Silva Gabreta	vol. 1	p. 209–219	1996

Hazel Grouse in Bohemian Forest: results of a 24-year-long study

Jeřábek lesní na Šumavě: výsledky 24-letého studia

Siegfried Klaus

Thüringer Landesanstalt für Umwelt, Prüssingstr. 25, D-07745 Jena, Germany

Abstract

Since 1972, the distribution, abundance and habitat use of Hazel Grouse, *Bonasa bonasia,* has been studied in a 100 km^2 area of Bohemian Forest (Czech Republic). Along the fixed routes (80 km) all reactions of the grouse to imitations of the male territorial song, as well as indirect indications (dust baths, feathers, droppings, tracks) were recorded. All reactions were assumed to indicate the presence of territorial birds. In the course of the study, Hazel Grouse densities varied between 2.4 and 5.4 territories per km^2. No statistically significant trend in numbers was found. Frequency of occupancy of the territories was highest in habitats rich in alder, the dominant deciduous tree species used for foraging in winter (79 ± 2 %); alder was followed by birch (64 ± 3 %), beech (59 ± 6 %), and rowan (50 ± 5 %). The differences between the frequencies of occupancy of territories located in the four habitat types are statistically significant ($0.01 < p < 0.05$, Fisher's problem test). Territories were patchily distributed in the cultivated forests. Autumn density was positively correlated with temperatures in the prelaying period (March).

Key words: Hanzel Grouse, Bonasa bonasia, distribution, density, habitat, forest management

Introduction

With the exception of the Alps, the Bohemian Forest is the most extensive area occupied by Hazel Grouse, *Bonasa bonasia,* in Central Europe. I estimate that the population was 2000–4000 pairs in 1993. Before 1950, the density of this species was low, but later an increase was observed, apparently due to habitat changes on extensive areas. After World War 2, thousands of landowners left this region, and forest succession began on abandoned fields and meadows. In addition to the natural regeneration of birch, *Betula pendula,* and alder, *Alnus glutinosa,* throughout the whole region, in all suitable habitats Norway spruce, *Picea abies,* was planted, mostly in small plots forming mosaics with a high density of forest edges. The increase in the amount of young mixed forests was accompanied by a pronounced increase in Hazel Grouse numbers on both sides of the border between Bohemia and Bavaria (Kučera 1975, Scherzinger 1976, Klaus 1991).

In this study, I asked the following questions:

1. Were Hazel Grouse declining in the course of the last 24 years?
2. Were fluctuations in numbers correlated with weather variables?
3. How do frequencies of occupation of territories by Hazel Grouse depend on habitat parameters?

Some of the results were described earlier (Klaus 1991, 1995). A more complex habitat analysis is in progress (Swenson & Klaus, in prep.).

Study area and methods

From 1972–1995, a Hazel Grouse subpopulation was studied in the central part of Bohemian Forest (district Klatovy, Czech Republic, Fig. 1a). In an area of 100 km^2, 97 Hazel Grouse territories were mapped, most of them along fixed routes (in total 80 km, Fig. 1b) using indirect indications (dust-bathing places, droppings, feathers and tracks) and by testing the reaction of males to whistling according to the methods described by WIESNER & al. (1977) and SWENSON (1991b). This method assumes that all whistling birds were territorial and that the indirect evidence also indicated separated territories. All data of „territories" are indices rather than direct counts. The study area includes four main types of Hazel Grouse habitats depending on the altitude: valleys with alder as the dominating deciduous tree (about 500–700 m a.s.l.), lower slopes with birch and hazel *Corylus avellana* as dominating potential winter food (about 700–900 m a.s.l.), montane mixed forests with spruce, beech and fir, where beech buds are the main winter food as indicated by qualitative fecal analysis (900–1100 m a.s.l.), and the natural mountain spruce forests where rowan, *Sorbus aucuparia,* forms the dominating food in winter when the snow cover is high (above 1100 m a.s.l., Fig. 2). Hazel Grouse eat primarily buds and catkins of these four species in winter in this area (L. KUČERA, KÄMPFER-LAUENSTEIN pers. comm., and own unpublished observations).

At 100 control sites selected by chance, the age and tree species composition was estimated. Both parameters were compared with those found in Hazel Grouse territories. In 1991 the Šumava National Park (Bohemian Forest–68,520 ha) was founded and the study area became a part of this reserve. Until this time, the whole area was managed by forestry with varying intensity. The present study is now continued with the permission of the administration of the Šumava National Park.

The number of occupied territories was estimated after the breakup of broods in autumn in 1972, 1973, 1975, 1977, 1981, 1984–85, 1987–90,1992–95, and before the breakup of broods in spring or summer in 1976, 1979–80, 1982, 1983,1986, 1991 and 1995. The density index of Hazel Grouse territories (proportion of examinated territories that were occupied) found each year was compared with weather conditions during the prelaying (March), laying (April, May), incubation (May, June) and chick period (June, July) because SWENSON & al. (1994) reported a correlation between weather in the prelaying period and Hazel Grouse reproduction in Finland and Poland. Weather variables were obtained from the Czech weather station at Kašperské Hory (740 m) located at the northern border of the study area. I have recorded the total precipitation and the mean of the mean daily temperatures for each month. These factors were used as independent variables to explain annual variation in the density indices. Analysis of covariance was used to determine which weather variables and month were best correlated with bird density. Only significant variables ($p < 0.05$) are discussed here.

Results and discussion

Distribution and frequency of occupancy of Hazel Grouse territories

Figure 1 shows the study area in the central part of Bohemian Forest. Territories are indicated by full circles in Fig. 1b. Most of these circles are connected by solid lines representing the fixed routes where the presence of birds was investigated each year. Forest areas between the circular routes were mainly uniform spruce forests where Hazel Grouse were found only rarely. Depending on the distribution of adequate habitats, the Hazel Grouse was distributed patchily in this area, as also found by SWENSON (1991a) at the Grimsö study area in Sweden.

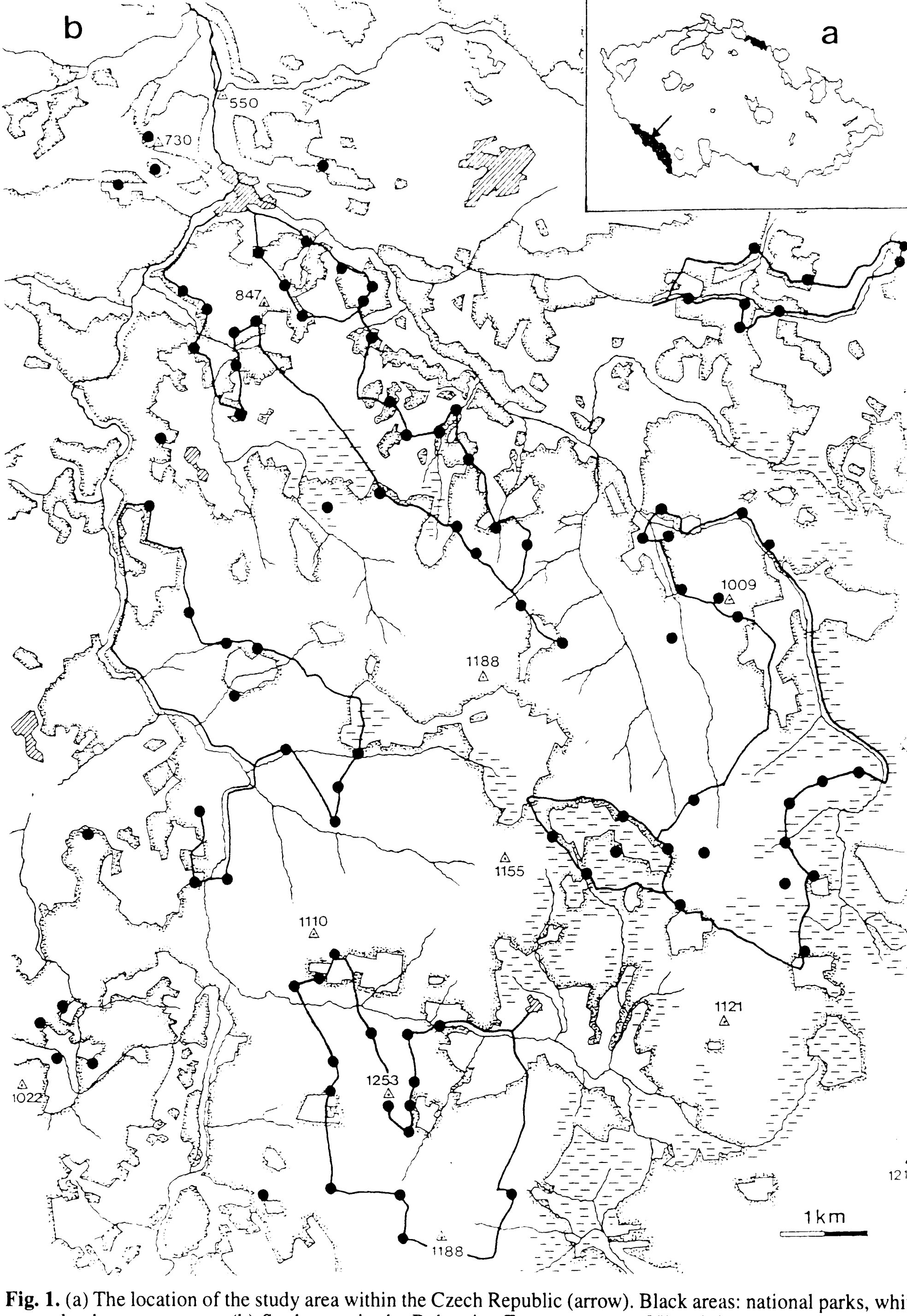

Fig. 1. (a) The location of the study area within the Czech Republic (arrow). Black areas: national parks, white areas: landscape reserves. (b) Study area in the Bohemian Forest: centres of Hazel Grouse territories (black circles) found along fixed routes (black lines), borders of closed forests (shadowed), bogs, hill tops (m ASL) and streams are shown.

Table 1 – Examples of different frequencies of occupancy of selected, individual tertitories

Territory	no.occup.[1)]	control[2)]	index[3)]	habitat type, forest structure
1	13	17	0.76	rowan-type: multilayered old mountain spruce forest
2	14	17	0.82	alder-type: multilayered old pine, spruce, alder
3	13	16	0.81	birch-type: multilayered old pine, spruce, birch
4	12	16	0.75	beech-type: beech-fir-spruce forest, multilayered
5	13	15	0.87	alder-type: pine-spruce-forest, multilayered, alder
7	12	14	0.86	birch-type: pine-birch-spruce forest, multilayered
9	14	15	0.93	birch-type: pine-birch-spruce forest, multilayered
10	12	13	0.92	alder-type: pine-spruce forest with alder, multilayered
12	6	14	0.45	rowan-type: mountain spruce forest, few deciduous
13	5	13	0.38	rowan-type: montain spruce forest, few dediduous
15	7	12	0.58	rowan-type: old spruce forest, few deciduous

[1)] number of years found occupied, [2)] number of years examined, [3)] quotient occupied/examined

Hazel Grouse territories were occupied most consistently in old, uneven-aged mixed forests over the 24-year period (Table 1). From such stable habitats, Hazel Grouse presumably dispersed into young successional stages of forest which were suitable for Hazel Grouse only for a few decades in each rotation. Territories located in spruce-dominated mountain forests with very low density of deciduous trees (*Sorbus aucuparia* or *Betula pubescens* near to bogs) were characterized by a lower frequency of occupancy. We assume that the predation risk was higher in habitats where deciduous trees used for foraging in winter were scattered over large distances (SWENSON 1991a).

Generally, the frequency of occupancy of a given territory seemed to depend on the altitude and thereby on the availability and/or quality of winter food (Fig. 2, Table 2): Rowan trees were distributed at low density in the mountain spruce forests. Beech was much more common in mixture with spruce. Neither beech nor rowan appeared to be preferred winter food trees. In contrast, alder and birch with catkins were preferred by Hazel Grouse in winter. The dominating role of alder as compared with birch has been described by SWENSON (1993). For this reason, we assume a rank order of preference of winter food trees used by Hazel Grouse. Territories were classified with respect to the dominant deciduous tree species delivering winter food (rowan, beech, birch and alder type). Territories of the alder-type were occupied in 79 % of all cases, followed by the birch type (64 %), beech type (59 %) and the rowan type (50 %, Fig. 2). By using the Fisher-problem-test, we found that the differences among the mean values of the frequency of occupancy of all four habitat types were statistically significant ($p < 0.01$ to $p < 0.05$, Table 2).

Influence of age classes and tree species diversity on Hazel Grouse occupancy

As shown in Fig. 3, Hazel Grouse were observed in young age classes of forests (11–40 yr) more frequently than ecpected. About 40 % of all territories were found in old mixed forests with openings and with islands of regenerating stands typical of the climax mountain forests of this region. Sometimes, uniform age-class forests with a second layer of shrubs like hazel were also used by Hazel Grouse. Stands older than 50 years without ground vegetation were avoided.

Table 2 Frequency of territory occupandy (in %) of Hazel Grouse in relation to habitat type

habitat type	number.of territoris	frequency of occupancy, s.d.	difference between habitat types (t-value) Fisher's problem test		
alder	15	79±2	t = 52.18	k = 33	p < 0.01
birch	22	64±3	t = 12.04	k = 32	p < 0.05
beech	19	59±6	t = 12.00	k = 27	p < 0.05
rowan	13	49±5			

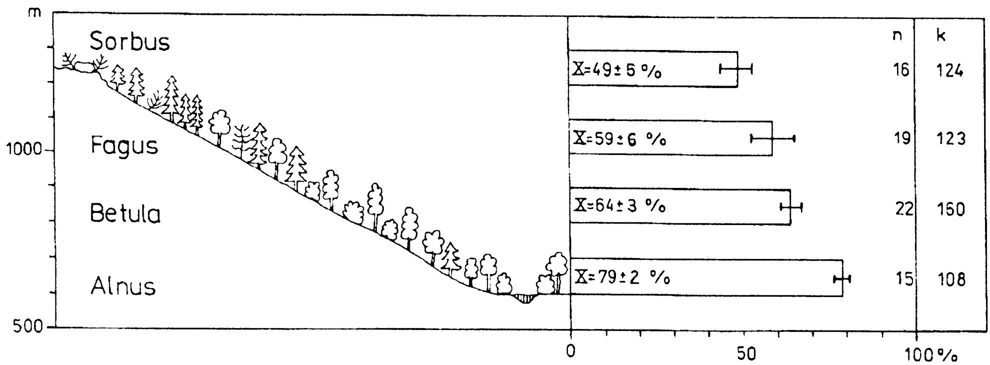

Fig. 2. – Frequency of territory occupation by Hazel Grouse in different habitat types (classified with respect to the dominant winter food tree species): n – number of territories found in a given habitat type , k – number of controls (k = n x years). Differences between the means of the occupation frequency are statistically significant ($p < 0.01$, Fisher's problem test).

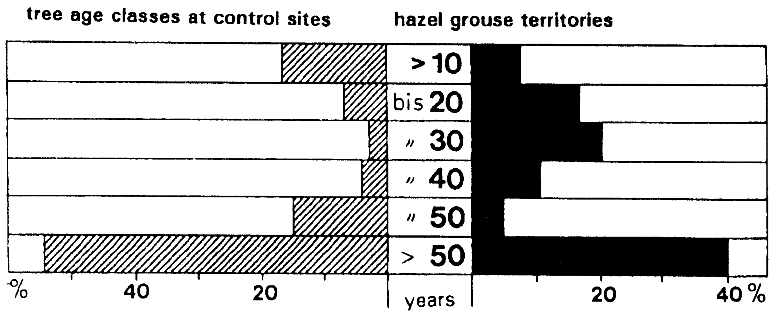

Fig. 3. – Age classes of forests used by Hazel Grouse (% of observations, right part) compared with age classes found at control sites (left part).

As shown in Fig. 4, the species diversity of trees was higher in habitats occupied by Hazel Grouse than in control sites. The first peak is due to spruce – dominated forests with rowan, birch or beech; the second peak represents mixed forests with fire, spruce, beech and *Acer*; and the third peak is due to rich mixed forests along creeks or in successional stages of forests growing on former agricultural land.

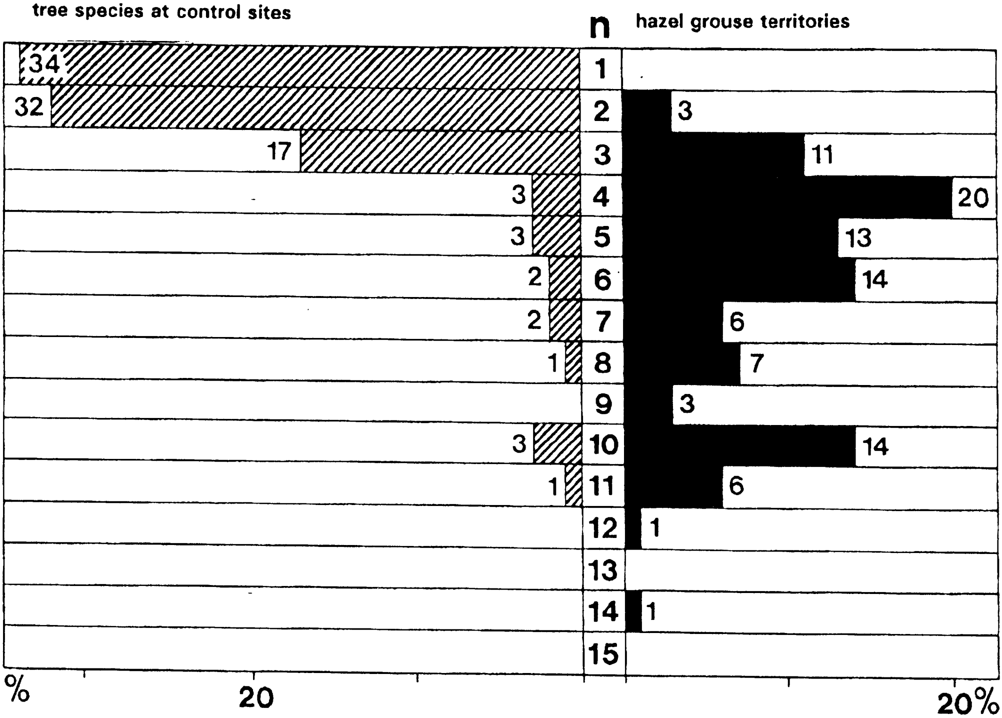

Fig. 4. – Number of tree species(n) found in Hazel Grouse territories indicated at the base of the columns (right part, % of all territories) compared with the number of tree species found at control sites (left part, % of all Control sites).

Population dynamics

Before our studies began, KUČERA (1975) collected data on Hazel Grouse numbers in the same area (200 km^2) and found that numbers increased significantly ($p = 0.05$) between 1962 and 1971 (Fig. 5). I found a slight decrease in the index of yearly density (spring and autumn counts combined) during my period of study, but regression was not significant ($p > 0.1$, Fig. 6).

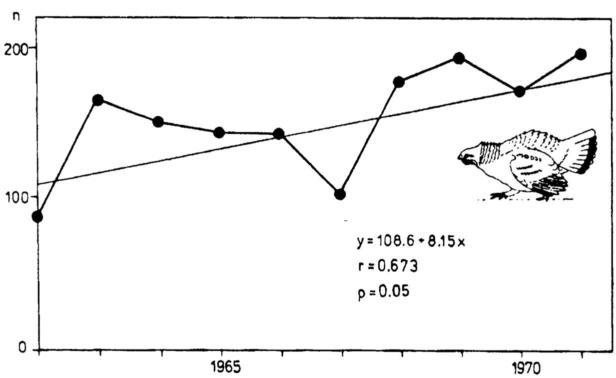

Fig. 5. – Number of Hazel Grouse found by Kučera (1975) in his 200 km^2 study area in 1963–1971.

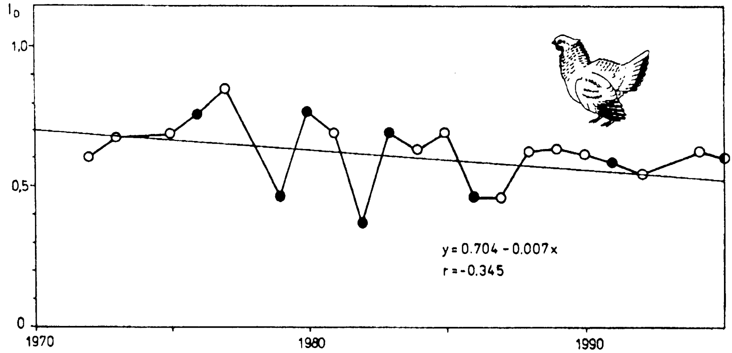

Fig. 6. – Index of Hazel Grouse density between 1972 and 1995 (occupied territories/examined ones), combined results of both spring(•) and autumn (o) controls.

Assuming that Hazel Grouse react to the whistle up to a distance of 80 m and that only territorial birds reply (SWENSON 1991b), the 80 km route corresponded to a surveyed area of 12.8 km². Thus, the density of occupied territories varied between 2.4 and 5.4 per km² between 1972 and 1992. This is similar to Hazel Grouse densities reported from the nearby Bavarian National Park (SCHERZINGER 1976, KÄMPFER-LAUENSTEIN 1995) and other mountain regions in Central Europe (BERGMANN & al. 1996). For comparison, in three areas of my study area, 2.0, 2.75, and 3.5 km² in size, in addition to the route census, all territories were counted by the same methods and similar density values were found: 5.0, 4.4 and 3.7 territories per km², respectively (mean of all years).

The fluctuations found in this study were much less than those found in more northern Hazel Grouse habitats like the Lapland Reserve or the Petchora- Ilyich Reserve in the Northern Ural Mountains (SEMENOV-TYAN-SHANSKI 1960, BESHKAREV & al. 1994) or Finland (RAJALA 1966). Fluctuations of grouse usually decline as one moves south (ANGELSTAM & al. 1985).

I found only a small difference between the mean densities in spring (3.2 territories / km²) and in autumn (3.7 occupied territories / km² KLAUS 1995). This could result from the location of my counts in the best habitats. Young birds may have a lesser chance to occupy territories in good habitats and therefore, may have been underestimated during my counts. However, the relationship between autumn densitiy and spring weather (see below) does not support this conclusion. Alternatively, there may be in fact small differences between spring and autumn densities in this area, as has been found in Sweden in recent years (SWENSON, pers. comm.).

Effects of weather on Hazel Grouse density in autumn

Different factors affect the reproductive success of tetraonids, including the physical condition of the female prior to laying (SIIVONEN 1957, MOSS & WATSON 1984), weather conditions during incubation (SEMENOV-TYAN-SHANSKII 1960) , hatching, or while the chicks are very small (BUMP & al. 1947, SLAGSVOLD & GRASAAS 1979), and predation on eggs or chicks (ANGELSTAM & al. 1985, MARCSTRÖM & al. 1988). Cold and wet weather increases the mortality of young chicks, which have poorly developped thermoregulatory abilities (BUMP & al. 1947, SLAGSFOLD & GRASAAS 1979). Studies showing that reproductive success correlates with weather factors have identified two different periods as most important. These are the prelaying period and the first weeks after hatching; with small species most affected in the early period, and large species in the latter period (SWENSON & al. 1994).

Mean precipitation (1970–1992) at Kašperské Hory (740 m), within the study area, was 55 mm in March, 69 mm in April, 76 mm in May, 104 mm in June, and 110 mm in July. Corresponding average temperatures were 1.6 °C in March, 4.9 °C in April, 10.4 °C in May,

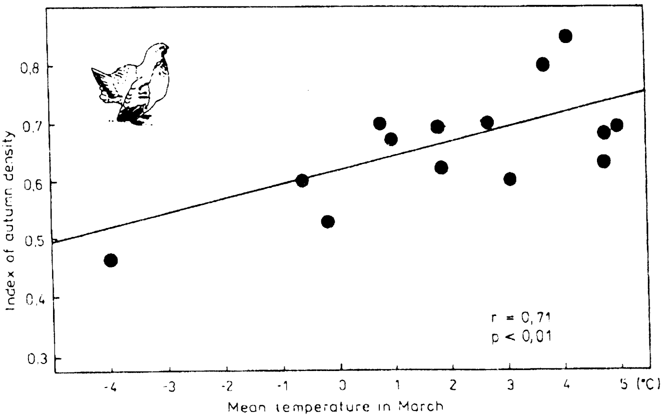

Fig. 7. – Relationship between mean temperature in March and the index of autumn density for Hazel Grouse during 20 years in the Bohemian Forest. The index of density was the quotient of occupied territories/examined territories in the given year.

13.4 °C in June, and 15.3 °C in July. From these figures, my Bohemian study area was very similar to that described by SWENSON & al. (1994) in the Carpathian Mountains and warmer and wetter than the Turku region in southwestern Finland.

I found that the autumn density index was positively correlated ($p < 0.01$) with the mean temperature in March (Fig. 7) as was also reported by SWENSON & al. (1994) for two different Hazel Grouse study areas (southwestern Finland and southern Poland). These authors argue that the availability of nutritionally rich food and the ability of the females to obtain it during the prelaying period determines in large part the reproductive success of Hazel Grouse. During this period, female Hazel Grouse forage primarily on newly sprouted forbs (SWENSON 1991a). The selection of places with the earliest plant phenology has been documented for other grouse females (SIIVONEN 1957) and was often observed by us, when Hazel Grouse were found foraging along small streams where ground vegetation was more diverse and became available earliest. Alternatively, March temperatures also could affect adult mortality, which is highest in early spring, especially after a harsh winter (SCHERZINGER, pers. comm.). The chance of hens to survive may be enhanced when high quality food is available early. In my study area, egg laying started normally at the end of April (in the warm spring in 1993 one hen started on April 14, another hen on April 23, KÄMPFER-LAUENSTEIN, pers. comm.) and hatching of chicks was observed in the first days of June.

Surprisingly, I did not find a correlation between indices of Hazel Grouse densities in autumn and weather variables after the hatching of chicks (mean temperatures and precipitation in June or July). EIBERLE & MATTER (1984) examined correlations between the number of Hazel Grouse harvested by hunters in Kanton Graubünden, Switzerland from 1919–1961 and temperature and precipitation during bi-monthly periods within and prior to the year of harvest. They found only one significant correlation ($p < 0.05$) with the number of Hazel Grouse harvested. This was the mean temperature during March-April during the year of harvest. Also SWENSON & al. (1994) failed to find any relationship between precipitation in June or July and reproductive success, in contrast to the situation in grouse with larger body mass such as Capercaillie *Tetrao urogallus*.

Conclusions with respect to species conservation

In this study, a Central European Hazel Grouse population is described. It started to increase after 1950 and has not declined up to the present in a region where commercial forestry has taken place all the time. We can draw some conclusions from this, regarding managing for-

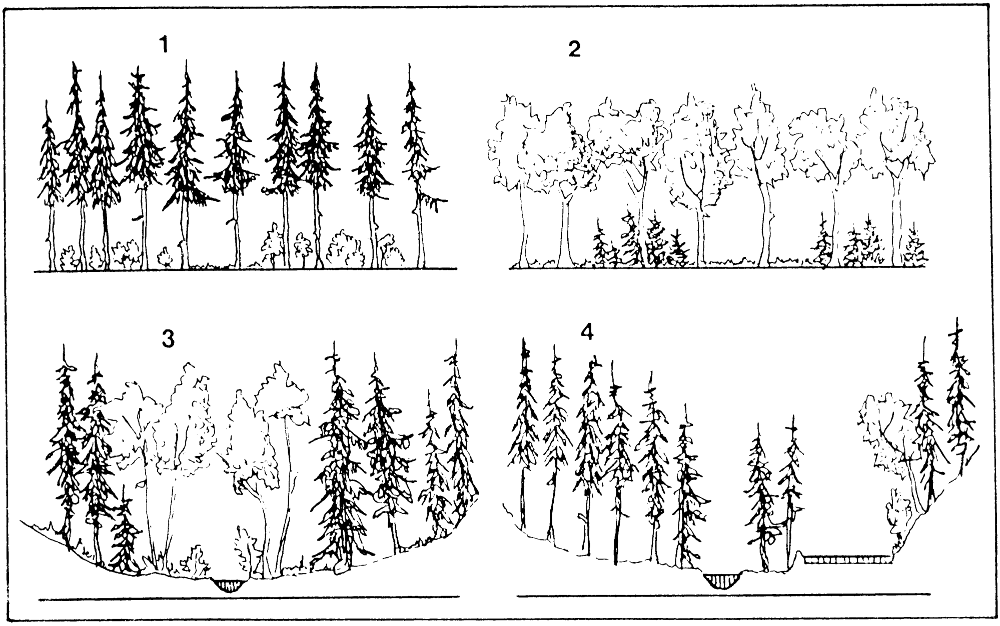

Fig 8. Graphic portrayal showing possible habitat management for Hazel Grouse: 1 – planting of deciduous trees as a second layer in an old, mono-layered spruce forest, 2 – planting of conifers as a second layer in a mono-layered deciduous forest, 3 – optimal forest structure with alder, birch or willows and spruce close to a stream as a linear connection between habitat patches, 4 – undesirable situation: deciduous trees are missing, spruce is planted dense to the stream bank, road nearby disturbes Hazel Grouse while foraging in the few decidues trees left.

ests to favour Hazel Grouse in Central European mountain habitats such as Bavarian Forest, Black Forest, Harz and Oberpfälzer Wald. In general, forestry management to favour Hazel Grouse is not expensive and could be combined with normal forestry, if the following demands are fulfilled (Fig. 8).

- favour deciduous trees including pioneer species like alder, birch, rowan and willow (> 10 %) in spruce-dominated forests
- favour spruce and/or fir (> 20 %) in pure, deciduous forests
- favour alder, willow and birch along streams (linear connections linking favourable habitats)
- keep the close vicinity of creeks and swamps free from spruce plantations, traffic and forest roads
- allow forest successions on openings, wind falls, abandoned fields and meadows
- leave parts of the forest wild including dead trees (standing, fallen)
- promote harvesting of timber in small-scale clearcuts (< 1ha) or as selective or group-felling
- allow the formation of a second layer (shrubs, rejuvenation of trees) in monolayered stands
- favour rich ground vegetation including *Ericaceae* by reducing high density of large herbivores
- regulate opportunist predators and wild boar *Sus scrofa* in order to reduce predation on nests and chicks
- stop tourist pressure in prime habitats

Hazel Grouse prefers high species diversity in ground vegetation which is typical of rich soils. Therefore, it is less sensitive to the input of airborne nitrogen into forest ecosystems than Capercaillie or Black Grouse, *Tetrao tetrix*. Both are declining or even became extinct in extensive regions of Bohemian Forest where the Hazel Grouse population is still stable.

The close proximity of cover and food at the ground and in tops of trees, species diversity in all vegetation layers of a forest, mosaic-like structure of different age classes on a small scale and availability of linear linking structures including streams, hedge systems and forest borders do not help only Hazel Grouse to survive, but also many other threatened species of our forest ecosystems.

Acknowledgement. This work was supported in part by Fonds der Chemischen Industrie. I am grateful to Ladislav Kučera (+) for his help in the field work, to Hans-Heiner Bergmann, David Jenkins, Manfred Lieser, Ilse Storch and Jon Swenson for their suggestions for the manuscript, to M. Rausch for help with the statistics and to Ludvík Škapec for the weather data. My thanks are also due to Jaroslav Červený, to the administration of the Šumava National Park and to the State Forest Service at Sušice for continuous interest and support of this work.

References

ANGELSTAM P., LINDSTRÖM E. & WIDEN P., 1985: Synchronous short-term population fluctuations of some birds and mammals in Fennoscandia – occurence and distribution. *Holarct. Ecol. 8:285–298.*

BERGMANN H.-H., KLAUS S., MÜLLER F. W. SCHERZINGER, J. E. SWENSON & WIESNER J., 1996: Die Haselhühner. *Magdeburg.*

BESHKAREV A., SWENSON J. E., ANGELSTAM P., ANDREN H. & BLAGOVIDOV A., 1994: Long-term dynamics of hazel grouse populations in source- and sink-dominated taiga landscapes. *Oikos 71:375–380.*

BUMP G., DARROW R. W., EDMINSTER F. C., & CRISSEY W. F., 1947: The Ruffed Grouse- life history, propagation, management. *New York State Cons. Dep., Albany.*

EIBERLE K. & MATTER J.-F., 1984: Untersuchungen über kritische Wetterfaktoren beim Haselhuhn (*Bonasa bonasia*). *Forstarchiv 55: 195–198.*

KÄMPFER-LAUENSTEIN A., 1995: Home ranges, habitat and dispersal of radio-marked Hazel Grouse in the National Park „Bayerischer Wald“, Germany- preliminary results. *In: Jenkins, D. (ed.). Proc. intern. Symp. Grouse 6:77–80. World Pheasant Association, Reading U.K. and Instituto Nazionale per la Fauna Selvatica, Ozzano dell' Emilia, Italy.*

KLAUS S., 1991: Effects of forestry on grouse populations: Case studies from the Thuringian and Bohemian forests, Central Europe. *Ornis Scand. 22: 218–223.*

KLAUS S., 1995: Hazel Grouse in the Bohemian Forest – results of a 20-year study. *In: Jenkins, D. (ed.). Proc. intern. Symp. Grouse 6:27–33. World Pheasant Association, Reading U.K. and Instituto Nazionale per la Fauna Selvatica, Ozzano dell' Emilia, Italy.*

KUČERA L., 1975: Verbreitung und Populationsdichte von Auerhuhn (*Tetrao urogallus*), Birkhuhn (*Lyrurus tetrix*) und Haselhuhn (*Tetrastes bonasia*) im westlichen Teil von Šumava (ČSSR). *Orn.Mitt. 27, 160–169.*

MARCSTRÖM V., KENWARD R. E. & ENGREN E., 1988: The impact of predation on boreal tetraonids during vole cycles: an experimental study. *J. Anim.Ecol. 57:859–872.*

MOSS R., & WATSON A., 1984: Maternal nutrition, egg quality and breeding success of Scottish Ptarmigan *Lagopus mutus. Ibis 126: 212–220.*

RAJALA P., 1966: The number of tetraonid birds and their occurrence in different habitat types in the Oulu district according to compass line census. *Suomen riista 19: 130–144.*

SCHERZINGER W., 1976: Rauhfußhühner. *Schriftenreihe Nat.Park Bayer. Wald 2: 41–71.*

SEMENOV-TYAN-SHANSKII O. I., 1960: The ecology of tetraonids. *Trudy Lapl. Gos. Zapov. 5:1–318 (in Russian).*

SIIVONEN L., 1957: The problem of the short-term fluctuations in numbers of tetraonids in Europe. *Pap. Game Res. 19:1–44.*

SLAGSFOLD T. & GRASAAS T., 1979: Autumn population size of the Capercaillie *Tetrao urogallus* in relation to weather. *Ornis Scand. 10:37–41.*

SWENSON J. E., 1991a: Social organization of Hazel Grouse and ecological factors influencing it. *Thesis University of Alberta.*

SWENSON J. E., 1991b: Evalution of a density index for territorial male Hazel Grouse *Bonasa bonasia* in spring and autumn. *Ornis Fennica 68: 57–65.*

SWENSON J. E., 1993: The importance of alder to Hazel Grouse in Fennoscandian boreal forest: evidence from four levels of scale. *Ecography 16: 37–46.*

SWENSON J. E., SAARI L., & BONCZAR Z., 1994: Effects of weather on Hazel Grouse reproduction: an allometric perspective. *J. Avian Biol. 8–14.*

WIESNER J., BERGMANN H.-H., KLAUS S. & MÜLLER F., 1977: Siedlungsdichte und Habitatstruktur des Haselhuhns (*Bonasa bonasia*) im Waldgebiet von Bialowieza (Polen). *J. Orn. 118:1–20.*