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Short communication

Winter movements of European bison in the Białowieża Forest, Poland

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There is a growing interest in the importance of large herbivores within European ecosystems (e. g. VAN WIEREN 1995; KUITERS et al. 1996). However, wildlife managers seeking information about the ecology of European bison (*Bison bonasus*) have mostly access to data collected in the Białowieża Forest where bison have been supplied with hay in winter since the 16th century (KRASIŃSKA et al. 2000). As a result of this management practice, most bison join one of the two main aggregations that count up to 100 individuals (KRASIŃSKA et al. 1987). The animals in these winter aggregations usually remain within 500 m of the haystacks (KRASIŃSKI 1967) and the extent of their home-ranges is very limited (KRASIŃSKA et al. 2000). Consequently, although the movements and habitat use of free-ranging European bison have been described for snow-free periods (CABOŃ-RACZYŃSKA et al. 1987; KRASIŃSKA et al. 1987), knowledge about their winter behaviour is restricted to animals congregating at feeding sites. The aim of this study was to provide an insight into the ecology of the few bison that do not join feeding sites in the Białowieża Forest. This research was a complement to a radio-tracking study of the activity and movements of European bison in the Białowieża Forest (S. ROUYS and M. KRASIŃSKA, unpubl. data). As all radio-collared animals joined the winter aggregations, bison that did not remain in the proximity of the feeding sites were snow-tracked. Specific objectives of this study were to document the daily walking distance, group size and habitat use of bison that do not congregate at winter-feeding sites.

The Białowieża Forest (52°30′–53°00′ N, 23°30′–24°15′ E) is a lowland forest straddling the border between Poland and Belarus. The Polish side of the forest covers about 600 km^2 with forest types ranging from ash-alder bog forests and oak-lime-hornbeam forests to pine and spruce plantations (FALIŃSKI 1994). Between November 1998 and March 1999, bison were snow-tracked in the Białowieża Forest and on the northern edge of the forest where agricultural land is interspersed with small forests that are connected to each other and to the Białowieża Forest (referred to as meadow/forest mosaic). Fresh bison trails (< 12 hours old) that were not in the vicinity of feeding sites were located and the trails were then followed until locating the bison taking care not to disturb them. The next day, snow-tracking was continued from the place where the bison had been located on the previous day until finding the animals again. The same bison group was followed

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on consecutive days until it became impossible to relocate it. This method provided the time at which bison had been at the beginning and end of each of 16 independent tracking events (Tab. 1). On some of the days it was possible to estimate the age of the tracks (based on the time of the last snowfall and the state of the droppings). The mean daily distances walked by bison on five tracking events for which data were obtained over known and estimated time periods did not differ significantly (*t*-test for matched pairs, $P = 0.825$), so that both types of data were pooled. Days for which it was impossible to estimate accurately the age of the trail were discarded. The data obtained for a lone bull tracked in the area around the village of Białowieża (3.7 km for 52 hours of bison travel) were also not included in the analysis since this animal was old and sick and later shot by the staff of the Białowieża National Park. To compensate for the different lengths of tracking events, the mean daily distance travelled, defecation rates and frequency of resting were calculated by weighting the data of each tracking event with the time the bison took to cover the trail as suggested by Theuerkauf and Ellenberg (2000). The length of the trail through different habitat types was measured by step counting (step length calibrated under similar conditions) and bison movements were mapped with a GPS (Global Positioning System). Habitats were classified as: meadows, clearings, deciduous forest, coniferous forest and roads. Signs of bison feeding (grazing, browsing or barking) were recorded during snow-tracking as well as the numbers of droppings and rests found in each habitat type. Selection of habitats for sleeping or foraging was determined by whether the mean number of times bison had rested or the mean number of droppings recorded per km in that habitat were higher than the mean numbers of rests or droppings per km for all habitats. To determine if snow depth or temperature influenced the movements of bison, snow depth was measured near the trail. The weather station in the village of Białowieża provided data for the mean daily temperatures.

Bison walked on average 5.1 km daily (Tab. 1). The daily distances walked were higher (*t*-test, $P = 0.018$) at the end (February–March: 7.6 km, SE = 0.6 km, n = 4) than at the beginning of winter (November–January: 4.3 km, SE = 0.7 km, n = 12). There was no difference between the distance walked by bison in the Białowieża Forest and the meadow/forest mosaic (*t*-test, $P = 0.413$). Bull groups walked in mean 6.0 km per day (SE = 0.8 km, n = 7) and mixed groups 3.9 km per day (SE = 0.9 km, n = 9) but the difference was not significant (*t*-test, $P = 0.100$). Temperature and snow depth did not affect the daily distances walked (multiple linear regression, overall $P = 0.221$, temperature: $P = 0.155$, snow depth: $P = 0.732$). Male groups rested on average 1.8 times a day (SE = 0.4, n = 9) and mixed groups 3.1 times per day (SE = 0.5, n = 7) but the difference was not significant (*t*-test, $P = 0.073$). Bison defecated on average 4.2 (SE = 0.5) times per day. There was no difference in the defecation rate of mixed and bull groups (*t*-test, $P = 0.232$). None of the mixed groups followed ever walked to one of the main feeding sites in the forest or used stacks of hay left out in the agricultural land. Bull groups in the meadow/forest mosaic once used a stack of rank hay and those of the Białowieża Forest walked to a small feeding site on two occasions. In the meadow/forest mosaic, the mean number of rests per km was higher in deciduous (7.8 rests/km, SE = 2.3, *t*-test for matched pairs, $P = 0.004$) and coniferous forest (9.2 rests/km, SE = 2.6, $P = 0.035$) than the mean for all habitats (4.0 rests/km, SE = 2.1), which indicates that bison selected to rest in forest rather than in the open. More droppings per km were found in deciduous forests (12.1 droppings/km, SE = 2.7, *t*-test for matched pairs, $P = 0.025$) of the meadow/forest mosaic than on average (4.8 droppings/km, SE = 2.2), suggesting that bison spent a longer time active in that habitat. The mean numbers of droppings and rests per km in other habitats (meadows and clearings) of the meadow/forest did not differ significantly from the average in all habitats.

Table 1. Results of 16 independent tracking events in the meadow/forest mosaic (MF) and the Białowieża Forest (BF) for mixed groups (M) and bull groups (B) from November 1998 to April 1999.

Date	Region	Bison hours	No. of bison	Group type	Distance walked (km/d)	Defecations per bison per day	Rests per day	Snow depth (cm)	Mean temp. (°C)
19.–21. 11.	MF	60.7	12	M	1.8	2.0	2.8	5	–12
20. 11.	BF	16.2	1	B	5.3	4.4	1.5	5	–10
21. 11.	BF	17.5	15	M	3.4	0.8	1.4	5	–13
27.–29. 11.	MF	48.3	1	B	5.9	6.0	3.5	5	–4
2. 12.	BF	8.0	1	B	4.8	3.0	0.0	5	–18
14.–15. 12.	MF	34.0	17	M	4.4	6.5	4.9	25	1
11. 1.	BF	12.0	9	M	2.9	1.7	2.0	5	–9
11. 1.	MF	3.0	8	M	6.3	3.0	8.0	5	–9
13.–14. 1.	BF	33.0	1	B	9.1	5.8	1.5	7	–3
16.–17. 1.	BF	34.8	2	B	3.0	3.1	0.7	4	3
17. 1.	BF	20.4	2	B	2.8	3.5	1.2	4	3
13.–14. 2.	MF	33.0	8	M	7.7	5.3	2.9	5	–2
23. 2.	MF	3.0	2	B	6.0	0.0	8.0	20	–1
28. 2.	BF	23.0	1	B	8.1	3.1	2.1	20	4
1. 3.	BF	23.2	1	B	8.6	4.1	1.0	15	3
10. 3.	BF	14.2	1	B	5.5	8.5	1.7	1	1
Mean ± SE					5.1 ± 0.6	4.2 ± 0.5	2.4 ± 0.4		

Likewise, the mean numbers of droppings and rests per km in all habitats of the Białowieża Forest did not differ significantly from the average.

Previous studies undertaken in summer in the Białowieża Forest estimated daily walking distances of 2 km (KRASIŃSKA et al. 1987) and 7 km (CABOŃ-RACZYŃSKA et al. 1987). Preliminary results of a radio-tracking study of bison in the Białowieża Forest indicated movements of 7.2 km per day in spring-summer and 1.3 km per day for bison at the feeding sites (ROUYS and KRASIŃSKA 2001). The radio-tracking method however overestimated the movements of bison by up to 82% (ROUYS et al. 2001), so the differences between winter movements of bison radio-tracked at the feeding sites and the bison snow-tracked in this study are likely to be even greater. The distance of 5 km found in the present study therefore indicates that bison that do not congregate at feeding sites do not reduce their winter movements. KRASIŃSKA et al (2000) noted that the home range size of radio-collared bison that remained at the feeding sites was negatively correlated to the duration of snow cover and temperature. In the present study, temperature and snow depth did not influence the daily movements of bison, and the animals walked greater distances at the end of winter. Furthermore, snow depths of about 60 cm do not limit the movements of American bison, *Bison*

bison (e. g. Reynolds and Peden 1987). It is therefore likely that the weather conditions in the Białowieża Forest are rarely severe enough to impede bison movements and that the correlation found by Krasińska et al. (2000) can be explained by the bison's attendance at the feeding sites. American bison sometimes live in larger groups in winter than in summer (Meagher 1973). The mixed groups observed here were however generally smaller than the mean size of 17 recorded by Krasińska et al. (1987) for summer in the Białowieża Forest, which contrasts with the large aggregations seen at the feeding sites. It is therefore likely that food abundance is the limiting factor for group size of bison. In the Białowieża Forest, Krasińska et al. (1987) mostly found bison in deciduous forests in spring and autumn, whereas these animals were usually in mixed coniferous forests in summer. In the present study, bison of the meadow/forest mosaic selected deciduous forests as a foraging ground. It therefore appears that deciduous forests offer European bison with the best feeding possibilities from autumn through to spring.

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