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The structure of habitat used by Hazel Grouse *Bonasa bonasia* during winter

Struktura zimskega habitata gozdnega jereba *Bonasa bonasia*

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A study was carried out over three winter seasons (1995-1998) to evaluate the most important habitat parameters for Hazel Grouse *Bonasa bonasia* on the forest stand scale. The study area was situated in the Southern Limestone Alps in Austria. It was divided into two parts, reflecting two different forest management strategies: (1) SIMPLE, an age class system with clear-cutting, and (2) MULTI, multi-layered stands with selection felling. An analysis of the roosting sites and habitat use was conducted, as well as a dropping investigation and diet analysis. Monotonous even-aged forest stands, as well as multi-layered old forests, can provide Hazel Grouse habitats but, compared to the latter, monotonous forests are risky habitats because the suitability can depend on only one factor. The habitats in the age class forest are limited in time, whereas multi-layered forests offer habitats for a full rotation period.

Key words: Hazel Grouse, *Bonasa bonasia*, winter habitat, habitat parameters, winter ecology, Austria

Ključne besede: gozdni jereb, *Bonasa bonasia*, zimski habitat, parametri habitata, zimska ekologija, Avstrija

1. Introduction

Negative effects of forestry on tetraonids are well documented and discussed in Central Europe (Swenson 1993, Klaus 1994, Tucker & Evans 1997). Multi-layered forests with high plant diversity have, in the past, been typical of small farm forests in Austria. They have usually been managed by single tree selection felling or group cutting, with natural regeneration. 46% (3.8 mill ha) of Austria is covered by forest; 53% of that area belongs to small forest owners with forest properties up to a size of 200 ha. Another common type of forest is the even aged forest with clearcutting and afforestation. Clearcuts are limited in size to two hectares, while most of them are smaller. According to Swenson & Angelstam (1993) Hazel Grouse *Bonasa bonasia* inhabits the early secondary successional stages as well as old growth forest. One common habitat denominator is dense cover from the ground up to two meters in height (Swenson 1993). The importance of a specific habitat structure for Hazel Grouse has already been mentioned by Valentinitsch (1892). Similarly, Bergmann *et al.* (1996) concluded that the structure of the habitat within multi-layered forests is perhaps the most important factor of all habitat requirements for Hazel Grouse. Moreover, Swenson (1991) detected a relationship between forest structure and the survival rate of Hazel Grouse. Predation rate was the highest in dense young forest stands, whereas the safest forest type consisted of two layers and was about 100 years old.

The aim of this study is to describe key indicators for the type of vegetation structure used of by Hazel Grouse and to analyse the effects of different forest management strategies.

2. Study area and methods

2.1. Study area

For our study we selected an area in the southern Limestone Alps, at the centre of the distribution zone

Figure 1: Situation of the study area in the Southern Limestone Alps, Carinthia, Austria

Slika 1: Lega območja raziskave v Južnih apneniških Alpah na avstrijskem Koroškem

of the Hazel Grouse where its occurrence is high. It is situated in the province of Carinthia in Austria at an elevation of 635 m a.s.l. (Figure 1) and has forest management regimes of selection felling as well as clearcutting. The area is characterised by a climate with alpine and illyrican influence (mean precipitation 1244 mm per year, and a mean temperature of 7.7°C). The specific climate and the limestone bedrock have resulted in a high vegetation diversity, with 38 different tree and shrub species and nine dwarf shrub species. Detailed habitat analysis was carried out on the core study area, which was limited to 41.75 ha.

2.2. Methods

The study area was separated into two parts (SIMPLE and MULTI) concerning their different type of forest management. MULTI was characterised by a multi-layered forest structure resulting in a very high plant diversity. The size of the area was 20.5 ha, of which 19 ha was covered by forest. Scotch Pine *Pinus sylvestris*, Norway Spruce *Picea abies*, Beech *Fagus sylvatica* and Larch *Larix decidua* dominate in the canopy. SIMPLE was characterised by a poor plant diversity and a monotonous vertical structure. The size of the area was 21.25 ha with 17.5 ha forested dominated by Norway Spruce (Figure 2).

Roosting site and habitat analyses were carried out in each of the two parts of the study area, to compare the ecological effects of the different forest management strategies. The two parts (SIMPLE and MULTI) were compared with respect to their habitat structure, vegetation and plant species composition. For the analysis of the roosting sites, we used 32 sample plots, each of 5 m radius. These plots were compared with 54 randomly chosen control points of the grid map. In each plot we surveyed the height of every individual tree and shrub, if DBH (= Diameter Breast Height at a height of 1.3 m) was more than 2 cm. The proportion of canopy closure was measured by Leaf Area Index (LAI) with the help of a Canopy Analyser (LAI 2000). LAI was measured as a ratio of green leaf area and base area.

To survey the habitat structure, the study area was described by grid system mapping of 162 0.25 ha plots. The corners of the squares were marked in the field by coloured ribbons or poles. A detailed habitat analysis was conducted in each of the squares separately for each layer (canopy, middle and shrub layer). The following parameters have been surveyed: the average diameter of trees at a height of 1.3 m (DBH), the average height of the trees, type of mixture, phase of age (not the years, but the stage of succession of a tree are important), percentage of different tree species, cover in ten-percent steps and the percentage of gaps within a square. Within the shrub layer (up to 2.5 m in height) we surveyed visibility with a cover board, canopy cover of the shrub layer in ten-percent steps, small spruce groups in thickets and ground vegetation.

The intensity of use of each square by Hazel Grouse was determined by collecting droppings over three winters (1995-1998). The collection was done systematically in all squares during five days after a period of four weeks without snow fall. Each site with five or more droppings was recorded. Roosting and feeding trees have been marked in the field by coloured ribbons or poles.

To determine the winter feeding spectrum of Hazel Grouse the collected droppings were used (BREUSS 1999).

For the statistical analysis we chose t-test and discriminant analysis (SPSS W6 PC-Version).

3. Results

Over three winter periods, 67 roosting trees and 37 feeding trees were marked. 16 roosting trees (24%) were used more than once during a winter season and over several years. Especially in a dense tree regeneration phase, the same tree was used several times by Hazel Grouse. The analysis showed that a preferred roosting site is characterised by a large number of Norway Spruce and Grey Alder *Alnus incana*. All the roosting trees (n = 32) were Norway Spruce, with an average DBH of 13.5 cm and an average height of 9.3 m. Roosting sites exhibited significantly higher shelter (LAI = 2.72,

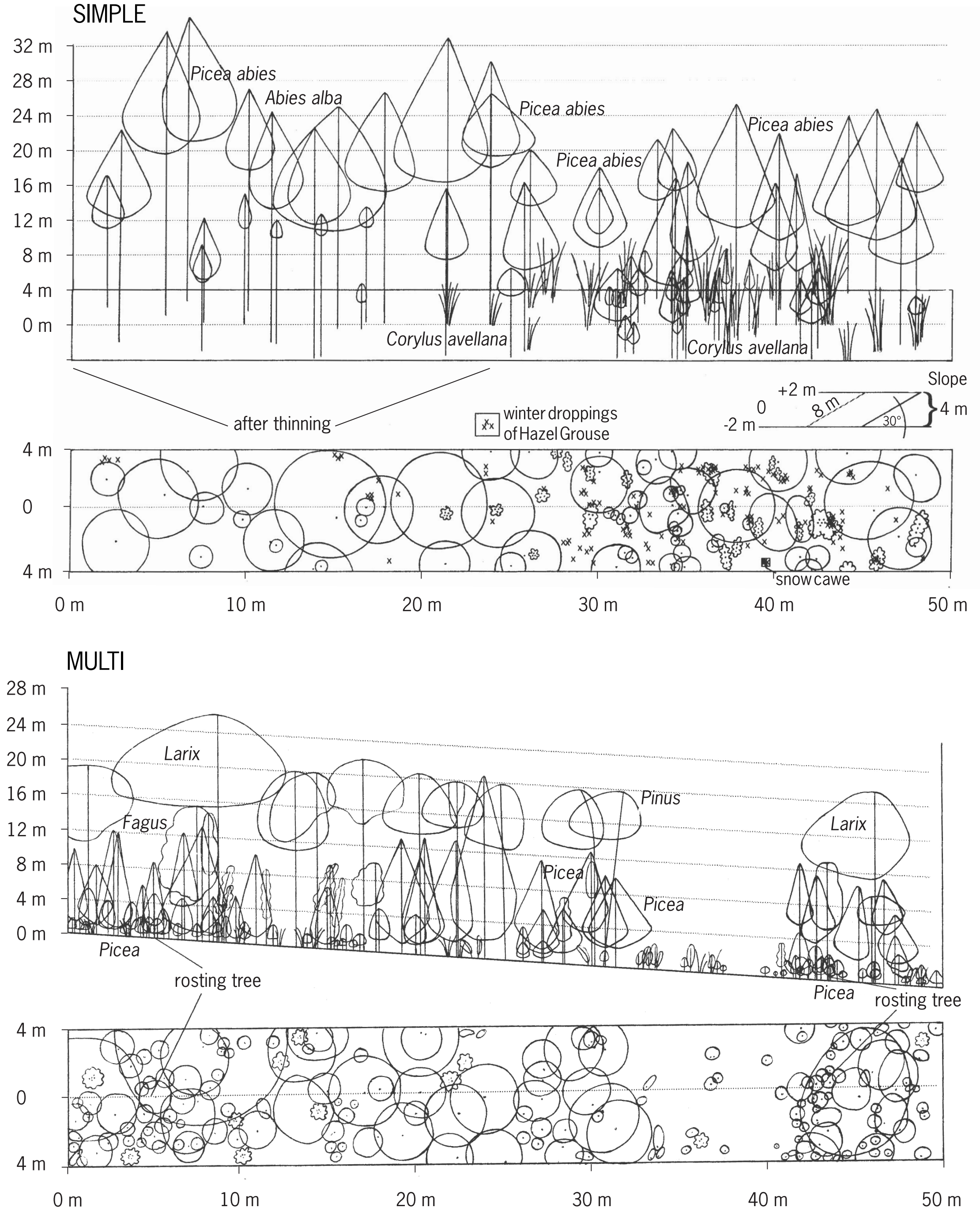

Figure 2: Cross sections of two different types of Hazel Grouse *Bonasa bonasia* habitat, SIMPLE and MULTI. Note the different vertical forest structure. In SIMPLE we additionally show the difference in use of thinned and unthinned areas by Hazel Grouse in the winter season 1997/98.

Slika 2: Prerez dveh različnih tipov habitata gozdnega jereba *Bonasa bonasia:* enostavnega (SIMPLE) in večplastnega (MULTI). Razlika je v vertikalni strukturi obeh tipov gozda. V enostavnem je dodatno prikazana razlika v uporabi razredčenega in nerazredčenega območja gozdnega jereba pozimi 1997/1998.

SD = 0.568) than control points (LAI = 1.77, SD = 1.040; t = 4.55, p < 0.0001, n = 69). A comparison of the proportion of coniferous and deciduous tree and shrub species at the control points and roosting sites provided the following result: at the control points, we registered an average proportion of 73.1% coniferous species and, at the roosting sites, 79.8% (Table 1). A more detailed observation of the deciduous species stressed the importance of shrub species. At the control points we registered an average proportion of 53.1% shrub species and, at the roosting sites, 69.3% (Table 1).

Table 1: Frequency of roosting sites of Hazel Grouse *Bonasa bonasia* in coniferous and deciduous species

Tabela 1: Primerjava prenočišč gozdnega jereba *Bonasa bonasia* glede na iglasti in listopadni gozd

	Coniferous	Deciduous
	73.1%	26.9%
Available	Tree species	Shrub species
	46.9 %	53.1 %
	79.8%	20.2%
Used	Tree species	Shrub species
	30.7%	69.3%

For the SIMPLE forest age class system four factors explained the difference between used and unused squares (Table 2). Canopy cover in the upper layer was determined as the most important variable for the differentiation of squares with and without records of Hazel Grouse, followed by the cover of Hazel *Corylus avellana* in the shrub layer. Small spruce groups in thickets were a significant parameter for explaining the use of a grid-square in both areas. The importance of cover was emphasized additionally by the frequency of squares with pole stands composed of 100% Norway Spruce in the canopy layer and with Hazel in the shrub layer, being used 13.4 times more frequently than those with a smaller Norway Spruce percentage (n = 61). Stands with only Scotch Pine in the upper layer and without undergrowth were strictly avoided by the birds (Table 2).

Within the multi-layered forest (MULTI), ten variables regarding the vegetation characteristics could be detected as important factors for differences between squares with and without records of Hazel Grouse (Table 3). Range of sight in the shrub layer was identified as the most important variable followed by small Norway Spruce groups in thickets and Grey Alder in the upper layer as well as in the under growth. Monotonous stands with Scotch Pine in the canopy layer without undergrowth (negative parameter), and the number of tree species in the upper storey followed in importance. Further characteristics were the percentage of deciduous trees, percentage of cover in the shrub layer, the forest age class in the upper layer and the percentage of Larch in the upper storey (Table 3).

Table 2: Four habitat parameters accounting for the use of squares (n = 162) by Hazel Grouse *Bonasa bonasia* in SIMPLE (even aged forest) in the case of forest age class system (Wilks' Lambda = 0.392, χ^2 = 41.71, p = 0.273).

Tabela 2: Štirje parametri habitata, ki pojasnjujejo izbor kvadratov (n = 162) pri gozdnem jerebu *Bonasa bonasia* v enostavnem (SIMPLE) gozdu enake starosti (Wilks' Lambda = 0.392, χ^2 = 41.71, p = 0.273).

Habitat parameter	F	p
Canopy cover in the canopy layer	6.661	0.012
Hazelnut in the shrub layer	5.599	0.021
Small Norway Spruce groups in thickets	4.881	0.031
100% Scotch Pine in the canopy layer without undergrowth	9.451	0.003

The habitat structure of the study area was documented by cross sections of 50 m length in stands of both SIMPLE and MULTI (Figure 2). The

Table 3: Habitat parameters accounting for the use of grid squares by Hazel Grouse *Bonasa bonasia* within the multi-layered forest (MULTI) (Wilks' Lambda = 0.549, χ^2 = 31.47, p = 0.443).

Tabela 3: Parametri habitata, ki pojasnjujejo izbor kvadratov pri gozdnem jerebu *Bonasa bonasia* v mreži znotraj večplastnega (MULTI) gozda (Wilks' Lambda = 0.549, χ^2 = 31.47, p = 0.443).

Habitat parameter	F	p
Range of sight in the shrub layer	12.158	0.001
Small Norway Spruce groups in thickets	9.724	0.003
Alder in the canopy layer	7.700	0.007
Alder in the shrub layer	7.534	0.008
100% Scotch Pine in the canopy layer without undergrowth	7.563	0.008
Number of tree species in the canopy layer	6.287	0.015
Percentage of deciduous trees	6.059	0.016
Percentage of cover in the shrub layer	5.546	0.021
Trees of high age in the canopy layer	4.219	0.044
Percentage of Larch in the canopy layer	3.959	0.051

vertical projection of the intensively used, even-aged forest in SIMPLE shows a clear dominance of spruce in the upper layer. The position of the cross section was chosen in such a way that half the strip was thinned and the other half unthinned. By recording the positions of droppings on the 50 m section, a strong preference for the unthinned part with Norway Spruce and Hazel could be detected. The vertical projection of the cross section in MULTI shows at least three different layers and a much higher species richness in the vegetation than in SIMPLE. The high canopy layer was dominated by light demanding species like Larch and Scotch Pine. Norway Spruce and Beech formed the middle layer. Shrubs as well as Norway Spruce regeneration dominated in the shrub layer.

In the multi-layered forest the potential food supply was more diverse. The results of the diet analysis showed that in MULTI stands Hazel Grouse mainly used buds, twigs and catkins of shrubs (ten species), deciduous trees (nine species), dwarf shrubs (four species) and coniferous trees (four species) – altogether 27 different species. Additionally, leaves of plants of the ground layer were used as well. In the age-class forest, the plant spectrum was less diverse and included 13 different species (two shrub species, four deciduous tree, three dwarf shrub and four coniferous tree species). There, Hazel Grouse used mainly buds and catkins of Hazel, Alder, Aspen *Populus tremula* and the leaves of Wood Sorrel *Oxalis acetosella*.

Roosting trees were located on sites with the densest shrub layer. A large number of Norway Spruce and Grey Alder at the roosting site indicates an availability of cover and food. Within the Norway Spruce groups, most of the roosting sites were found in trees up to a height of 9 m. Temperature measurements which we took on roosting sites in dense Norway Spruce cones and in neighbouring mature stands without undergrowth showed differences of 1.5°C at average temperatures of about –3°C.

4. Discussion

Besides cover, dense Norway Spruce groups offer thermal benefits (Swenson & Olson 1991). Thompson & Fritzell (1988) created a model which indicates that coniferous roosts are the best alternative for reducing heat loss in Hazel Grouse. Repeated use of roosting trees is documented for Capercaillie *Tetrao urogallus* (Fuschlberger 1956) but not for Hazel Grouse. Roosting trees were used several times during one winter season and in different following winter seasons, in contrast to the results of Thompson & Fritzell (1988). The main reason for this difference can be the forest type. We explain the repeated use of roosting trees by the very good habitat quality in our study area and therefore small winter territories. Small winter territories lead to repeated use of "ideal" roosting sites. The small size of winter territories is emphasized by telemetry results (Zeiler 1998). Roosting sites were common in the forest layer at about 2 – 4 m in height. Shrubs offer better cover than broad-leafed tree species at that height. Based on the results in Table 3, the demand for more than twice as much shrub than tree species in the deciduous class stresses the importance of structure at roosting sites. Coniferous trees are preferred because of cover and thermal benefits. Although the use of roosting trees was common in our study area the birds also roosted in snow caves on forest openings or even on unploughed forest roads if the snow depth allowed it (Andreev 1977).

Within the forest age class system (SIMPLE), cover of the canopy layer and a cover of Hazel in the shrub layer was the most important for the use of a grid-square (Figure 2). In particular, a high percentage of Norway Spruce in pole forest stands influenced the habitat use in a positive way. Dense young groups of Norway Spruce stands in thickets were important for the habitat use in both parts of the study area. This is in agreement with the results of Swenson (1991) who detected a positive relationship between the amount of Norway Spruce stands in the habitat and the survival rate of birds, assuming enough food was available. While in the forest age class system shelter was important for the use of a square, within the multi-layered forest the number of tree species in the upper layer as well as the percentage of Larch and high age trees were essential. These three parameters are responsible for the structure of the canopy. Forests with a high percentage of light demanding species, like Larch and Scotch Pine, in the upper layer have a loose canopy structure and therefore more light can reach the ground layer. In Larch forest, a dense and good structured undergrowth offers better cover and food for Hazel Grouse. There the tree regeneration is able to grow in dense clusters preferred for night roosting sites by Hazel Grouse (Figure 2). Therefore, two opposing parameters can explain habitat use in the different age classes: dense cover in young stands versus light canopy layer in old stands. Dense cover in even aged pole stands can be associated with early successional stages which are generally identified as typical Hazel Grouse habitat (Valentinitsch 1892, Lieser 1993, Swenson 1993). On the other hand, a fragmented canopy with gaps in between corresponds to late successional stages of gap dynamics.

The density of the shrub layer, as well as the percentage of cover in this layer, were main important factors for habitat use in the whole study area. The denser the shrub layer the higher was the use by Hazel Grouse. Squares with even aged monotonous old-growth Scotch Pine stands without undergrowth, and squares with very poor forest structure were avoided by Hazel Grouse during winter.

The results of our analysis also indicate that shrubs with a high stem diameter have more stronger branches and a more plentiful supply of buds. These shrubs offer better cover and birds can climb more easily on them. A high stem diameter in shrubs thus results in greater availability of both food and cover.

The overall number of different tree and shrub species was not important for the use of a square. However, the results of the diet analysis (Breuss 1999) showed that the birds in the even-aged forest, with fewer species, used about half the number of species for feeding than in the multi-layered forest with a high species diversity. All the same, MULTI squares with a high percentage of Grey Alder (Table 3) in the upper as well as in the undergrowth, were significantly preferred by the birds. The results show that Hazel Grouse is able to colonise comparatively monotonous stands. However, in with the context of contemporary forestry, this could be very risky, because thinning in these stands normally results in instantaneous habitat loss for Hazel Grouse.

Our results show that only four out of 12 significant habitat parameters have a strong connection to food. Flexibility in the use of the available food plants can be seen. Depending on their occurrence, different food plants can play an important role in winter feeding ecology. In MULTI, Hazel Grouse used a wider spectrum than in SIMPLE, explained by a higher vegetation diversity in the former (Breuss 1999). The remaining eight parameters account for the importance of habitat structure for Hazel Grouse.

5. Conclusions

Hazel Grouse is often seen as a typical species for young successional forest stages. From our results we can conclude that monotonous even-aged forest stands, as well as multi-layered old forests, can provide Hazel Grouse with a winter habitat. Compared to multi-layered forests, monotonous forests are risky habitats because their suitability can depend on only one factor, such as a single main winter food plant. The habitats in the age class forest are limited in time whereas multi-layered forests offer habitat over the full time of the rotation period common in age class forest systems (100 – 120 years). Our results, as well as those of Swenson (1991), suggest that the most secure forest type is multi-layered old forest with selection felling as the management strategy. This type of forest includes all successional stages in the same area, as is typical for primeval forest. Multi-layered forests support high habitat quality as well as low risk in terms of contemporary forestry.

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6. Povzetek

Avtorji prispevka so v treh zaporednih zimah (1995-1998) ocenili najpomembnejše parametre habitata gozdnega jereba *Bonasa bonasia* v Južnih apneniških Alpah v Avstriji glede na tipe gozdnih sestojev. Glede na različni strategiji gospodarjenja z gozdom je bilo preučevano območje razdeljeno v dva dela: (1) enostavni (SIMPLE) - sistem starostnega razreda z jasami in (2) večplastni gozd (MULTI) - večplastni sestoji s selektivno sečnjo. Avtorji so opravili analizo počivališč, izbora habitata, iztrebkov in prehrane. Monotoni gozdni sestoji enakih starosti kot tudi večplastni stari gozdovi lahko zagotavljajo bivališče gozdnemu jerebu, le da so monotoni gozdovi v primerjavi z večplastnimi gozdovi tvegano bivališče za to ptico, saj je ustreznost habitata lahko odvisna že od enega samega dejavnika. Bivališča v enostavnem tipu gozda so časovno omejena, medtem ko večplastni gozdovi zagotavljajo bivališče v celotnem ciklusu.

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