European Bison Conservation Newsletter Vol 5 (2012) pp: 39–46

Seasonal and daily activity of free-ranging European bison females fitted with GPS collars

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Abstract: We studied activity of European bison females in free-ranging groups in the European part of Russia. Animals fitted with GPS-collars were observed from March until July. The whole patterns of diurnal activity (the highest during the evening twilight and the lowest in the dawn) were the same between the snowy and snowless period while European bison were more active during the latter (Apr-Jul). There were no periods of the sharp increase in activity during the day but there is a period of the more prominent decrease in activity in the evening. There was also a period of the sharper decrease in the morning in May which could be related to pregnancy and calving.

Key words: European bison; telemetry; daily activity; seasonal activity; collars; free-ranging group.

Introduction

The telemetric studies on animals have been successfully applied in zoology since the second half of the XX century (Mech 1967). It allows achieving exact and full data on species ecology: location, time of motoric activity, diving depth, body temperature etc. depending on the set of sensors on a transmitter. Activity sensors on collars were used even in the time of VHF-telemetry when different number of signal pulses allowed discriminating whether an animal moved or remained still (Green & Bear 1990). But in this case a researcher got data only from the time intervals of the direct connect with the transmitter. The appearance of the collars capable of transmitting information through the satellites or GSM-network allowed us to achieve all data from the animal activity sensor collected during the whole period of its work. There are different methods of recording the information from the activity sensor, e.g. count of the active seconds during the time interval (Rozhnov *et.al.* 2011) or assigning of the fixed value to the certain interval in which activity measurement took place (Chistopolova *et.al.* 2011).

One of the aims of European bison telemetry was the study of activity dynamics. For this purpose we fitted European bison cows with transmitter collars with the GSM-module and activity sensor. The characteristic features of diurnal and seasonal activity of the European bison's free-ranging groups in the European part of Russia were estimated through the subsequent statistical analysis of the data.

Study area

The activity of European bison females was studied in three regions of the European part of Russia.

A group of six European bison dwells in Kaluzhskie Zaseki Nature Reserve (53,57°N 35,70°E) which is located in Ulyanovo district of Kaluga region. On its southern border the reserve is adjacent to Orlovskoe Polesye National Park.

These animals belonged to six free-ranging groups differing in space use. One of them were equipped with the collar two times (in 2011 and 2012) and two of them (Kudryvaya and Morena) belonged to the same group.

Three animals dwell in Orlovskoe Polesye National Park (53,27°N 35,30°E) which is located in Khotynetsk district of Orel region. All of them also belonged to three free-ranging groups differing in space use.

Studied European bison from Kaluzhskie Zaseki and Orlovskoe Polesye have never met; the closest recorded distance among them was at least 20 km (GPS data).

One of the studied animals dwells in Klyazminsko-Lukhskiy Reservation (56,30°N 42,35°E) which is located in Vyazniki district of Vladimir region. The free-ranging group of this game park is situated 500 km NE from those of Kaluzhskie Zaseki and Orlovskoe Polesye.

Materials and methods

In this paper the data from eleven GPS-collars from European bison females were analyzed. All animals were equipped with the collar in March when they remained around the feeding sites. Beforehand they were immobilized with the anesthetic mixture of Zoletil and Xilazine injected intramuscularly with the Cap-Chur, Dan-Inject or Telinject tranquilizer dart guns. Two types of collars were used. Both were equipped with GPS-module and activity sensor but one of them transmits data through Thuraya satellites and the other – through GSM-network. All collars were made in A.N. Severtsov Institute of Ecology and Evolution as experimental equipment.

The device measures activity "one-time" in 0, 10, 20, 30, 40, 50 min of every hour. 30 instant measurements of the acceleration absolute value at three axes with the interval of 1 sec i.e. 90 measurements were summed and if the sum exceeded the given threshold it indicated that the animal was moving at this moment and the value "1" is given to this interval. If an animal did not move, the value "0" is given. Also for the acceleration measurements we applied frequency filtering (this method increases the number of the instant measurements for high-frequency noise muting) and analogue filtering (this method takes into account only smooth animal motions, i.e. excluding movements during rumination and lying down). We treated an interval with the "1" value

Table 1. Name of radio-tracked E. bison cow, location of the study, date of fitting an animal with the collar, and characteristics of activity sensor work

No.	Name	Location	Date of the collars equipment	Period of work, days	% of received data from the possible	Data transmission system
1	Musyanay	Kaluzhskie Zaseki	22.03.2009	124	79%	GSM module
2	Kudryavaya	Kaluzhskie Zaseki	06.03.2010	85	85%	GSM module
3	Morena	Kaluzhskie Zaseki	07.03.2010	128	26%	Satellite module «Thuraya»
4	Pesnya	Orlovskoe Polesie	12.03.2011	157	99%	GSM module
5	Mukaltin	Kaluzhskie Zaseki	13.03.2011	142	88%	GSM module
6	Dubenka	Kaluzhskie Zaseki	07.03.2012	74*	100%	GSM module
7	Mukaltin	Kaluzhskie Zaseki	07.03.2012	73*	100%	GSM module
8	Polushka	Kaluzhskie Zaseki	07.03.2012	73*	99%	GSM module
9	Polya	Orlovskoe Polesie	09.03.2012	72*	99%	GSM module
10	Podruga	Orlovskoe Polesie	09.03.2012	72*	99%	GSM module
11	Prima	Klyazminsko-Lukhskiy Reservation	21.03.2012	60*	100%	GSM module

* – number of days taken into account for the analysis (the collar still works)

as entirely active and gave to it 10 min of activity. We treated an interval with the "0" value as entirely inactive and gave to it 0 min of activity.

Animals, their locations, dates of collar equipment and several features of the sensor work are shown in Table 1.

We did not take into account data from the activity sensor for the first seven days after European bison's immobilization because animal's behavior differs from the natural for some time after the anesthesia (White & Garrott 1990).

Data were collected from the different years and locations but Chi-square test did not reveal any differences in the diurnal activity of all European bison for the same period (29 March-17 May) so we merged data on all animals into one sample.

We compared European bison activity by months (March-July). The data for an animal from one month were included in the analysis only if the activity sensor has worked more than 6 days in this month. Thus activity data in March were got from 9 European bison, in April and May – from 11, in June and July – from 3. We also distinguished snowy (March) and snowless (April-July) periods. For the analysis of diurnal activity we distinguished day, night, dawn and twilight (1 hour before and 1 hour after the dawn and the sunset respectively).

Statistical analyses were performed with Microsoft Excel 2003, Statistica 6.0 & GraphPad Prism 5. Due to low sample sizes nonparametric tests were applied.

Results and discussion

Chi-square test did not reveal any differences in the diurnal activity of all European bison females for the same period in different years and in different locations ($p > 0.99$) so we merged all these animals in one sample. The activity increases gradually through April and May and in June and July it is higher than in spring (Fig. 1). In March the activity significantly differs from activity in May-July (Dunn's Multiple Comparison Test, $p < 0.01$ for all pairs, March N=9, May N=11 June N=3 July N=3)

Motoric activity of the European bison significantly differs between months from March until July (Kruskal-Wallis Test, H = 21.72, $p < 0.001$). The lowest activity is observed in March. It increases gradually through April and May and in June and July it is higher than in spring (Fig. 1). In March, the activity significantly differs from activity in May-July (Dunn's Multiple Comparison Test, $p < 0.01$ for all pairs, March N=9, May N=11 June N=3 July N=3). Motoric activity in March is the lowest because European bison are still around feeding sites and they do not need to move much to search for food, so they spend more time on rest and rumination (Caboń-Raczynska *et.al.* 1983). Their activity increases gradually until summer when it becomes stable and high. This pattern can be related to the higher abundance of insects. European bison then need to search for places where insects are less abundant and move more frequently to minimize the exposure for biting.

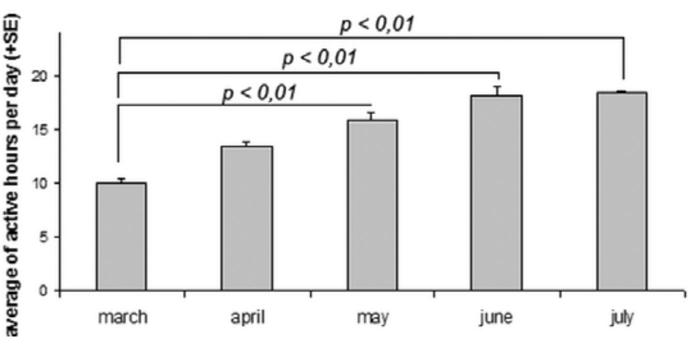


Figure 1. Monthly activity of E bison cows

Significant differences between European bison activity in every distinguished light condition phase between the snowy and snowless periods were found. During the snowless period the European bison (N=11) were more active than during the snowy one (N=9) (Mann-Whitney U Test, $p < 0.001$ for day and twilight, $p < 0.01$ for night and dawn). Such differences in seasonal activity are typical not only for the European bison but for all ungulates in the climate with the marked season change (Green & Bear 1990; Kamler *et.al.* 2007). During the snowless period European bison activity increases evenly

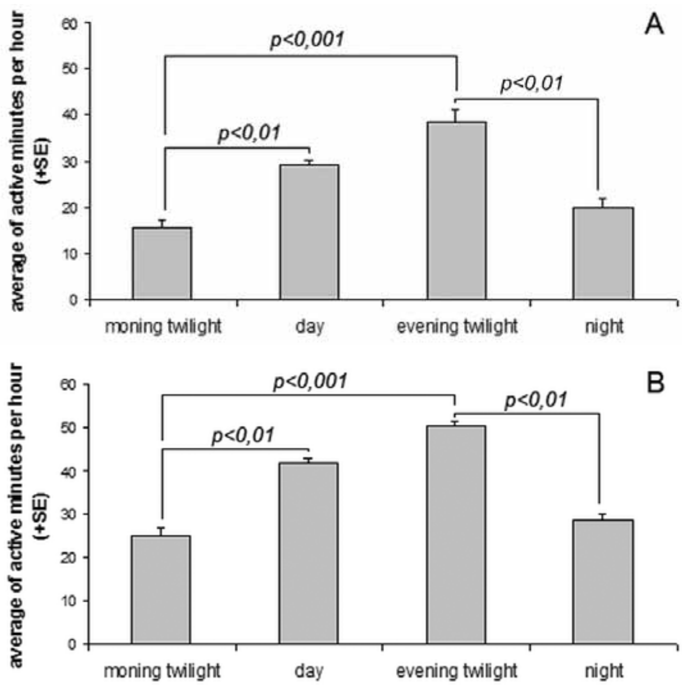
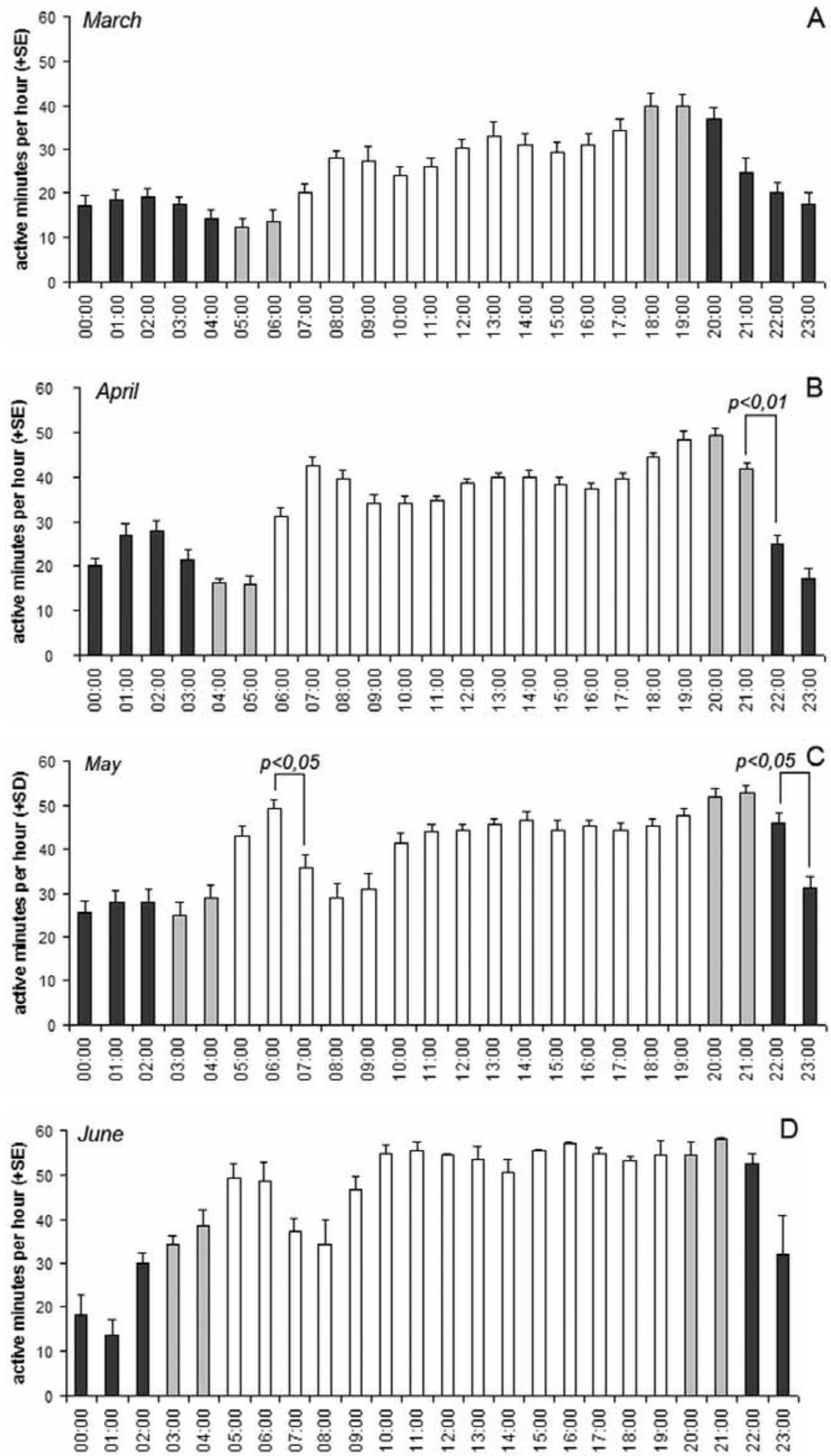


Figure 2. Light conditions during the snowy period (A) and snowless period (B).

during the day. Bonferroni-corrected exact Fisher test did not reveal any differences between the snowy and snowless period in the distribution of activity between different times of the day.

The analysis of diurnal activity during the snowy period (N=9) showed that European bison have been the least active in the dawn (Fig. 2A). Their activity in this time differed significantly from day (Dunn's Multiple Comparison Test, $p < 0.01$) and evening (Dunn's Multiple Comparison Test, $p < 0.001$). The most active time for the European bison were twilight (it also differs from the night: Dunn's Multiple Comparison Test, $p < 0.01$). The same differences were shown for the snowless period (Fig. 2B).

More detailed study of the diurnal activity in one-hour intervals showed that in March (N=9) activity fluctuations have been smoother. There were no differences between the adjacent one-hour intervals (Fig. 3A). In April (N=11), as it was mentioned earlier, the general activity level were higher but the sharp peaks of its increase during the day were not found. Significant differences were shown only for the second hour of the twilight and beginning of the night (Dunn's Multiple Comparison Test, $p < 0.01$). In this time European bison decreased their motoric activity sharply and started to rest (Fig. 3B). Significant decrease in motoric activity before the night rest were also found for May (N=11) but in this month it shifted one hour forward, the


March
A
active minutes per hour (+SE)
April
B
p<0,01
active minutes per hour (+SE)
May
p<0,05
p<0,05
C
active minutes per hour (+SD)
June
D
active minutes per hour (+SE)
00:00
01:00
02:00
03:00
04:00
05:00
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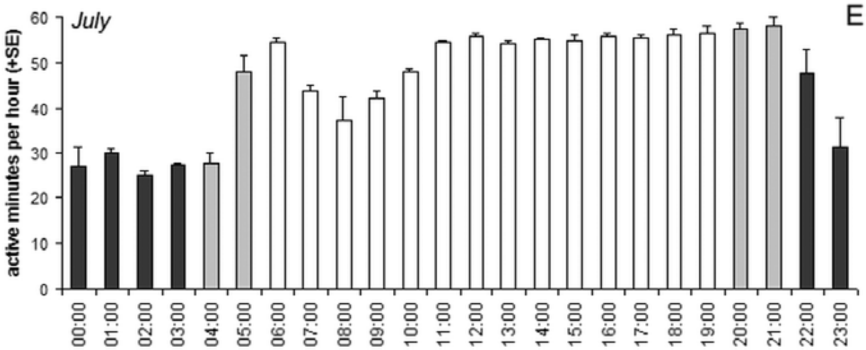

Figure 3. Figure 3. Daily activity during the month: March (A), April (B), May (C), June (D) and July (E). (Bar color: white – day, gray – dawn and twilight, black – night).

difference between the first and the second hour after the sunset was shown (Dunn's Multiple Comparison Test, $p < 0.05$). Besides in May European bison decreased significantly their activity after the first two hours of the day activity (Fig. 3C), we found differences between 06:00 – 07:00 and 07:00 – 08:00 intervals (Dunn's Multiple Comparison Test, $p < 0.05$). Perhaps the sharp change from high to the low activity was related to the last days of pregnancy and calving. After the calving females tend to move less and feed more (Krasińska & Krasiński, 2007). No sharp changes in diurnal activity were found in June and July (N=3) (Fig. 3D 3E). The activity changed smoothly through the day. Perhaps such situation is caused by the more stable abiotic factors in this season (diurnal temperature dynamics, precipitation).

Conclusions

The following features of seasonal and diurnal activity for the European bison females from the free-ranging groups in the European part of Russia were found:

1. Winter feeding significantly decreases motoric activity
2. Change of the seasons does not influence proportion of day and night activities.
3. The activity is the highest during the twilight and the lowest for the dawn.
4. Peaks of diurnal activity were not found for the whole observation period from March until July.
5. There are periods of the sharp decrease in activity during the day, perhaps caused by the pregnancy and calving.

Acknowledgements

The authors express their gratitude to the Head of the Veterinary Dept. of Moscow Zoo Mikhail V. Alshinetskii for his help with immobilization and administration and staff of Kaluzhskie Zaseki Nature Reserve, Orlovskoe Polesye National Park and Klyazminsko-Lukhskiy Reservation for carrying of field action.

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