirmed this (pers. comm. F. Zanderink, April 2011). The most of these people also like the project.

Later, people who did not know of this project were supplied with a short introduction, and the majority of the questioned people have a positive opinion about reintroducing locally extinct species. Only 2 percent has the feeling that the reintroduction is a nuisance for him/her (**FIGURE 4.3.**).

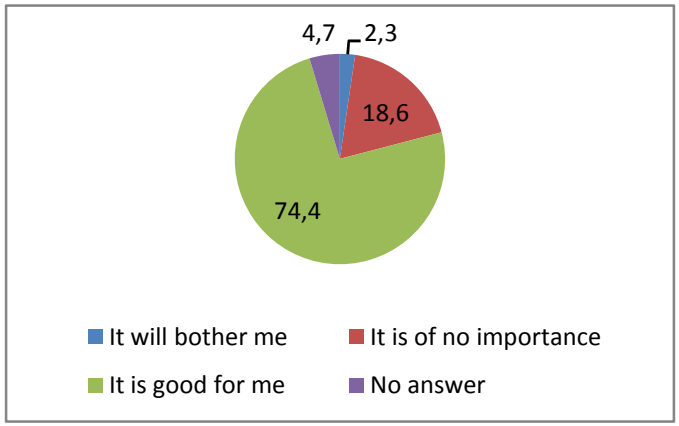


FIGURE 4.3. Attitude towards reintroduction of locally extinct species (%)

4.13.6 Wilderness, eco-tourism and economics (questions 17 and 18)

According to the majority of the people it seems that the region is ready for eco-tourism. However, the region has a lot of improvements to make according to them. Suggestions were made mostly towards governmental institutions, the improvement of the infrastructure, and the availability of governmental and financial means for the region. Observations were made that the infrastructure is bad and needs repairing. Also, villages like Chernichino are not well connected to Madzharovo. This is an obstruction for the development of eco-tourism.

It seems that the people are positive towards the project; most of them love the nature and really want to see that something is done for it. But to discuss and asses the social or cultural understanding we need to be careful, because sometimes love for nature does not need to coincide with support of the policy or execution of certain projects. It could even result in active resistance towards certain management practises in nature (Elands & Turnhout, 2009). But active resistance also indicates expressions of involvement in the nature, so this should be positively handled. It is not said that there will be active resistance, the opinions are positive, but social and cultural understanding is never on a constant level.

As written before, the people and the history were clear about the factors responsible for the disappearance of certain species, including the horses. These were mostly human factors and according to a report of the IUCN (1998), a thorough assessment of the attitudes of the locals is in this case very important.

Experience of the past decennia in the Netherlands teaches that reintroduction is a complex experiment, which is sensitive for social factors. The success rate of reintroduction of animals is always limited. The reintroduction of species might be eased when the species in question have a so called 'cuddle'-factor, which means that certain species speak more to the imagination than others (such as wild boar and deer species). Social understanding and support is also easier when species can be regarded as having an ambassador-function in nature management or restoration. Experience in Scandinavia and Northern America has shown that the reintroduction of predator species (wolves and bears) is socially speaking more difficult (Smulders *et al.*, 2006).

When such a high percentage of the questioned people do not know the project, it might be that the ambitions of the project are not settled in the people's minds, even in the ones that do know the project. According to Smulders *et al.* (2006), clear ambitions towards the local people and intensive social research can increase the success rate of a project.

▼▲*Photographs showing the typical atmosphere of the (almost abandoned) rural areas of South-Eastern Bulgaria during early spring.*

5 | CONCLUSIONS

PART I: TRADITIONAL LAND USE

1. Which large herbivore species were indigenous to the Eastern Rhodopi Mountains and what influence did they have?

Large herbivorous mammals, indigenous in the Eastern Rhodopes, include: Wild boar (*Sus scrofa*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*) and chamois (*Rupicapra rupicapra*). A species like mouflon (*Ovis mussimon*) is probably not indigenous but introduced by humans. European bison (*Bison bonasus*) is absent. The influence they had on the landscape was less than in natural situations due to non-regulated hunting, making their numbers low.

2. How can the traditional (small scale) livestock raising, with focus on horses, in the Eastern Rhodopi Mountains be described as regarding to grazing pressure?

Animal husbandry has been very important since the beginning of Bulgarian civilization, which can be categorized as small scale – extensive – livestock breeding. It was common to use a wide variety of animals, mostly goats and sheep but also cows and horses. Before the communistic times, horses played an important part in the tradition of local tribes; there were even clear distinction of breeds between the tribes. One of them was the *Karakachan*-horse, named after the tribe. The horses were fairly small and adapted to the region and to the work they were bred for – which varied in different regions of Bulgaria. On the precise numbers of horses used, and thus grazing pressure, nothing is known. In qualitative terms, their grazing can be regarded as natural grazing and when not used for work they lived in the mountains without supplemental feeding. This accounts for sheep, goats, cows and horses. They did not get protection from predators and either used or developed a natural anti-predator instincts (possibly remains of their wild ancestry), which is still present. During communistic times local breeds disappeared because of the collectivisation programmes, and some of the nowadays rare breeds only survived in remote mountainous areas.

3. What were the effects on the landscape and the biodiversity of small scale livestock breeding?

Since the small scale of livestock breeding can be regarded as natural grazing, the effects were that of a diverse landscape in which the succession of species was directed by the behaviour of large herbivores, including horses. The pastures and meadows would eventually turn into forests because of the rejuvenation of tree species within thorny scrubs. The forest, in turn, will degenerate because of the failure of natural rejuvenation due to the influence of herbivores and will turn into natural grasslands again. Small scale livestock breeding can be held in an analogy with this system, called the cyclic turnover of vegetation (based on Vera's work, 1997, 2000). However, nowadays people are moving away and as a result the small scale livestock breeding is diminishing, and without sufficient amount of wild herbivores which can take over the role they naturally had, this natural process will come to an end which will result in the closing of forests.

PART II: HORSE HABITAT USE AND HORSE ECOLOGY

4. What is the home range of the horses within the spring period?

The estimated size of the spring (March and April, 2011) home range of the Karakachan horses is 32,36 km^2, according to Kernel 95% home range estimation (calculated with 1.880 GPS-fixes of the collared leading mare). It should be regarded as an indication of the actual size; this size could differ from the given number, depending on season and year. For this thesis, it is assumed that Kernel method is the most realistic estimator and has many advantages when compared to the Multi Polygon Convex estimator.

5. How can the landscape be described within their home range?

The landscape within the horses' home range is heterogeneous, with different land use types spatially scattered, the abundance is varying. The most abundant land use type is *broad leaved forest* (66%) within Kernel 95% home range estimation. The other forest types are not that abundant or not present at all. *Mixed forest* occupies only 9% of the home range and *coniferous forest* is not present. The grasslands occupy together 15%, with *land principally occupied by agriculture* the highest amount of 7%. *Transitional woodland* has only 9% of the home range. Within all the land use types there is a large diversity on a small scale. The overall landscape is mountainous with average heights between 300 and 700 meters. There are a lot of artificial water sources available and small streams are abundant.

6. Which elements form natural boundaries in the presence of the horses?

There is no conclusive answer to this question. It seems that large out stretched forested areas are a natural boundary, but the horses will probably use the forest more in the summer, possibly because of a lower abundance of flies and a lower temperature. More research is needed to see what natural boundaries are to the horses.

7. What are the potential feeding grounds for horses within their home range?

Potential feeding sites were determined on forehand and based on the available GIS data and studies on Przewalski horses and Koniks. Combining the information of these two, a selection of land use types became obvious. The potential first choice of the horses would be: *natural grassland* and *pastures*. The second choice of land use types included: *land principally occupied by agriculture* and *non-irrigated arable land*. Assumed was that *forests* are less attractive for horses, making that not a potential feeding ground together with *transitional woodland*, *complex cultivation patterns* and *discontinuous urban fabric.* This estimation proved to be correct.

8. Is there a relationship between the distribution of the horses and potential feeding grounds?

There is a relation between the actual distribution of the horses and the potential feeding sites. The horses show a significant preference for the land use types (in order of preference): *Natural grassland, pastures, and non-irrigated arable lands.* This is dependent on the time of season. The preferred land use types of the horses show little characteristic differences with the random land use types.

The differences between the grassy land use types: *Pastures, natural grassland,* and *non-irrigated arable lands* are minimal, except that *natural grassland* is more dominated by herbaceous species, making the visual obstruction higher than the others. *Transitional woodland* showed more deciduous tree species (mostly dwarfed due to browsing) and more juniper (*Juniperus spp.*). Also *land principally occupied by agriculture* showed some higher vegetation like juniper. With both it causes sometimes a higher visual obstruction. Although we measured visual obstruction, there were no significant differences between sites discovered. Therefore, it is impossible to say anything about the choice or preference of the horses in this.

An important factor for the presence of horses is the size of a watercourse. A bigger distance is observed when the Strahler-value (a higher Strahler-value means that the stream has not been diverged much from its initial source, finally resulting in 1) gets bigger. This is noticeable for fixes within their preferred vegetation types; pastures, non-irrigated arable lands and land principally occupied by agriculture – except for the fixes within natural grassland this is not the case. The presence of smaller watercourses (lower Strahler-value) could be an estimator for the occurrence of the horses in the other preferred land use types.

Most of the GPS-fixes within their home range (as calculated by Kernel 95% estimation), are within 200 meters from the land use type broadleaved forest – which is the type of forest that covers most of the area.. There are no fixes further away than 400 meters. The preference showed for the presence of forest means either that they use the forest as some sort of shelter (from the wind) or that the preferred (grazed) sites are so small, scattered across the fragmented landscape, and that forests surrounds these places. Both can be true and there is no definite conclusion.

The recorded peaks of GPS-fixes in distances (at 0-199 / 1.000-1.399 / 2.000-2.599 m) from roads correspond with the preferred land use types (such as natural grasslands and pastures) at the mentioned distances from the asphalted main roads. This does not show a preference or avoidance from any roads available. In the meanwhile, it can be stated that they use the main roads mainly as means of transport. It should be noted that the use of forest roads is probably higher than is currently noticeable, but no data on the distribution, and use, of the forest roads is available.

The highest preference for natural grassland is at heights between 400-500 meters, and their highest preference for any given land use type at heights 400-500 is the same. This is the same for pastures, but then at heights 500-600 meters. Both are grassy vegetation and are preferred more than any other. This showed that they mainly used the mid elevations, the lowest and the highest they do not use or to a lesser degree. However, the horses have been reintroduced recently which means the horses are still orientating in the area.

PART III: SOCIAL STUDY

9. What purpose has understanding/support of local people in the process of reintroducing or recolonizing species?

The success rate of reintroduction is always low; experience shows that reintroduction is a complex experiment, which is sensitive for social factors such as support or active resistance. The social interest in projects with 'cuddly' species is often high. This makes it an important factor that can help or frustrate a project or process. When a reintroduction project has sufficient social understanding and support, the success rate will increase, to what extend is never sure.

10. What was the reason for disappearance of the small scale livestock raising in the rural areas (of Southern Bulgaria)?

The reason is communism. It started with the collectivisation of goods, and the disinterest in local breeds. From that point on, every animal was owned by the state and the animals that were left were used for the production of animal products for the state. To feed all the people within the communistic empire, the natural grasslands were turned into more productive lands for agriculture which meant the destruction of habitat for the small scale livestock. In some areas livestock breeding was not allowed because of the fact that every part of the communistic empire was appointed having a specific role to fulfil. In the 1960s industrialism developed and people moved to the cities because of the high demand for workers. The shift in the 1970s from agricultural toward industrial products made the need for livestock breeding lessen. In combination with national purification, or ethnic cleansing of some parts of the country, the traditions and the use of local breeds for small scale livestock breeding disappeared even more. After the communistic times, the movement from rural areas towards the cities was still ongoing resulting in the abandonment of the rural areas.

11. What is the current understanding of local people on the matter of reintroducing herbivorous species in general?

Amongst the local people questioned (43), it is widely known that local breeds (cows, sheep, and horses) are better adapted to stay in the nature on their own, and are more self-reliant. Another prevailing public opinion is that people think they give better milk and meat. A good third of the people questioned, concur with the fact that reintroducing rare breeds will save the breed from extinction. Concerning extinct wild animals; people often acknowledge that it is due to overhunting and poaching that they have disappeared. Almost half of the questioned people say that reintroducing them is good, because more species is always better (resulting in a higher biological diversity) – and even state that it will make the local ecosystem more complete. In general, people have a good understanding of reintroducing herbivorous species.

12. In which way can Ark Foundation interact to positively influence the (local) understanding in semi-natural ecosystems?

Affection for nature can work in two ways, both negative and positive, and handling this affection should be done carefully. Currently, the local people are optimistic about the reintroduction of species and their role in developing semi-natural ecosystems, but more deepening in subject matter is needed. Species, such as large herbivore mammals, can be used as an ambassador species – which can help to enhance the local support for the reintroduction. Local people should have something to say in the project, or at least they should be able to explain/illustrated their opinion in one way or another. Local authorities should be well informed and involved in such a project.

An introduction needs careful planning, and also after the animals are put into the nature well-planned scenarios are needed. It is very important to have guidelines to work with when the project continues. After the moment of actual reintroduction, the project does not end but it is only the beginning. With a good planning, or a well thought scheme of possible scenarios, conflict situations with local people can be avoided or at least handled correctly. Bad planning can cause a lowering in local support, and thus a lowering in the sustainability of the reintroduction programme. Therefore, one is almost obliged to regularly monitor the public opinion about the reintroduction or management of nature, in which case the shift of a preferably positive attitude will be noticed early and can be handled accordingly. When conflict situations develop, the (local) project leaders should invest time and effort in handling these situations in order to really know what is going on and to handle these situations as quickly, and as good, as possible.

MAIN QUESTION:

What determines the habitat use of the re-introduced horses, and how can human influence help to restore the semi-natural ecosystems?

During the research we conducted it became clear that a lot of factors determined the habitat use of horses and that the answer to this questions lies beyond the duration of our thesis. Important factors that might have effect on the movement and habitat use of the horses are:

- *Food, water, mineral and other resource abundance in an area (home range):* Although, horses are more adequate or suitable to feed in poor situation than other ungulates (cows, sheep) they do have needs for a certain amount of daily intake of forage and water. When this amount is not present in the area were they are introduced, they will logically search for other potential feeding grounds and will not even establish a home range there. Concerning minerals; horses absorb a lot through the food they take if the area is suitable for this minerals. For certain minerals horses will lick stones or eat other vegetation. It is assumed that it is necessary to be available within their home range
- *Seasonal or yearly changes in abundance of resources:* Heavy droughts, rain, or extreme temperatures can have a major effect on the growth of the vegetation. When heavy droughts are influencing the growth, horses might search for more wet areas, closer to streams or rivers, perhaps even depending on the Strahler-value.
- *Predation:* Sometimes horses are killed by wolves, and if it has an effect is researched by many researchers. The dimension of this effect might differ per season, if the prey spectrum of the wolves is larger due to higher abundance of other prey species (seasonal changes of food stock for the ungulates). An example is the theory that horses do search for areas with good sight lines, probably for protection or early warning.
- *Human activity:* Humans disturb the horses sometimes, for example poaching or simply being near the horses. Horses might know places within their home range that are not often visited or disturbed by human activity and will probably also use these.
- *Accessibility of the area*: horses have the same tendency as other animals, to optimize their energy use. Forest roads are a great help for transportation to other areas, they do not need to travel across difficult terrain. Horses might also avoid certain steep areas.

There probably more factors determining the horses' use of their habitat than we mentioned above, due to our insufficient knowledge of horse ecology.

Social support during reintroductions is an important factor that can help or frustrate a project or process. Handling the affection of local people for nature should be done carefully. Currently, local people are optimistic about the reintroduction of species and understand their role in natural ecosystems. In reintroductions, local people are to be involved and local authorities should be well informed. A good planning can avoid conflict situations when problems will be handled adequately, and thus enhance the sustainability of the project.

▲ *The newly introduced Karakachan stallion (with GPS-collar) fighting with another younger male from the herd, in order to secure its new place as leading stallion.*

▼ *An impression of the long term consequences of reintroducing horses in natural areas. Here the herd studied in this thesis is temporarily mixed with another one showing a remarkable amount of horses in peace with eachother.*

6 | FUTURE RESEARCH TOPICS & PRACTICAL RECOMMENDATIONS

Because of the exploratory character of this thesis, this report ends with a chapter filled with research topics and recommendations for the future of this project. This chapter is one of the most important parts of the report; because it is were future project members will get ideas from. The future research topics are divided according to subject and are hardly to be prioritized. All of them are as important and most of them can be researched using differing time scales. However, the last two research topics are found to be of critical importance for the long term of the project (social study and long term management of horses). This chapter ends with recommendations for carrying out research for this project in the future; it provides both experienced examples of problems and possible solutions.

6.1 Future Research Topics

HORSE ECOLOGY

6.1.1 Changes in home range size

According to King (2002, 2005) the home range of the Przewalski horses in Mongolia differs per season and year. Possible factors for this could be for example; the food abundance, group composition and adaptation their new environment, even in summer heavy droughts could change their home range size.

Further research is necessary to see how the home ranges of the Karakachan horses change in size, what the causes are and how much overlap occurs when new harems are introduced. Harems in Mid-West America and Mongolia do show differences in overlap (**FIGURE 6.1**), so overlap for harems of Karakachan horses could be different as well. This also indicates that, if possible, home ranges of new released harems should be investigated and monitored.

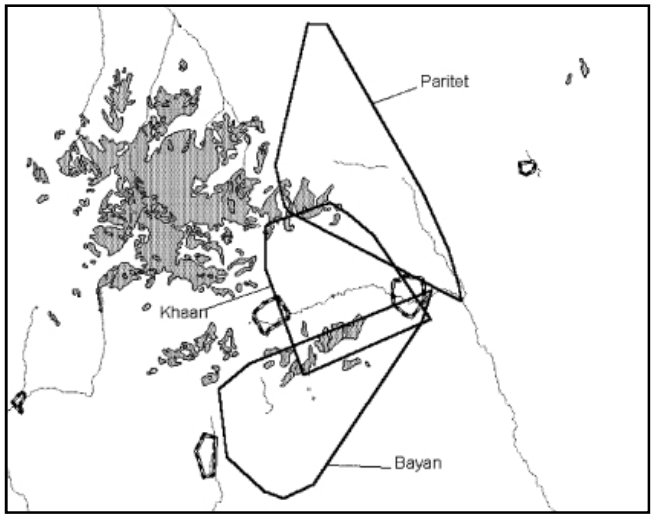


FIGURE 6.1 100% MCP for the harems in King's study (2002) showing overlap

As written in discussion about home range (**4.5 Home range**), animals often have a core area in their home range. We did not search for such a core area. It might be interesting to know what the core area of the present Karakachan horses is.

6.1.2 Used method and local situation

The method used in this report for measuring the vegetation structure is proven to be fairly quick. It will slow down when there is more focus on the species composition. For the speed it is necessary to make some generalizations as it comes to species. Another influential factor is the fact that some areas are very dense (especially with thorny shrubs); this might slow down as well. For future research this method can still be used.

6.1.3 Nutritional value of the available forage

The amount and nutritional value of available forage is important as it comes to horse ecology. This can be measured in the height and abundance of the different plant species, but can also be determined by the soil. In this research we focussed actually on everything except (the mostly dominant) grasses, in order to visualize the horizontal and vertical structure. From a horse's ecology point of view it is worth while investigating the actual plants they eat. The data collected can be used for measuring the nutritional value of certain sites, because plants can be a measure for the site richness. This can be combined with a behavioural study to see what the horses actually eat and where they eat certain plants, and the general carrying capacity.

6.1.4 Grazing and browsing pressure on grass and shrubs (by horses and other wild animals)

With a wide variety of grazers present, the grazing pressure on grassy sites will change as well. It is interesting to know in which way different herbivores use different vegetation. More important, is to know whether the grazing / browsing pressure of the newly reintroduced horses (or deer species) competes with the already present cattle, including the semi-wild horses. Knowledge on this subject might help to solve possible conflict situations more easily (*6.2.4 Landownership & communal grazing grounds*).

6.1.5 Area use by other grazers and wild animals

Investigating the area use of other grazers/browsers might result in an understanding of places of key interest. This can be discussed if there is any overlap in the home ranges of different types of animals. Knowledge of such key places within a home range of these animals can play an important role in future reintroduction of species (in order to see whether a place is suited for reintroduction).

6.1.6 A measurement for visual obstruction based on horse ecology

For the measurement of visual obstruction the method used in this report was developed by Robel (1970), and was designed to assess bird nesting habitat, which is basically a density board that has been reduced and modified for grassland communities. We suggest investigating first into the importance of any visual obstruction for the presence of horses. With more knowledge in mind, a better measurement for visual obstruction can be developed more from a horse's point of view.

6.1.7 Differences species composition of used sites between different herds

As shown by King (2002) different herds (of horses) within the same region might have a preference for different vegetation types. It is worthwhile investigating if there is a difference in the species composition of used sites between different herds. This will improve the knowledge about the local ecology (their preference and diet) of the horses.

6.1.8 Key locations within home ranges

Features in home ranges such as water sources, mineral intake sites, etc. are important. King (2002) suggests that these features are important for the horses' choice of an area in which to settle. In the future more research on this subject is needed for upcoming released harems, and for a general understanding of the movement of the horses.

6.1.9 Behavioural study

With the GPS-collar fixed on the horses, it is much easier to use the initial method for our research, provided that a horse or a 4x4 car is used. This makes behavioural observations less problematic.

The research topics on the behaviour we think that are necessary are:

- Time budget (Dierendonck *et al*., 1996; Boyd & Bandi, 2002): this means that it must be investigated when and how long the horses graze, rest, move, stand or are suckling (foals). This gives an understanding when the horses are the most active and this could give the management ideas when to move the horses to other places, in a manner to disturb or stress them as least as possible. The difference between foals and adults in time budget is an item to take into account in the same research.
- Behavioural synchrony (Boyd & Bandi, 2002): this says how many animals are engaged in the same activity (see time budget).
- Conflict handling within and between groups: a harem of horses has certain tasks divided amongst them. Which group member does what, when and where?
- Places for giving birth: this is important in connection with predation and disturbance of humans. The management can anticipate on this.

When new members are introduced within an already composed harem there will be a lot of interactions. By knowing the tasks in a harem, the management can anticipate on their actions and reactions. New members will never be accepted in a short period of time. This takes a lot of effort and time of the management. With the results of this research, handling new introductions can be done more efficient.

6.1.10 Inventory of water sources and forest roads

During the recently conducted fieldwork we had no data about water sources (ponds, watering holes and manmade created water sources) and forest roads. It makes sense that horses use the forest roads for ease of travel and make regular use of some water sources more than other (pers. comm. H. Hristov, T. Jenkins, March - April 2011).
When the roads and water sources are known, important conclusions can be made like; how many water sources the horses need in their home range or, if they use regular travel routes and preferably the forest roads. This data can be obtained while doing other kinds of research.

6.1.11 Predation study

We know from personal communication (T. Jenkins & H. Hristov, March-May, 2011) that there is a certain amount of (wolf) predation. In the past, there have been studies on wolves. Most of those are not accessible for non-Bulgarians, because of the language barrier. It is worth investigating in the already available literature to make an estimation of predator density.

Current losses by wolves occur both within cow herds that are 'protected' by guard dogs and the newly introduced horses. The area also knows a high abundance of stray dogs and jackal, which might cause problems as well (e.g. mortality). Without any real data on abundance and distribution of predator animals, any statement on so called killings of wolves might be either caused by a group of wild dogs, jackal or wolves. The difference (bite-mark injuries) between the killings of these *canids* is hard to distinguish. However, there are other methods of determining the abundance of predator species. This can in turn be used as the likelihood that an animal predated on by wild animals is either killed by wolves, jackals or stray dogs. Methods used in most other researches include the use of camera traps and snow tracking (if possible). More precise data on the numbers of wolves and other predator species might help in social support for restoring ecosystems on all levels.

6.1.12 Social study

The importance or power of the public opinion is often underestimated. A lot of projects, in all sorts of branches, do not succeed because of this (Smulders *et al*. 2006). According to both Smulders (2006) and IUCN (1998), it is advised to continue monitoring the social opinion about the ongoing project, certainly if there are more projects to follow in the same area. That makes it preferred to monitor the public opinion and to conduct more questionnaires in Madzharovo and surrounding villages and cities. Also providing regular publications in scientific or popular literature might improve the public relations and can be advised as a post-release activity (IUCN, 1998).

6.1.13 Long term management: (re-)colonization of truly wild horses in Bulgaria and surroundings

The ultimate goals of Ark Foundation suggest that the ecosystem should be complete again and that natural processes are dominant factors in nature management (if you can still speak of management). This is the most ideal situation, in which humans play only a minor role. With the growing of the herds, and the self-distributing character of (wild) animals, human intervention (i.e. management) needs to decrease to a minimum. But since these parts are still inhabited by people, the social dimension of these expanding animals should not be underestimated. Horses are still closely connected to everyday life of the local people, and therefore acceptance of these animals as *wildlife* is a long way to go as they are regarded as working or pet animals (and this is the case not only in Bulgaria).

The loss of animals by 'wild' processes, such as sicknesses or predation by wolves mainly, needs to be socially accepted in order to decrease the human dimension in managing nature. In the present pilot project the horses are still owned privately, and clear guidelines should be stated as it comes to animal losses and damage to private properties. Our opinion is that especially for horses it will be tremendously hard to let everyone regard these animals as truly wild. It is only after social acceptance that the horses can be 'allowed' to live as wild animals.

6.2 Practical Recommendations

6.2.1 Wild animals

Problem

It is known among researchers, managers, veterinarians and everybody who works with large wild or free roaming animals: It is very hard to control their actions and movements, if it is even possible. And if it is tried, it will cost the effort of a lot people involved, long or accurate planning and a large amount of money. For our research we had none of the two at our disposal. Our first research strategy was to observe the horses. But soon it became very clear that unpredicted difficulties would arise.

Solution

The only way such problems could be prevented is to anticipate as much as possible on the actions of the animal(s). Try to oversee every possible scenario and include this in a planning. This might seem overdone, but when executing a pilot project with a social background, this is important and thus not to be underestimated. For example, future release efforts for new herds of horses (perhaps even other ungulates) should be carefully handled. Some of the animals that King (2002) studied were already bonded at arrival in Mongolia and were first situated in an enclosure (40 ha). After release it became clear that all the harems situated their home range and territory close to their release point.

A permanent valuation of cost-effectiveness and success of reintroduction techniques is also recommended, as this gives the employees in the project regular feedback and method development.

6.2.2 Guard (stray) dogs

Problem

Almost every herd of cattle, sheep, cows, and goats, does have a pack of guard dogs at their disposal. Those dogs are bred for protection of cattle (versus wolfs or jackals) and when they are still young, they are placed at a herd. The shepherds often do not care for the education, either because their lack of money or input of the herd owner/shepherd. This makes these dogs also dangerous for humans who will just pass the herd at an apparent save distance. The terrain also makes it difficult because some moments it is just not visible (through dense vegetation) what distance has been regarded. The shepherds do not see that this is a problem for the eco-tourism. For other cattle or dogs (domestic or guard dogs) they also form a problem. They will not tolerate anything near 'their' herd. During our own research, we had a collision with guard dogs several times.

Solution

There are devices, so called 'Dazers', on the market that produce sounds which dogs do not like and have a frequency too high for human hearing. It is strongly recommended to first test the devices (each day) before doing fieldwork. In any case it is wise to take a sufficient distance into account. It is strongly opposed not to bring any form of fire arms. This will lead to less fear for dogs or other wild animals, resulting in dangerous situations. Another, more sustainable solution, is to start an education program for the shepherds or herd owners.

6.2.3 Private properties

Problem

In this part of Bulgaria most of the grounds are used as common grounds and therefore accessible. There are small patches of private properties where people manage to grow their own vegetables and other crops. The fields are very precious for the local people because these are of a huge importance for their food supply. The free roaming horses, and in the future other wild animals, can (negatively) influence the production on these small fields and this is proven to be not good for the social support.

Solution

In order to describe the magnitude of this problem, an inventory is needed in the abundance of such properties. When there is a case of damaging of private property, it can be checked with the data available of the GPS-collars in order to see if it was caused by a herd of Ark Foundation. It can also be caused by other (free roaming) horses. The use of a compensation system might be necessary in order not to cause any social problems, and in that way harm the long term success of the project.

6.2.4 Landownership & communal grazing grounds

Problem

As with every country, landownership plays an important role in managing nature and wild animals. As can be read above, horses are not likely to follow orders – especially if they are supposed to be (semi-)wild. Most grazing grounds in Bulgaria are communal grazing, however it is rented by only one owner, often primarily to graze his animals on (cows, goats and sheep). When previously not present animals (grazers) will use the landscape as they please, and probably use the fields and meadows 'owned' by other people, conflict situations will develop. In this research this has been seen by the horses using the preferred grassy areas, which was allocated to a local farmer not included in the project. Most of the social frustration is based on the impression that the horses will eat the entire cow's grass, and that different animals can not live in peace with each other. Also the fact that horses might be a problem for young calves (in spring) has proven to be of effect (personal experience).

A lot of properties are not registered and measured at all by the state (cadastre). This is a general problem in Bulgaria. Ownership is also complex due to forgotten parts of land or is divided amongst different members of a family.

Solution

Agreements with landowners can be made regarding to the presence of the animals – but it is difficult to artificially manage the animal's presence (without the use of fences, i.e. as wild roaming animals). As for the food competition between the animals, more education is needed for the local people. For substantial loss of forage due to the grazing of horses a compensation system might be in place. More important is the calf problem, which should be really taken care of. Any loss of calves due to the trampling hooves of the horses, as with private property, is a strong (negative) influential factor in the social support of any reintroduction or projects within this area.

6.2.5 Planning & communications

Problem

In order for a project to work, every team member should be kept well informed by all others and at least the common goals within the project should be the really same for everyone. Minor differences can occur. Differing languages can be an obstruction in the cooperation between team members, but this should not be seen as a real hindrance since most members are able to communicate in a universal language (English). Some progress in this research was obstructed in the way that common goals were actually not common at all, and that different team members had different opinions about how towards work to these goals – resulting in what can be described as chaotic and a not pleasant working atmosphere. In which the project and the horses do not benefit at all.

Solution

This problem can easily be handled by discussing beforehand what the problems are and try to find a solution which can be accepted by every team member. In this way everyone's opinion is respected, more difficulties and solutions are thought of, and it will be easier for the members to work to a common goal. It is especially important for the long term progress of the project (sustainability). Not only should local people agree with the project, but also the project itself should operate with a healthy basis – which is with the least amount of frustrations.

6.2.6 Logistics for carrying out research

Problem

The distances, the terrain and vegetation in the Eastern Rhodopi Mountains constitute a remarkable test to navigate on foot through the terrain, as well physically as technically. There are no proper updated topographical maps with a proper scale (1:50.000 or 1:100.000) available and forest roads are not mapped in GIS or any other system. When leaving the road the vegetation can be remorseless towards clothing and naked skin. The terrain can be very steep what could make it a physical challenge.

Solution

The area is well accessible when travelling over main roads. Next to that, forest roads are abundant and by those roads, it is possible to come close (500 m to 1 km) to the research site, enabling a higher speed of research and perhaps a larger amount of data (also mapping of these roads is recommended, see *6.1.10 Inventory of water sources and forest roads*). When travelling over forest roads it is recommended to be in possession of a car

with four-wheel drive. The roads are often not in a good condition. Also recommended is, if available, an updated topographic map (preferably military for the best orientation) or a GPS device.

6.2.7 Species composition

Problem

Insufficient knowledge of local flora can prohibit effective data collection on species composition. Knowledge of these species and composition in different areas is a must for future research.

Solution

In order to get the most out of data extraction when doing fieldwork on vegetation, it is advised to be updated regarding to the local plants. It is not a problem to generalize certain species, i.e. grasses or shrubs, but for more in depth research one is almost obliged to at least bring a good determination book or use knowledge of local people. The help of a Bulgarian team member – with knowledge of their flora - may be crucial.

Most important of all is to pick the right season when measuring vegetation. This can be done best in late spring or early summer, depending on the goal of recording transects. We recommend investigating to see what is the right season / time of year. As with every kind of research, it is important to investigate a good deal into the way the data is going to be analyzed. This can be done in close connection with the goals of doing research on plants.

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