

## Distribution and number of black grouse, *Tetrao tetrix* in southwestern Poland and the potential impact of predators upon nesting success of the species

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**A b s t r a c t .** During the winter period 2006/2007, research was carried out on the distribution and number of black grouse in coniferous lowland forest, Bory Dolnośląskie and the Karkonosze Mountains in southwest Poland. During 27 workshops, more than 800 members of various hunting clubs and representatives of the local State Forest Service presented information about place i.e., forest compartments and date when black grouse was seen. Next, this information was put on forest maps. Birds that could be seen twice or more were arbitrarily excluded by time-space analysis. In Bory Dolnośląskie, a declining black grouse population was present in 12 hunting districts covering 50.5 thousands ha of forest. The estimate of this species was 60 birds, i.e., 1.18 birds per 1 000 ha. In the Karkonosze Mountains, increasing black grouse population occurred in 8 hunting districts within a forest area of 30.1 thousands ha. The black grouse number was estimated to 169 birds, i.e., 5.61 birds per 1 000 ha. In the heather-land of Bory Dolnośląskie, 200 artificial nests were distributed on transect lines between the habitat (A) where black grouse is still present and the one (B) where it disappeared, and 14 movable digital cameras with movement detector triggered by infrared sensor were temporarily located at randomly selected nests that were destroyed by predators. The picture analysis showed that raven (*Corvus corax*) destroyed 93.9% and red fox (*Vulpes vulpes*) 6.1% of the nests. All the nests were damaged within 7 days. The rate of nest damage was faster in habitat B. Population dynamics of lowland and mountain black grouse population is analysed and discussed.

**Key words:** artificial nests, heather land, population dynamics, raven, red fox

### Introduction

In the last three decades there has been serious decline in distribution and population number of black grouse (*Tetrao tetrix* L.) in Poland. Official statistics (based on reports from hunting districts) showed that in 1977 there were 33 000 black grouse in Poland. In the following years the population number was dwindling to reach 13 000 in 1983 and 5 000 in 1994 (K a m i e n i a r z 1997, 2002, 2007). As a result, black grouse became protected species in 1995. According to State Forest data, in 2006 there were 2 000 black grouse in Poland (B u d n a et al. 2006). Decline in Polish population is considered to be due to the following factors:

1. Negative changes in environment where black grouse lives, like for example the draining of wetlands, which were next transformed into agriculture areas. In forests, there has been also decline in area of young plantation. Recently, there has been practice of clear-

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cuts, but their amount is being limited by introducing selective-cuts of trees. All these changes led to shrinking of black grouse habitat. (Pomarnicki 1965, Brittas & Willebrand 1991, Klejnowski & Sikora 1992, Kurki et al. 2000, Ludwig 2005).

2. Increase in terrestrial predators caused by using rabies vaccines as well as forest fragmentation, which increased food resources of such predators as fox (*Vulpes vulpes*), badger (*Meles meles*), and marten (*Martes* sp.). In Poland, the fox harvest went up from 25 000 in 1992 to 150 000 in 2006. Also the harvest of badger and marten increased seven times in this period (Budna et al. 2006). In the same time, the number of hunters increased only from 99.5 thousands to 104.6 thousands (Budna et al. 2006). It means that harvest of predators is a good relative indicator of population number and population dynamics. During this period there was also an increase in number of raven (*Corvus corax*). In Poland at beginning of 1990s, population size of raven was estimated as 3–6 thousands pairs (Snow & Perrins 1998) and it rapidly grew up to 12–18 thousands of pairs in 2003 (Walsz 2003). Negative influence of predators on nesting and population number of black grouse is well proven by many studies (Storaas 1987, Krupka et al. 1994, Kurki et al. 1997, Storaas et al. 1999, Baines et al. 2004, Summers et al. 2004).
3. Global climate changes, that caused lowering temperature and increase in rainfalls in spring, during hatching period. Black grouse chicks have problems with maintaining stable body temperature and finding food rich in protein because activity of insects during raining period is very low (Loneux 2002, Kamieniarz 2002).

The purpose of this research was to examine the distribution and population number of black grouse in Southwestern Poland. The potential level of damage that predators, raptors and raven make to nesting of black grouse was examined as well.

## Study Area and Methods

The study area in southwest Poland is under the administration of Regional Directorate of State Forest in Wroclaw (RDSF). This area includes habitats of two important, but isolated black grouse populations, one of which is in the Karkonosze Mountains (part of the Sudety Mountains) and the other in the lowland forest named Bory Dolnoslaskie Forest (Palucki 1988, Klejnowski & Sikora 1992, Kamieniarz 1998).

The habitat of the mountain black grouse population is at 600–1 200 m a.s.l. These areas are dominated by mountain mixed deciduous forest (51.0%) and mountain mixed forest (31.3%). At the beginning of 1980s forests were decaying here due to very high pollution and outbreaks of pest insects. As a result of removing damaged trees, the area of young plantations increased significantly: it takes currently up 25% of the forest area. Spruce (*Picea excelsa*) forests are now transformed into mixed forests with a high percentage of fir (*Abies alba*) and beech (*Fagus sylvatica*) (Blaży et al. 2007).

The area of Bory Dolnoslaskie Forest consists of 165 000 ha and is the largest complex of lowland forest in Poland. It is dominated by fresh coniferous forest and mixed coniferous forest constituting 41.1% and 40.3% respectively. Mixed deciduous forests take up only 9.0% of this complex (Kobielski et al. 2007, Stankiewicz et al. 2007). The main tree species of this complex is pine (*Pinus silvestris*) and the percentage of spruce and fir is steadily rising. The important environments for black grouse are large areas of military

exercising area, where heather (*Calluna vulgaris*) and young trees of birch (*Betula* sp.) are the dominant vegetation.

In February 2007, there were 27 workshops organized with the aim of working out a ten-year management plan for game species in Bory Dolnoslaskie and Karkonosze Mountains. Over 800 members from 38 hunting clubs and representatives from twelve Districts of State Forest Service attended the workshops. Information about place, i.e. forest compartments, and date of observation of black grouse in autumn–winter 2006/2007 was collected. Next, this information was put on forest maps. Birds that could be seen twice or more were arbitrarily excluded from this observation by time-space analysis. Black grouse population from 1998–2006 was analyzed based on the data from RDSF, which were collected by a similar method to that described above.

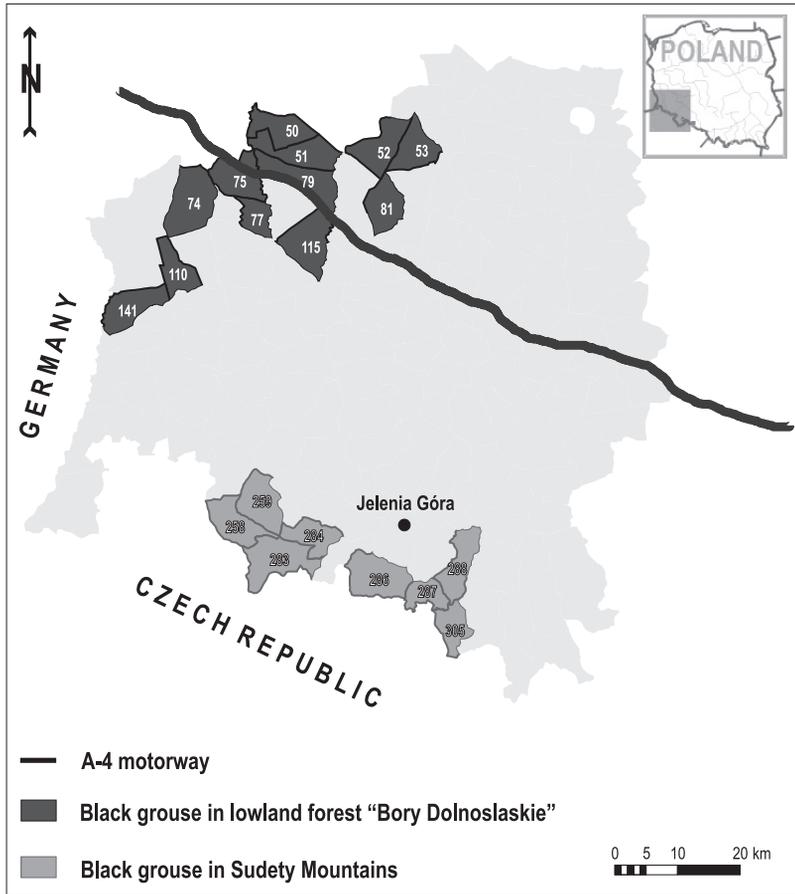
Research on the potential impact of terrestrial and avian predators on black grouse nesting was conducted on 6 600 ha of heather-land located in Bory Dolnoslaskie (Przemkow Forest District). Using data on present and historical distribution of black grouse, two habitats were selected: the Habitat A where black grouse still occurs, and the Habitat B from which black grouse has disappeared during last few years. The distance between habitat A and habitat B is 2–3 km. Four transect lines were established in both places and artificial nests (five hen eggs in each nest) were put every 100 meters on them. There were 200 artificial nests in total and half of them were in the area where black grouse lives nowadays and the other half in the area from which black grouse disappeared. On four of the transect lines we placed 14 digital cameras (Bushnell Trail Scout 2,1 MP) with movement detector triggered by infrared sensor. All artificial nests and cameras were checked every day. Every time the artificial nest was destroyed the camera was moved to the nearest nest.

## Results

The data collected during this research show that black grouse was present in twelve hunting districts that cover 50.5 thousands ha of forest in Bory Dolnoslaskie Forest. The estimate population number of this species during the 2006/07 autumn-winter time period was 60 birds, i.e. 1.18 individuals per 1 000 hectares of forest habitat. The birds were found mainly in Swietoszow Forest District (hunting districts number 50, 51, 75, 77 and 79) and in Przemkow Forest District (hunting districts number 52 and 53). In Ruszow, Chocianow, Boleslawiec, Wegliniec and Piensk Forest Districts, the presence of black grouse was limited to one hunting district in each Forest District (Fig. 1).

Population of black grouse in the Karkonosze Mountains was present in eight hunting districts of total forest area of 30.1 thousands ha. The population number was estimated to 169 animals, i.e. 5.61 birds per 1000 hectares. The black grouse was present in three hunting districts (number 286, 287 and 288) situated in Sniezka Forest District and in two hunting districts situated in Swieradow Forest District (number 258 and 259). They were also present in two hunting districts in Szklarska Poreba Forest District (number 283 and 284) and in the hunting district number 305 in Kamienna Gora Forest District (Fig. 1)

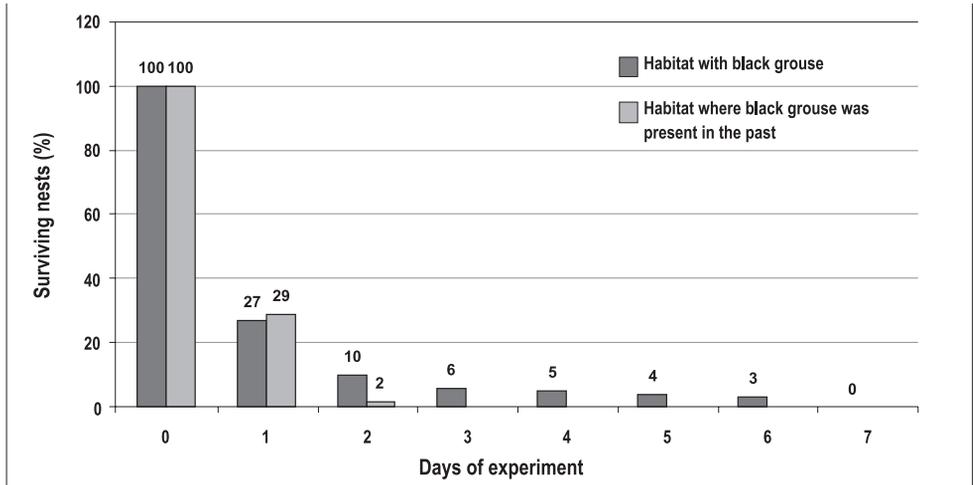
The results of the impact of terrestrial and avian predators on artificial nesting of black grouse are presented in Fig. 2. It showed the fast rate of nest damage on the area where black grouse disappeared a few years ago. In this area, on third day of control the predators had destroyed all the 100 nests. In the area where black grouse is still present (Habitat A), the period before the all nests were destroyed was 7 days. The analysis of photos taken by the digital cameras showed that ravens destroyed 93.9% and foxes 6.1% of the nests.



**Fig. 1.** Distribution of black grouse population in the Regional Directorate of State Forests in Wrocław, Southwestern Poland. Based upon reports from hunting districts in 2006.

## Discussion

According to unpublished data of the Regional Directorate of State Forest in Wrocław, in 2006 the population of black grouse was 26 birds in Bory Dolnoslaskie Forest and 197 in the Karkonosze Mountains. In the Karkonosze Mountains these are similar numbers as it was estimated in the present paper and data reported by State Forest Service (169 versus 197 individuals). But a significant difference in the population size obtained by these two independent censuses was found in Bory Dolnoslaskie Forest (60 versus 26 birds). Such differences may result in habitat structure and size of sampling units. It is very probable that estimate based on small sampling units, i.e. hunting districts, was more precise than the one based on bigger sampling units. Average forest area of hunting district is similar in the Karkonosze Mountains and in Bory Dolnoslaskie Forest (3.8 and 4.2 thousands ha, respectively). However, the average size of forest district is much smaller in the Karkonosze Mountains than in Bory Dolnoslaskie Forest, i.e. 14.7 versus 19.0 thousands ha respectively. Additionally the grouse forest habitat is more open in the Karkonosze Mountains than it is in Bory Dolnoslaskie Forest (see description of the study area).

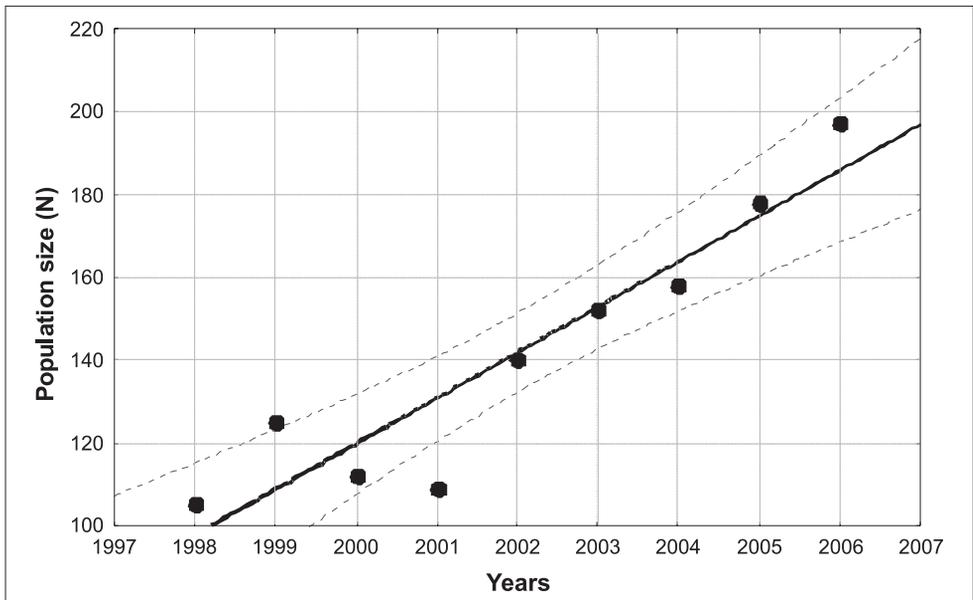


**Fig. 2.** Estimates of potential pressure of predators upon nesting success of black grouse in lowland coniferous forest Bory Dolnosląskie, Przemkow Forest District, during June 2007.

The mountain and lowland black grouse showed significantly different population dynamics during last 9 years (1998–2006). According to unpublished data of RDSF in Wroclaw, the population number in the Karkonosze Mountains went up from 105 animals in 1998 to 197 in 2006. The growth of black grouse in this area (Fig. 3) was statistically significant ( $r = 0.94$ ,  $p = 0.0002$ ) and it is described by the following formula:

$$y_t = - 220E2 + 11.03 x$$

where  $y_t$  is the population size of black grouse and  $x$  is the time in years.

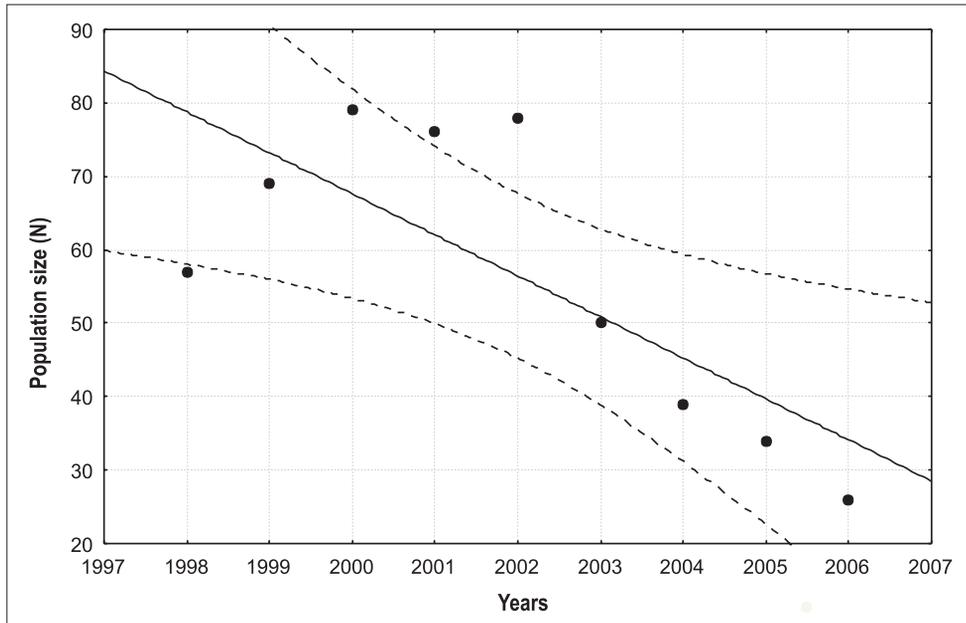


**Fig. 3.** Population dynamics of black grouse in the Karkonosze Mountains, Southwestern Poland ( $r = 0.94$ ;  $p = 0.0002$ ).

The population number of black grouse population living in Bory Dolnoslaskie Forest ranged during 9 years period from 26 to 79 individuals (Fig. 4), but population dynamic analysis shows fall in numbers ( $r = -0.75$ ,  $p = 0.002$ ). It can be described by the following equation:

$$y_2 = 11234.0 - 5.58 x$$

where  $y_2$  is the population size of black grouse and  $x$  is the time in years.



**Fig. 4.** Population dynamics of black grouse in lowland forest Bory Dolnoslaskie, Southwestern Poland ( $r = -0.75$ ,  $p = 0.02$ ).

It is probable that the increase in population number in the Karkonosze Mountains was caused by positive changes in environment where black grouse lived as well as relatively low presence of predators. At the beginning of 1980s big complexes of spruce monocultures were dying down. Removing dead trees caused the creation of big and open areas that are currently afforested. It created perfect conditions for black grouse that likes big, open and slightly bushy areas. The remains of trunks, wholes after removing trees, growing bushes and planting with young saplings caused creating highly differential environment that was rich in food and cover. It is hard for predators to find black grouse nests in such environment. Moreover fox and raccoon dog (*Nyctereutes procyonoides*) population is small in this area. The hunting statistics shows harvest rate of fox as 4.8 and raccoon dog as 0.3 animals per 1 000 ha of forest per year. The total number of inhabited dens by terrestrial predators (fox, badger, raccoon dogs) amounts to 3.5 dens per 1 000 ha of forest (B o b e k & M e r t a , unpubl. data). To sum up, the perfect habitat that has been created for black grouse and small number of predators led to increase in black grouse population number.

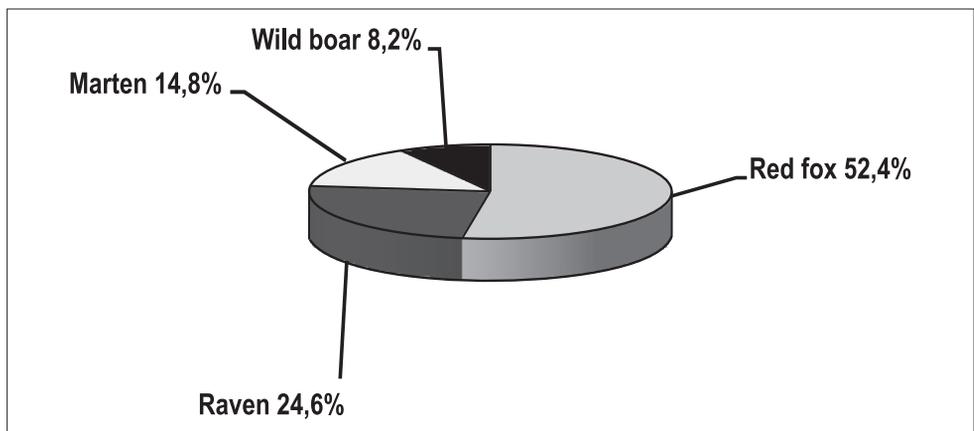
In Bory Dolnoslaskie Forest the black grouse lives in completely different habitat. During the last decade, forest management started to limit the size of clear-cut that were habitat preferred by black grouse. Currently, some amount of timber is exploited through

selective cut system. Heather is the main habitat of black grouse in this area. The level of heterogeneity of such environment is low, so black grouse do not access to good nesting cover. As a result nests are easily found by avian predators, what was evidenced by this research. The number of terrestrial predators in Bory Dolnoslaskie Forest is higher than in the Karkonosze Mountains. Fox and raccoon dog harvest is 5.0 and 1.1 animals per 1 000 ha of forest per year respectively. The number of dens that are used by terrestrial predators equals to 6.1 dens per 1 000 ha of forest (B o b e k & M e r t a unpubl. data).

Artificial nests are often used to examine the influence of predators upon nesting success (S t o r c h & W i l l e b r a n d 1991, K r u p k a et al 1994, B a y n e et al 1997, L i g o c k i et al 2004). During experiments, hen eggs, imitations of eggs made of wood and plastic or shell of hen eggs filled with wax and plasticine are used (S t o r c h 1991, B a y n e et al. 1997, A n t h o n y et al. 2006). L i g o c k i et al (2004) showed in Beskid Zywiecki Mounts (Southern Poland) that in habitat where the capercaillie occurs, predators destroyed within 4 weeks 27% of artificial nests comparing to 100% of nests in habitat where capercaillie disappeared 10 years earlier. The similar trend in habitat where capercaillie currently occurs and in habitat where it disappeared was noticed in Bory Dolnoslaskie (M e r t a et al. 2007). The numbers from these experiments are usually higher than the percentage of natural nests destroyed by predators (S t o r a a s 1988, B a y n e et al 1997). Therefore, this method allows estimating the relative potential impact of predators on nesting success of some bird species (S t o r a a s et al 1999, Z a w a d z k a & Z a w a d z k i 2003). Percentage of destroyed artificial nests is a relative index of nest predation that shows the scale of risk to which bird nests are exposed in a specific region (A n d r e n & A n g e l s t a m 1988).

In the similar experiment carried out in Bory Dolnoslaskie Forest, where the capercaillie is below minimum viable population size (about 50 km far from the present black grouse study area), only 3% of artificial nests survived. Forest habitat of capercaillie provides better nesting cover than heather land where black grouse occurs. That is why the predation pressure by raven is smaller and artificial nests were destroyed mainly by fox (52.4%) and then by ravens (24.6%) (M e r t a et al. 2007) (Fig. 5).

In the present work, it seems that differences in nesting cover resulted in distinct survival rate of artificial nests between Habitat A and Habitat B. In the area where black grouse is still present, the density of young birch trees is higher than in the area where black grouse



**Fig. 5.** Percentage share of red fox, raven, marten and wild boar in artificial nests damages. Data were collected in coniferous lowland forest Bory Dolnoslaskie, Ruzow Forest District, during May and June 2007.

disappeared. Many authors thoroughly described the negative impact of ravens on forest grouse population dynamics (Storaas & Wegge 1987, Saniga 2003). Therefore, the population of raven must be considered as one of the most important factor that is responsible for decline of black grouse number in Bory Dolnośląskie Forest.

## Conclusions

1. The big open areas in forest appearing during the last two decades in the Karkonosze Mountains and the relatively low density of predators created the optimum conditions for black grouse and were the main reasons of an increase in black grouse number in this area. However, the young age class of forests that were in early stage of succession will be getting older. It means that open areas will disappear, that will have a negative impact on black grouse habitat and may reduce the black grouse population size in future.
2. In Bory Dolnoslaskie Forest the black grouse habitat is mainly large areas of heather where pressure of ravens and terrestrial predators is very high. That is why the recovery of black grouse population depends on reducing the number of ravens and foxes.
3. It is recommended that the State Forest Service started a professional monitoring of black grouse number and population dynamics that would provide more reliable data from Bory Dolnoslaskie Forest and the Karkonosze Mountains.

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