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Utilisation of the terrain by wisents in Bieszczady Mountains

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Abstract: Analysed were frequency of use and preferences of wisents (*Bison bonasus* L.), towards three selected categories of terrain features: valleys, slopes and mountain ridges in Bieszczady. The most frequented category, regardless of the season were slopes (almost 99%), and a tendency for avoidance has been found towards valleys (Ivlev's index values: -0.88 in winter and -0.93 in summer). In summer, wisents were most frequently recorded at elevations between 550 – 849 m a.s.l. while in winter between 450 – 749 m a.s.l. There were no records of wisents' presence in summer below 450 m a.s.l. and in winter above 949 m a.s.l. Posssible reasons for such habitat selection patterns were discussed.

Key words: wisent, Bieszczady Mountains, terrain, habitat use

Introduction

Although in the past, wisents inhabited both lowland and mountainous parts of Europe, and even names of old villages provide evidence for their presence in higher elevations, since the population bottleneck and beginnings of species restitution at Białowieża, they are generally perceived as lowland animals (Pucek *et al*. 2004, Krasińska, Krasiński 2007).

There were even raised doubts, during the preparatory phase for introductions of wisents to the Carpathians, whether those animals will be able to cope with steep slopes. Nevertheless, already almost 50 years after first wisents were reintroduced to Bieszczady Mountains, all available evidence proves, that at least terrain of medium size mountains (just below 1500 m above sea level) does not create any difficulties for their movements and use of the habitat (Perzanowski, Paszkiewicz 2000; Perzanowski 2001; 2005; 2008; Perzanowski *et al*. 2006). Nonetheless, knowledge on preferences of this species towards various aspects related to the terrain (e.g. elevation, parameters of the slope, ridge and the valley) is important for identification of optimal sites for future introductions, corridors suitable for migrations, and the assessment of potentials for the extension of present spatial distribution of the species (Perzanowski, Olech 2007). This paper, based on data collected during 5 years

of monitoring of so called "western Bieszczady" herd, is supposed to answer basic questions related to the preferences of wisents towards selected aspects of the terrain.

Study Area, Materials, Methods

Utilisation and preferences of wisents towards various aspects of the terrain was analysed on the basis of data collected for so called western herd of Bieszczady, inhabiting the area administered by forest districts of: Baligród, Komańcza, Cisna and Lesko. The origins of this population date back to the late 80-ties of XXth century, when animals belonging to Lowland-Caucasian line, brought for the acclimatisation from various breeding centres of Poland to the enclosure at Wola Michowa (Komańcza Forest District), were gradually released to the wild. This part of wisent population in Bieszczady Mountains is monitored since 1998 (Perzanowski 2001, 2005, 2008), but in this paper used were data obtained since winter 2002/2003 i.e. the beginning of the project, supported by a Directorate of State Forest Administration at Krosno, focused on a continuous monitoring of Bieszczady wisent population, until summer of 2007.

The extend of this population home range was assessed on the basis of data on wisents' presence, collected during field observations (random – performed by the personnel of State Forests and routine – carried out by the staff of Carpathian Wildlife Research Station). Those data were supplemented with data from ground telemetry of 5 individuals being radiocollared at this area. In total, 4422 records of wisents' presence (1588 from winter and 2834 from summer seasons) were used for this analysis. Frequency distribution, elevation above sea level, and availability of selected aspects of the terrain were analysed with ArcView 9.2.

Categorisation of terrain features was based on the standard system used in forestry (Smykała 2003), within which distinguished are:

1. flat grounds
2. river valleys
3. hollows
4. hollows without outflow
5. basins
6. foot slopes
7. low slopes
8. mid-slopes
9. upper slopes
10. slopes
11. ridges
12. tops
13. flattening

Since the absolute majority of records of wisents' presence: over 98% in winter and in summer comes from slopes, for final analysis, categories: 1, 2, 3, 4, 5, 6 were grouped into one: "valleys", categories: 7, 8, 9, 10 into: "slopes", categories: 11, 12 and 13 into: "mountain ridges", so finally we made comparisons among 3 collective categories:

– valleys
– slopes
– mountain ridges

For certain types of features (e.g. swamp, rocky cliff, some roads, buildings) – 42 within winter and 17 in summer ranges, there was no description at forestry maps, allowing to assign them to terrain categories. However, for all of them determined was their elevation above sea level. For the assessment of vertical distribution of wisents, distinguished were 7 elevation ranges of 100m each, starting from 350 m above sea level up to 1049 m a.s.l.

Preferences of wisents towards various aspects of the terrain were estimated with Ivlev index (Gras, Saint-Jean 1982).

Results

Regardless of the season, an absolute majority of records of wisents' presence during all years of the study (on average over 98%), comes from slopes. Wisents were rarely observed in valleys, and only a little more frequently along mountain ridges (Tabl. 1).

Table 1. Numbers of records of wisents' presence in consecutive summer and winter seasons, within three distinguished categories of terrain features.

Season	**summer**	**winter**
valleys	9	8
slopes	2780	1528
mountain ridges	28	10

In summer seasons, wisents were most frequently recorded at elevations between 550–849 m a.s.l. while in winter between 450–749 m a.s.l. There were no records of wisents' presence in summer below 450 m a.s.l., and in winter above 949 m a.s.l. (Tabl. 2)

Table 2. Numbers of records of wisents' presence in summer and winter seasons of the study, within consecutive elevation ranges.

Elevation in m a.s.l.	350–449	450–549	550–649	650–749	750–849	850–949	950–1049
summer	0	61	819	1359	453	135	6
winter	15	452	794	311	10	6	0

The availability of distinguished categories of terrain features was estimated as a sum of their area at forest subcompartments administered by State Forests (such data were not possible to obtain for privately owned forests), situated within or being crossed by a boundary of MCP, estimated for this population in a given season. Those values varied greatly between almost 90% for slopes, and depending on the season 1.95–2.26 % for mountain ridges (Tabl. 3a, b).

Table 3a. Availability of distinguished categories of terrain features (%) within MCP and the percentage of records of wisents' presence there in summer seasons during the studied period.

Distinguished terrain features	Availability		Records of wisents' presence	
	area (km^2)	% of MCP	No.	%
valleys	408.49	8.45	9	0.32
slopes	4335.57	89.60	2780	98.69
mountain ridges	94.53	1.95	28	0.99

Table 3b. Availability of distinguished categories of terrain features (%) within MCP and the percentage of records of wisents' presence there in winter seasons during the studied period.

Distinguished terrain features	Availability		Records of wisents' presence	
	area (km^2)	% of MCP	No.	%
valleys	353,75	8,38	8	0,52
slopes	3770,45	89,35	1528	98,83
mountain ridges	95,50	2,26	10	0,65

The assessment of wisents' preference towards three distinguished categories of terrain features shows a weak tendency for the preference of slopes in both seasons, while valleys and mountain ridges were avoided in vegetative and winter seasons (respectively: –0.93 to –0.88 and –0.33 to –0.55). (Tabl. 4).

Table 4. Values of Ivlev's index reflecting seasonal preferences of wisents in Bieszczady towards selected categories of terrain features.

Distinguished terrain features	Vegetative seasons	Winter seasons
valleys	–0.9270	–0.8831
slopes	0.0483	0.0504
mountain ridges	–0.3265	–0.5533

Discussion

The problem of selection among various aspects of the terrain by free ranging wisents is so far almost totally unknown, because a majority of our knowledge on this species originates from lowland Białowieska Primeval Forest, where variability in elevation barely exceeds 30 m (Rouys 2003; Daleszczyk *et al.* 2007, Okołów *et al*. 2009). Selection among various habitat features including the relief, was however an object of a number of studies on large ungulates, where discussed were habitat selection patterns typical for various species, and their reasons, depending on a season, climatic conditions, plant phenology, predators' pressure, human related disturbance etc. (Jeppesen 1984; Bobek *et al.* 1992; Kendall *et al.* 2000; Gavashelishvili 2004; Namgail 2006; Klich in press).

Dominating proportion of slopes as a feature where wisents were recorded the most frequently (Tab. 1; 3 a, b) is obvious, considering the relief of this mountain range, where valleys are generally narrow and deeply cut, so slopes occupy the majority of the available area. This is very well reflected by calculated preference index, where the value for slopes indicates only a weak preference (Tabl. 4).

In case of wisents in Bieszczady, undoubtedly an important driving factor for selection among lower and upper elevations are phenological phases of plant development, and connected with them, their seasonal vertical movements, which already was described in the paper by Perzanowski *et al*. (in press). Significant there may be also differences in extreme temperatures connected with elevation and accumulation of snow (Michna, Paczos 1972; Winnicki, Zemanek 2009). Data presented in this paper confirm that elevation ranges frequented by wisents in summer and winter differ by at least 100 – 200 m (Tabl. 2).

With no doubts as well, decision of animals whether stay at slopes or move along ridges or valleys is influenced by climatic conditions, especially the depth of snow cover in winter, which greatly differs among various slope expositions, and the wind which belongs to factors having the most pronounced influence upon costs of thermoregulation (Parker, Robbins 1983).

Considering, that wisent is the largest terrestrial mammal of this region, and cases of predation on this species were so far recorded only very rarely, a preference towards ridges as described for Argali sheep, being a component of anti-predation strategy, could not be expected in this case (Klich in press). In some cases, movements along ridges as not requiring climbing of slopes may be connected with a choice of a route that is energetically less expensive (Parker *et al.* 1984). Nevertheless, the effort necessary for getting up to the ridge and increased exposition to the wind along such structures, may explain a negative value of preference index towards ridges in case of Bieszczady wisents.

Interesting however in this case is quite obvious avoidance of valleys by wisents in Bieszczady (Tab. 4.). Valleys or related terrain features e.g. flat grounds, hollows, basins etc. are generally situated at low elevations, with less snow and higher temperatures in summer, and a good access to water which supports the growth of plants, should theoretically belong to most frequented parts of wisents' home range. An explanation there can be a fact, that in mountainous area, valleys and flat grounds are sites being also the most intensively used by people, including farming, settlements and communication routes. Strong tendency for avoidance of roads by wisents of Bieszczady depending on traffic volume was already discussed in an earlier paper (Perzanowski *et al*. 2007). Human related distribution pattern was also described for lynx in Scandinavia (Basille *et al*. 2009), and a spatial response of white-tailed deer towards forest exploitation in central Apallachians (Campbell *et al*. 2004).

Nevertheless, more detailed explanations of selection patterns towards various aspects of the mountain terrain need further studies. The most important seems to be the selection among variously exposed slopes depending on weather and the season, as well as the relation between seasonal vertical movements and development of ground flora at various elevations.

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Wykorzystanie rzeźby terenu przez żubry w Bieszczadach

Streszczenie: Analizowane były częstość użytkowania oraz preferencje żubrów (*Bison bonasus* L.) należących do zachodniej subpopulacji bieszczadzkiej, w odniesieniu do trzech wyróżnionych kategorii rzeźby terenu: dolin, stoków i grzbietów górskich. Kategorią najczęściej użytkowaną przez żubry, niezależnie od sezonu były stoki (niemal 99%). Stwierdzono natomiast wyraźną tendencję do unikania dolin (wartości wskaźnika Ivleva: -0.88 w zimie i -0.93 w sezonie wegetacyjnym.

Analizie, poddano również dane o stwierdzeniach obecności żubrów, w obrębie 100 metrowych przedziałów wysokości nad poziomem morza (od 350 – 1049 m n.p.m). Na badanym obszarze nie wykazano obecności żubrów poniżej wysokości 450 m n.p.m. w sezonie wegetacyjnym oraz powyżej 949 m n.p.m. w zimie. Najczęściej użytkowanymi były przedziały wysokości: 450–749 m n.p.m. w zimie i 550–849 m n.p.m. latem.

Niewątpliwie w Bieszczadach, jednym z decydujących czynników o doborze siedlisk przez żubry jest dostępność pokarmu, tak więc ich sezonowe przemieszczenia związane są przede wszystkim z fazami fenologicznymi roślinności w obrębie przedziałów wysokości nad poziomem morza. Z uwagi na fakt, że żubr jest największym ssakiem lądowym Europy i jak na razie rzadkie przypadki stwierdzeń drapieżnictwa wilków czy niedźwiedzi w odniesieniu do tego gatunku, wykluczają raczej użytkowanie grzbietów górskich, jako strategii unikania drapieżników. Dodatkowo, koszty energetyczne związane z pokonaniem różnicy wysokości oraz zwiększona w takich miejscach ekspozycja na wiatr, tłumaczą tendencję do unikania przez żubry obszarów położonych wzdłuż grzbietów górskich.

Stwierdzona tendencja do unikania przez żubry dolin, pomimo łagodniejszych tam relatywnie warunków klimatycznych i łatwej dostępności wody warunkującej obfitość bazy pokarmowej wytłumaczona być może przez fakt, że w rejonach górskich, doliny pozostają pod największą presją antropogeniczną (szlaki komunikacyjne, zabudowania, intensywne uprawy). Niemniej szczegółowe wyjaśnienie przyczyn preferencji siedliskowych przez żubry wymagać będzie badań nad zależnością obecności żubrów w odniesieniu do ekspozycji stoku w poszczególnych sezonach i różnych warunkach pogodowych oraz procesu rozwoju wegetacji w aspekcie wysokości nad poziomem morza.