

Analysis of Polish Primitive Ponies Migration under Registration of the Global Positioning System

E. Jodkowska, A. M. Kuźniak, R. Piķuła and M. Smugała

Abstract— The aim of the study was to determine the influence of environmental conditions on the migration of a herd of Polish primitive ponies (Polish Konik) held in the reserve area of 664.57 ha. In the first stage of the study (April 2011) there were 11 horses (6 mares, 1 stallion, and 4 foals), and in the second stage (April 2012) - 18 horses (7 mares, 1 stallion, 4 yearlings and 6 foals). The movement of a herd of horses was observed on the basis of indications of Ecotone camera's GPS and Google Maps. A total of 57 maps were analyzed. The 7 habitats and weather conditions were taken into account. The results showed that in both stages of the study the herd usually stayed in the meadows in the mornings and afternoons and in the ancient forest from afternoon to night. The changes in air temperature has significantly affected the frequency and range of the daily migration of horses. At higher air temperatures the herd often migrated, but the range of its stay in a particular place was shorter than at lower temperatures. The choice of habitats by a herd of primitive horses may be an indication of organization of their maintenance.

Keywords—Polish primitive pony; GPS, migration; nature reserve; habitat; microclimate

I. INTRODUCTION

The Global Positioning System is one of the advanced telemetry technologies. Since the mid-90s of the twentieth century the GPS has been getting more and more popular in ethological animal studies [1, 2]. In Poland, telemetry studies have been carried out during the migration of european bison [3].

The GPS device was used in the maintenance of horses, especially in order to observe their migration [4]. A team of researchers from Australia proved that the distance traveled by a herd of horses was the longer the larger the area on which they reside (from 4.7 to 7.2 km /day) [5]. In other studies, the GPS measured distance of herds of horses from the water source and how frequently they approached the water [6]. GPS cameras were also used in order to observe of motivation the horses to move. One of such solutions was constructing an automatic feeder which, by closing and opening access to hay, made the horses move continuously [7]. A permanent GPS monitoring has been functioning over a herd of horses in Polish Reserve Forest District Kliniska since 2010 [8].

The Polish primitive ponies (Polish Konik) are the only native Polish breed of horse in the primitive type [8]. They are characterized by 130-140 cm height of withers, mouse color with dorsal dark strip and without white spots or markings "Fig. 1". Maintaining the Polish primitive ponies in an



Figure 1. The Polish konik (author M. Smugała)

environment that is similar to the natural one, surrounding them with other wild animals. Maintaining a minimal human intervention is aimed at consolidating the features that the Polish primitive ponies got from the Tarpan (*Equus gmelini*) [9].

The living conditions provided by the reserves, give the horses a high level of welfare and a manifestation of their natural forms of behavior [10, 11].

The aim of the study was to determine the influence of environmental conditions and microclimate on the migration of the Polish primitive ponies kept in the reserve system.

II. MATERIALS AND METHODS

The research was focused on a herd of the Polish primitive ponies held in the Kliniska Forestry reserve. Studies were carried out in two stages; stage I in April 2011, the second stage in April 2012. In the first stage the herd consisted of 11 horses (6 adult mares, 1 stallion, and 4 foals) and in the second stage of 18 horses (7 mares, 1 stallion, 4 yearlings and 6 foals). Observed movement of the herd of horses, based on the readings of the GPS Ecotone camera mounted on the neck of one of the animals "Fig. 2".

There were 7 habitats marked on the maps covering an area of about 600 hectares: northern meadows (1), middle meadows (2), southern meadows (3), space of hunting (4), planted forest (5), young forest (6) and ancient forest (7) "Fig. 3".

DOI: 10.5176/2345-7880_1.2.11



Figure 2. The Polish primitive pony with a GPS collar standing in the planted forest, ancient forest can be seen behind it (author A. M. Kuźniak)

Based on the location of GPS tags, the frequency of stay of the Polish primitive pony on particular habitats in different times of the day was analyzed on the maps. Then, the dispersion of GPS indicators on individual maps and days in April of 2011 and 2012 was observed “Fig. 4”. On this basis the range of migration in the whole reserve area was determined: small (up to 30%), medium (50%), large (over 50%).

In the analysis of the test results, the following meteorological indicators occurring in April 2011 and 2012 in Kliniska Forestry area were made available by the Institute of Meteorology and Water Management: rainfall, sunshine, temperature, relative humidity and pressure.

The obtained results were subjected to statistical analysis; R package version 3.0.2 (The R Foundation for Statistical Computing, 2013), using Fisher's and Wilcoxon's tests and the method of least squares. The significance level was $\alpha = 0.05$.

III. RESULTS

The observations carried out showed that in both years the herd mostly stayed in ancient forest and middle meadows, a bit less frequently on space of hunting (Tab. I). Least likely the horses were to be observed in the northern meadows, in the young forest and, in 2012, also on planted forest.

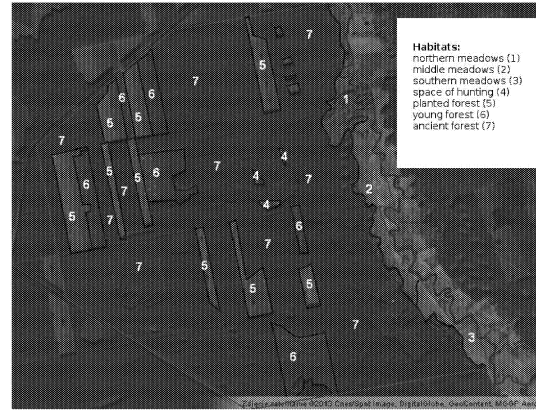


Figure 3. Distribution of habitats in the Kliniska Forestry reserve.

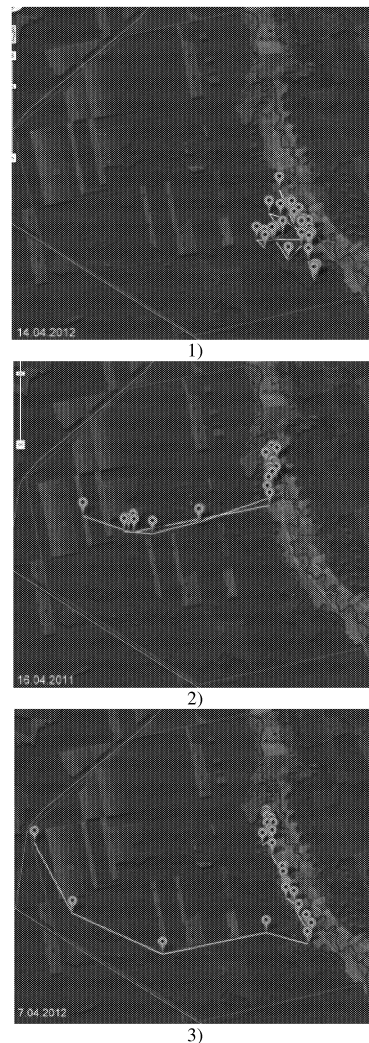


Figure 4. Ranges of migration of the Polish primitive pony herd during the day: small (1), medium (2), large (3).

TABLE I. THE PRESENCE OF THE HERD IN 7 HABITATS IN I AND II STAGE.

Day	Habitat ^a I stage							Habitat ^a II stage						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1		x ^b	x	x			x		x		x	x		x
2				x			x				x	x		x
3		x	x				x		x	x				x
4	x			x	x		x		x	x	x			x
5	x	x					x		x					x
6		x		x	x		x	x	x				x	x
7		x					x		x					x
8		x		x	x		x	x	x			x		x
9		x		x			x	x	x	x	x			x
10		x	x	x			x		x	x				x
11	x	x	x	x			x	x	x	x				x
12					x		x	x			x			x
13		x			x		x		x					x
14		x	x	x	x		x		x					x
15	x				x		x		x					x
17		x		x	x		x	x	x		x			x
18		x		x			x		x	x				x
19		x		x			x		x	x				x
20		x			x		x		x					x
21		x					x		x		x			x
22		x			x		x		x		x			x
23		x			x		x		x		x			x
24	x	x		x	x		x		x	x				x
25	x				x		x		x	x	x			x
26		x		x	x	x	x	x	x					x
27	x			x			x	x			x			x
28				x			x	x	x					x
29		x		x	x		x	x	x		x	x		x
30	x				x		x		x			x	x	x
31		x		x	x		x		x		x	x		x
Σ	8	22	5	17	17	1	30	9	27	9	12	5	2	30

^aHabitats: northern meadows (1), middle meadows (2), southern meadows (3), space of hunting (4), planted forest (5), young forest (6), ancient forest (7)
^bx – presence of the herd

In both stages the herd mostly migrated between 6 a.m. and 8 p.m. with a slightly lower activity from 2 p.m. to 6 p.m. (Tab. II). Summing up similar habitats (all meadows), it has been found that the horses were staying there the most frequently between 6 a.m. and 5 p.m., while in the ancient forest from 5 p.m. to 5 a.m. The frequency of changing the location was greater in the first stage of the study.

The migration range of the herd was different “Fig. 5”. In 2011, the dispersion valued 2 (small) and 3 (large) prevailed, while in 2012 there were mostly days in which the value of the dispersion was 2.

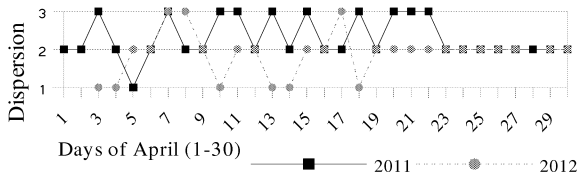


Figure 5. GPS indicators in 2011 and 2012 year characterizing the dispersion of the herd during the day: small (1), medium (2), high (3).



Figure 6. Horses wandering in a hierarchically set order (author M. Smugala)

By changing the place of stay, the herd often moved in a fixed hierarchical order “Fig. 6”. Another study, on the Hucul horse, showed a similar animal behavior of horses that threaded particular paths [12]. Therefore, it can be assumed, that these behavioral patterns are characteristic of primitive horses.

TABLE II. THE PRESENCE OF THE HERD BASED ON THE NUMBER OF INDICATORS IN A GIVEN BIOTOPE IN DIFFERENT TIMES OF THE DAY IN I AND II STAGE.

Time	Habitat ^a I stage							Habitat ^a II stage						
	1-3	4	5	6	7	1-3	4	5	6	7				
4.00/5.00 a.m.	7	2	4	1	15	13	5			1	11			
5.00/6.00 a.m.	7	4	4	2	15	17	3			2	23			
6.00/7.00 a.m.	36	6	1	2	13	23	7			4	15			
7.00/8.00 a.m.	41	5	1	1	11	32	5				12			
8.00/9.00 a.m.	43	3		1	9	33	2			1	11			
9.00/10.00 a.m.	47	1	1	1	8	35					10			
10.00/11.00 a.m.	46	2		1	8	38	1			2	6			
11.00/12.00 a.m.	52	2			6	32	4			1	10			
12.00/1.00 p.m.	50	2		1	7	31	8			1	9			
1.00/2.00 p.m.	43	4	1	3	8	31	6				11			
2.00/3.00 p.m.	42	2	1		12	36	3			2	7			
3.00/4.00 p.m.	40	4	1	3	11	30	4	1			7			
4.00/5.00 p.m.	25	7	2	5	20	28	4	1	1	1	14			
5.00/6.00 p.m.	19	8	6	1	19	13	3	3	1	1	22			
6.00/7.00 p.m.	9	6	7	1	35	14	1	1	4	4	22			
7.00/8.00 p.m.	6	3	9	3	39	14	5				25			
8.00/9.00 p.m.	2	2	6	1	19	12	2				13			
9.00/10.00 p.m.	2	2	5	1	20	2								
10.00/11.00 p.m.	3		4	1	21	3					1			
11.00/00.00 p.m.	4		1		5	2	1				1			
00.00/1.00 a.m.	2	2	6	1	19	6	1	1	3	3	9			
1.00/2.00 a.m.	3	2	5		19	6		1	3	3	9			
2.00/3.00 a.m.	6	2	3		18	5	3		4	4	8			
3.00/4.00 a.m.	6	2	4		18	5	3		4	4	8			
Σ	541	73	72	30	375	461	70	9	34	264				

^aHabitats: northern meadows (1), middle meadows (2), southern meadows (3), space of hunting (4), planted forest (5), young forest (6), ancient forest (7)

TABLE III. MICROCLIMATIC CONDITIONS IN THE KLINISKA RESERVE IN APRIL OF 2011 AND 2012

Microclimatic conditions	April 2011			April 2012		
	Mean	SD	Median	Mean	SD	Median
Precipitation [mm]	0.62	2.03	0.09	1.21	1.64	0.09
Sunshine [h]	7.52	4.60	7.45	5.95	4.12	5.80
Temperature [°C]	11.67 ^a	2.68	12.28	8.77 ^b	4.39	7.72
Humidity [%]	68.19	12.39	68.00	70.30	13.11	68.19
Air pressure [hPa]	1017 ^a	3.82	1017	1005 ^b	6.15	1005

The influence of microclimate conditions on the migration of the herd of horses was studied. Air temperature ($p = 0.002$) and pressure ($p=2.164 \cdot 10^{-11}$) were statistically significantly higher in April 2011 as compared to April 2012 (Tab. III)

Dependence of the range of herd migration on microclimatic conditions was studied by observing the dispersion of the GPS indicators per day (low (to 30%), medium (up to 50%), large (over 50%), (Tab. IV).

Statistically significant differences ($p = 0.015$) of temperature between the medium and high dispersion have been shown in April 2012. This means that during the day, the herd was moving to a smaller area at higher temperatures and to a larger area at lower temperatures.

CONCLUSION

A herd of the Polish primitive ponies kept in the Kliniska Forest District is the only herd in Poland equipped with a GPS receiver. This creates great opportunities to observe natural behavior of horses, especially their migration.

In the reserve the horses could stay on varied terrains with 7 available habitats: northern meadows, central meadows, southern meadows, hunting plots, forest plantations, young forest and old growth of trees. They were staying mainly in the area of meadows and old growth of trees. The horses frequently stayed on middle meadows. The horses' preference of the old growth of trees kind of biotope may be indicative of their genetically well-established need for shelter as the Polish primitive pony derives from the Tarpan horse.

The herd mostly stayed in the meadows between 6 a.m. and 5 p.m. and in old growth of trees from 5 p.m. to 5 a.m. In other

TABLE IV. THE DEPENDENCE OF GPS INDICATORS DISPERSION DURING THE DAY ON MICROCLIMATE CONDITIONS IN APRIL 2011 AND 2012

Microclimatic conditions	Dispersion of GPS indicators					
	April 2011			April 2012		
	Low	Medium	large	Low	Medium	Large
Precipitation [mm]	0,10a	0,45a	1,01a	1,04a	1,29a	1,53a
Sunshine [h]	5,10a	7,03a	8,70a	4,14a	5,99a	7,16a
Temperature [°C]	10,28a	11,81a	11,54a	7,33ab	9,92a	3,21b
Humidity [%]	72,88a	68,92a	66,33a	74,79a	69,06a	73,57a
Air pressure [hPa]	1021a	1017a	1016a	1002a	1005a	1006a

biotopes the animals stayed sporadically, the most seldom at night.

The frequency of relocation of horses was greater in the first stage of the study as compared to the second stage. In the first stage, statistically, the temperature and air pressure were significantly higher than in the second stage. Meteorological studies found statistically significant differences between the April 2011 and April 2012.

Statistically significant differences with respect to temperature differences of the dispersal range of the GPS indicators showed a lower dispersion at higher temperatures.

Therefore, at higher air temperatures the herd migrated more often but the range of its stay was smaller than at lower temperatures.

In conclusion, environmental factors had minimal effect on migration of primitive horse. However equine migration concept was practically achieved because GPS indicators showed the choice of habitats by a herd of primitive horse during the day. It can be an indication of organization of their maintenance in various possibilities of use, in the area of breeding, sport recreation and hipotherapy.

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AUTHOR'S PROFILE



Dr. Ewa Jodkowska. My scientific activity is related to the Wrocław University of Environmental and Life Sciences in Wrocław for past 42 years. In 1971 I defended Master's thesis and in 1980 - PhD thesis. I passed the habilitation exam in 2005. From 2006 I have worked as associate professor and I have been the head of Department of Horse Breeding and Equestrian Sciences. My research interests concern the ethology and welfare of horses, the body horse conformation, the body surface temperature and the use of nutritional supplements for horses. Since 20 years, I have organized postgraduate studies "Horse Breeding and Horsemanship".

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