Assessment of weed invasion at bait sites in the Mátra Landscape Protection Area

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Abstract: The effects of wild game feeding have been widely investigated, but little consideration has been given to it in Hungary. Feeding places for capturing and shooting wild boar (so-called bait sites) are spreading in some regions and they have a growing impact on vegetation. The aim of our study was to assess the extent of weed invasion in two different aspects. For this purpose, we selected two types of bait sites, located in forest and clearing areas, in the Mátra Landscape Protection Area. Four transects were arranged from the centre of the bait sites, each consisting of 22 1×1m quadrats, where vegetation surveys were carried out in May and August 2016, 2018. The results revealed a stress gradient along the transects: the proportion of weeds decreased further from the centre, while indigenous plant species increased. Bait sites in clearing areas were most invaded by weeds, possibly due to its greater accessibility. Here we detected a significant difference between plant communities as T4 weeds dominated in August. Conversely, bait sites in the forest were less weedy with similar vegetation states between the two surveys which had a sparse understory cover.

Keywords: wild game feeding, weed infection, habitat degradation, biological invasion

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Introduction

Supplementary feeding and baiting of game wildlife is a widespread conservation and management practice in the world (Selva et al. 2014). It is particularly common throughout Europe and North America (Putman and Staines 2004; Inslerman et al. 2006; Apollonio et al. 2010; Arnold et al. 2018).

Most studies focus on animal populations and only a few of them deal with the effects on vegetation. Some research indicates that supplementary feeding impacts the local environment at feeding sites, modifies plant-herbivore interactions and the high browsing impact often causes locally reduced shoot growth (Ginnett et al. 2001; Smith et al. 2004; Heltai and Sonkoly 2009; Mathisen et al. 2015).

Study of the effects of supplementary feeding on the herbaceous layer are specifically neglected. A limited number of publications describe feeding places as focal points of exotic species invasion and they can induce severe habitat degradation (Kosowan and Yungwirth 1999; Spurrier and Drees 2000; Rinella et al. 2012).

In Hungary the importance of supplementary feeding is low due to the mild winters. However, feeding places for capturing and shooting wild boar (so-called bait sites) are spreading and they have a growing impact on surrounding vegetation. A bait site is a small clearing established approx. 30 to 50 metres from hunting blinds. Usually corncobs or corn seed is scattered at the sites, although agricultural and food industry by-products (e.g. fresh and dried beet slices, marc, molasses, bran or wheat middlings) are used in many cases. Currently regular feeding implemented year-round involves more than 30,000 feeding places; the total weight of nutritive mixes used exceeds 60,000 tons per year (Heltai and Sonkoly, 2009). Additionally, feed is generally scattered on the ground (Selva et al., 2014).

Taking into consideration that agricultural products – in particular cereals – contain weed seeds (Fay, 1990; Shimizu, 1998; van Barneveld, 1999; Shimono 2008; Wilson et al, 2016; Gervilla et al, 2019) it can lead to the invasion of noxious weed species in natural habitats. Furthermore, detrimental impacts are enhanced by anthropogenic activity due to feeding, increased game density, bare and degraded soil and increased availability of nutrients. This clearly indicates the potential dangers of frequent bait use and related placement of animal feed contaminated by weed seeds. Though, weed invasion typically extends to the intermediate environment of the bait sites (Rusvai 2018), valuable habitat patches can also be destroyed and bait sites may be the focal points of biological invasions. Strong evidence of this was found by a national survey according to which annual ragweed (*Ambrosia artemisiifolia*) was present in almost all of the nearly one hundred feeding places included in that study (Hirka and Csóka 2009).

The aim of our study was the spatial and temporal investigation of the effects of the bait sites on the herbaceous layer in the Mátra Landscape Protection Area. We examined two types of bait sites; three bait sites were in clearing areas and three bait sites in forests. Vegetation surveys were carried out in two parts, in May and August of 2016 and 2018. We hypothesized (i) a stress gradient along the transects where the proportion of weeds decreased from the centre of the bait sites, while the natural species increased. (ii) There would be differences between the weed invasion of bait types and (iii) we assumed a temporal difference in plant communities where there would be more weed species in August than in May.

Materials and Methods

Study area

The study was carried out in a typical Central European low mountain region, in the Mátra Landscape Protection Area. Mátra is part of the North Hungarian Mountain Range. The study sites belong to a submontane region. Depending on the altitude mean annual temperature vary between 6.0 and 8.0°C. Annual precipitation at the highest peaks and lower slopes is approx. 800 to 850 mm and 600 to 700 mm. Fast-flowing mountain streams can mainly be found at higher altitudes, while water shortage can be experienced in the southern slopes (Földváry, 1988; Bereczki et al., 2014).

Table 1. Species number and the proportion of the degradation indicator species on the bait sites (bait sites average in the examined aspects)

		2016		2018	
		No. of species	The proportion of degradation indicator species	No. of species	The proportion of degradation indicator species
C average	May	57,7	28,1%	64,0	34,1%
	August	60,3	34,7%	59,7	37,7%
F average	May	43,3	19,7%	34,7	21,5%
	August	45,3	25,3%	35,0	22,9%

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Table 2. The most abundant degradation indicator species and their cumulative coverage on the bait sites

2018		Cumulative coverage of the degradation indicator species (%)	The 3 most abundant degradation indicator species and their cumulative coverage (%)		
			1.	2.	3.
C1	May	765	Polavi (273)	Capbur (221)	Cynoff (87)
	August	2603	Xanspi (909)	Polavi (700)	Datstr (604)
C2	May	1645	Capbur (599)	Broste (336)	Polavi (285)
	August	2171	Polavi (967)	Triino (603)	Xanspi (222)
C3	May	3896	Broste (1350)	Polavi (1025)	Capbur (423)
	August	2870	Polavi (1334)	Broste (794)	Balnig (252)
F1	May	12	Helann (5)	Ambart (5)	Galapa (1)
	August	10	Ambart (5)	Polavi (4)	Galapa (1)
F2	May	100	Conarv (43)	Rumcri (26)	Polavi (15)
	August	88	Conarv (28)	Polavi (17)	Rumcri (16)
F3	May	94	Rumcri (43)	Chealb (14)	Polavi (9)
	August	92	Chealb (20)	Rumcri (19)	Polavi (18)

The examined area was located at lower elevation of the mountain, near Markaz that belongs to the oak forest belt. The forests are mainly semi-natural, dominated with mainly commercial forestry tree species and characterized by intensive wild game management. The majority of the area is part of the hunting grounds of Egererdő Zrt, while other hunting societies and communities undertake hunting and wildlife management tasks in the remaining forest. Main wild species are wild boar (*Sus scrofa*), mouflon (*Ovis aries*), European roe deer (*Capreolus capreolus*) and red deer (*Cervus elaphus*) (Katona et al., 2011).

Field experiment

We selected two types of bait sites, located in forest areas (F1, F2, F3) and in clearing areas (C1, C2, C3). Four transects were arranged from the centre of the bait sites, each consisting of 22 1 m^2 tangential quadrats, in which vegetation surveys were carried out with visual estimation of percentage cover.

The transects were directed in four directions with a relative angle of 90 degrees. The first direction was determined by a random number generator set between 0 and 360 degrees. In case a species was represented in a quadrat its value was at least 1%. Depending on the vegetation density abundance values may have exceeded 100%. Centres of the bait sites were determined by the actual placement of the feed station, clearly visible in each case.

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The survey was carried out in May and August 2016 and 2018 with 3-3 repetitions per bait sites. Altogether, 88 (4×22) quadrats were set down and examined for each bait site. 528 and 1056 examination units were checked in one examination period and during the entire survey.

Results

A total of 175 plant species were surveyed in the study sites (6 bait sites, 2 months, 2 years) with more than a quarter (28,6%) of degradation indicator species according to the Borhidi ecological indicator value categories (Borhidi 1995). The proportion of degradation indicator species was always higher in the clearings than in the forest (ii), and in general it was higher in August than in May (iii) (*Table 1*.). The average proportion of degradation indicator species in the clearing was more than one third of the species. The maximum was 44,4% (C3, 2018 August). This proportion was lower in the forests. The average was about quarter of the species, and the maximum was only 34,7% (F2, 2016 August). The species count was also different. It was always higher in the clearings with a maximum of 77 species in C1 (2018 May). While in the forest we found 28 species (F1, 2018 August) and the maximum was only 49 species (F2, 2016 May). The number of plant species was highly variable during the examined months. It can be explained by the typical weather conditions and life form characteristics of the plants.

The interannual difference was not remarkable, but 2018 was slightly more wet, and it improved the conditions of weed germination in clearing areas with high sunlight exposure. This might be the reason for the higher proportion of degradation indicator species. In the forest, the high level of groundwater along with the high canopy closure discouraged growth of plant species, resulting in a decrease in species number and in weed proportion as well.

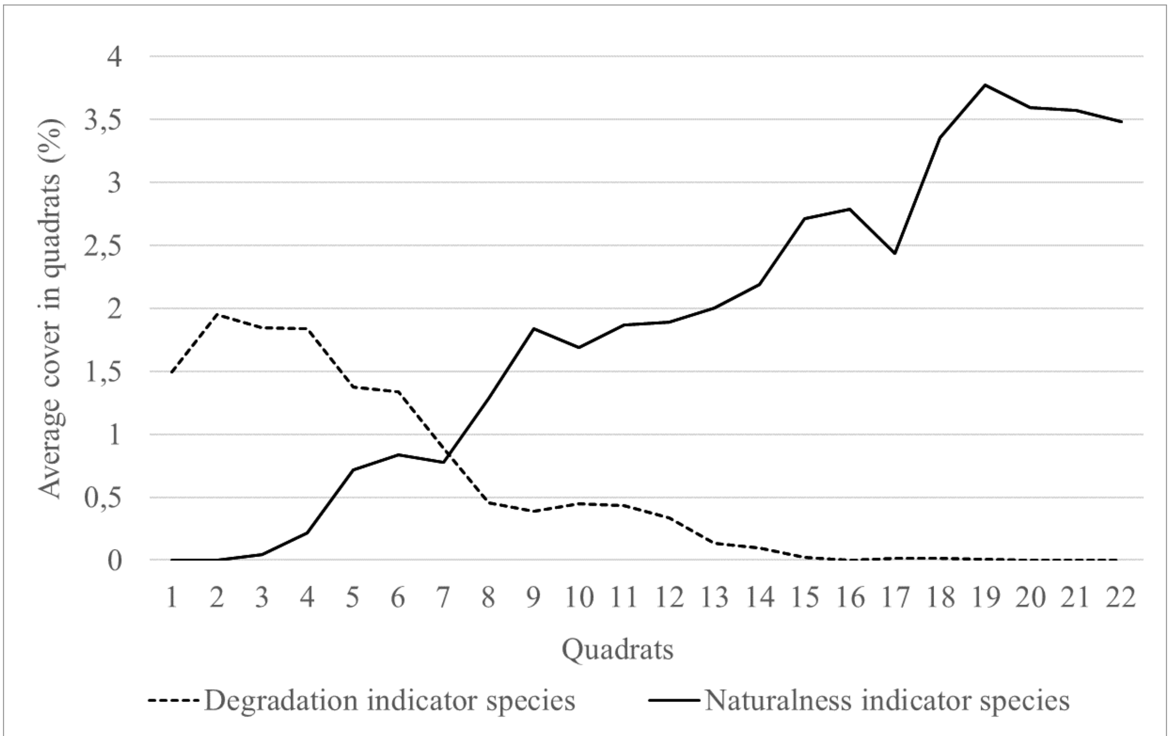

Figure 1. The average proportion of degradation and naturalness indicator species in quadrats (C1, 2018 August)

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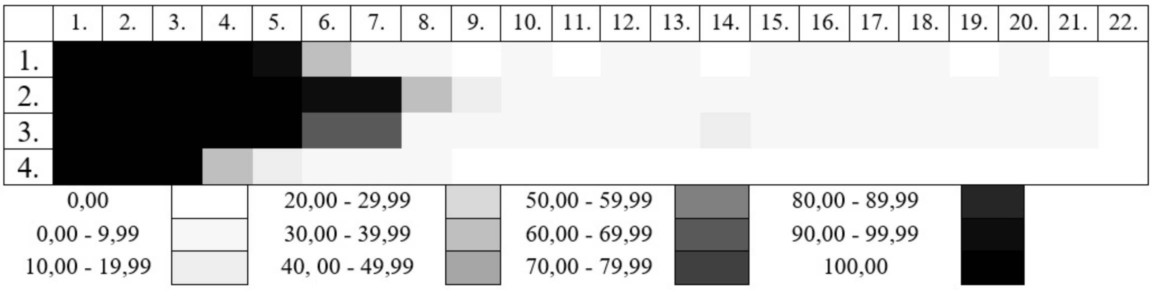

Figure 2. The cover of the degradation indicator species in quadrats (C2, 2018 August; rows: the 4 transects; columns: the 22 quadrats)

Focusing the species rank based on their cumulative coverage (*Table 2*.), it is clear that weed species were dominant in August not only by species count but in abundance as well (iii). The most abundant weed species in May were T1 and T2 weeds, e.g. *Capsella bursa-pastoris* and *Bromus sterilis*. In August, T4 weeds dominated (e.g. *Polygonum aviculare*, *Xanthium spinosum* and *Datura stramonium*) in the clearings. Additionally, it is evident that bait sites in the clearings were the most weed infected. In these places the cumulative cover of the degradation species was very high and, in general, it continued to increase in August. Forest bait sites were less weedy, their state was similar in the two surveys with a low cover of degradation indicator species and a sparse understory cover.

We could confirm the stress gradient hypotheses (i) over the two years, in all aspects and at all bait sites. If we consider the average number of the degradation and naturalness indicator species in the quadrats, it is clear that the number of the degradation indicator species is the highest in the centre of the bait sites and it decreases with distance. Naturalness indicators became dominant from the 8th to 10th meter (*Figure 1*.).

The stress gradient can also be detected based on species abundance (i). This was evident at all of the feeding sites and most significant at bait sites in the clearings. If we look at the cover of degradation indicator species in the quadrats (from the total cover per sites), it is clear that the abundance of the degradation indicator species is very high, often 100%, in the centre and it decreased with distance (*Figure 2*.).

Discussion

Based on the survey of the bait sites in the Mátra Landscape Protection Area, it can be concluded that the bait sites can cause significant degradation in natural habitats. Weed invasion typically extends to the immediate environment of the bait sites. We detected a stress gradient along the transects, originating from the centre of the bait sites. In general, the degradation indicator species are present in higher abundance only until the 8th-10th meter. Then it almost disappears and the natural plant species become dominant. Rinella et al. (2012) and Mathisen et al. (2015) had similar results. They examined the effects of supplemental winter feeding and they found that the degradation did not appear to extend great distances. Lloyd et al. (2006) also found that the invasive and dangerous weedy species are present only near to touristic structures similar to bait sites.

We found a significant difference between the invasiveness of examined sites. Forest bait sites were less weedy and had a sparse understorey in the two examined aspects, possibly due to the dense canopy closure (Honnay et al. 2002; Ibáñez et al. 2009; Burst et al. 2017). However, bait sites in the clearings proved to be highly degraded. The

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stress gradient mentioned and the temporal variables between the examined aspects were more prevalent on these sites due to greater accessibility (Wesson and Waering, 1969; Pons, 2000).

Consequently, if feeding sites are located in small, valuable habitat patches (such as the examined forest clearings), degradation of their vegetation, species loss or the complete loss of habitat can happen and bait sites may be the focal points of biological invasions. Therefore, we recommend the regulation of the quantity and quality of forages used at bait sites and the revision of related laws. However, it is also suggested that bait sites mainly be positioned in forests, and possibly not in clearings or near protected areas.

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