

INFLUENCE OF SUPPLEMENTARY FEEDING OF WILD BOAR (*SUS SCROFA*) ON GROUND-NESTING BIRDS

Ragne Oja

University of Tartu, Institute of Ecology and Earth Sciences, Vanemuise 46, Tartu
e-mail: ragneoja@ut.ee

Abstract. With regard to the decreasing numbers of gallinaceous birds in Estonia and Europe in general, it is important to know which factors influence their nesting success. Because the latter is related to the density of nest predators, the supplementary feeding, a common method in game management in order to increase the numbers of the wild boar, may increase nest predation. The aim of the present study was to find out if supplementary feeding of wild boar increases nest predation probability in ground-nesting birds. In spring 2010, 81 artificial nests were arranged around supplementary feeding sites of different feeding intensity and in control sites. A three-week experiment demonstrated that wild boar feeding sites attract nest predators of ground-nesting birds and this effect is related to the feeding intensity of the site. Artificial nests around sites of high feeding intensity were depredated sooner compared to the sites of low feeding intensity, which may have more detrimental consequences for the birds, since re-nesting attempts occur later. Therefore, with regard to protection of gallinaceous birds, supplementary feeding of wild boar should be avoided in the vicinity of nesting territories.

Introduction

A long-term decline in the numbers of gallinaceous birds has been observed in Estonia as well as elsewhere in Europe. The irreversible decline in the numbers of the black grouse (*Tetrao tetrix*) started in the second half of the 19th century or the beginning of the 20th century and was mainly caused by human activity (Viht 1987). Some former important game species now belong to the list of protected species in Estonia – the black grouse and the hazel grouse (*Tetrastes bonasia*) belong to Category III (Regulation No. 51 of the Minister of Environment, May 19, 2004), the western capercaillie (*Tetrao urogallus*)

to Category II and the willow ptarmigan (*Lagopus lagopus*) to Category I of protected species (Government of the Republic of Estonia Regulation No. 195, May 20, 2004). In addition to habitat loss, also nest depredation and chick mortality are considered as potential factors of population decline (Saniga 2002). It has been demonstrated previously that female black grouse are faithful to their breeding areas, irrespective of whether the breeding has been successful or not (Warren *et al.* 2012). In Finland it has been demonstrated that habitat characteristics (conspicuousness of the nest, forest density and drainage) were commonly linked to increased rates of nest predation of the black grouse. Moreover, the effect was even stronger at higher densities of potential predators (Ludwig *et al.* 2010a). Also Kurki and colleagues (1997) pointed out that in areas with increased predator density, the nests of black grouse and capercaillie are more likely to be depredated. However, while Wegge and Kastdalen (2007) pointed out predation as the foremost reason accounting for the deaths of young western capercaillie, Ludwig and colleagues (2010b) showed that predator abundance did not affect the survival of the young. In the present study we will describe the possible effects that supplementary feeding of wild boar poses on the breeding success of gallinaceous birds. We study whether wild boar feeding sites attract also other nest predators and elucidate whether nest predation is associated with the feeding intensity of the site.

Supplementary feeding of game species as a common method in game management has gained considerable attention in Europe as well as in Estonia. The number of feeding sites for wild boar has been constantly increasing during the past decade. According to Statistics Estonia, the number of feeding sites for wild boar remained below 2400 until the year 2000, but over 2000 additional sites have been established since (Statistics Estonia 2012). The supplementary feeding in Estonia usually takes place from November to April, but some food is also available during summer months with the intention to keep the game in the hunting district. Establishing feeding sites that supplement additional energy into the ecosystem enables to increase the carrying capacity and the population density of game animals. Food availability and environmental conditions affect primarily the survival of young animals, and to a lesser extent that of the adults (Bieber and Ruf 2005,

Geisser and Reyer 2005). Thus, supplementary feeding boosts reproductive success by increasing the number of younglings as it has the strongest effect on the survival of juveniles and yearlings. Geisser and Reyer (2005) have shown that the fluctuations in population size of wild boar in Switzerland could be mostly explained by the effect of food availability and temperature. In addition to natural food supply, the availability of alternative food resources, namely agricultural crops, may also contribute to an expansion of wild boar populations (Bieber and Ruf 2005). Boitani and colleagues (1994) have noted that the seasonal home range of wild boar is determined by food availability, whereas animals may move long distances from the core area in order to exploit the areas of high food abundance.

Supplementary feeding of game animals is also used as a method to lure the animals away from agricultural land in order to reduce the level of damage to the crops. Effectiveness of this method is largely contradictory, and studies with positive outcome often ignore long-term effects of supplementary feeding due to the increase in population densities. For example, during a period when natural food availability was scarce and vineyards were particularly vulnerable to damage, the spreading of maize was an efficient tool for reducing the level of damage to vineyards (Calenge *et al.* 2004). Still the authors emphasized that providing maize was rather an alternative than a supplementary feeding of wild boars as the amount of food as well as its effect on population size was negligible. Alternatively, Geisser and Reyer (2004) noted that supplementary feeding during harvesting does not lure animals off the fields. Also Schley and colleagues (2008) demonstrated that probability and intensity of damage to the crops correlated with wild boar population density. However, Jiménez and Conover (2001) in their review on the effect of alternative prey on the nesting success of birds concluded that supplementary feeding of game species (potential nest predators) is not an effective measure for decreasing nest predation. Also, in order to suppress the population growth of wild boar, supplementary feeding ought to be avoided (Bieber and Ruf 2005). According to the Estonian Nature Conservation Act, supplementary feeding of wild boar is strictly prohibited within the

protection areas for the western capercaillie (Law of the State Council, February 21, 2007).

Non-target species, which should not be supplementary-fed, potentially use feeding sites for ungulates. Cooper and Ginnett (2000) showed that artificial nests located close to supplementary feeding sites of white-tailed deer (*Odocoileus virginianus*) had a higher probability of depredation by raccoons (*Procyon lotor*) and striped skunks (*Mephitis mephitis*), compared to more distant nests. Thus, even if the target species of supplemental feeding does not oppose any threats to the local bird fauna, the negative effect may arise indirectly, from non-target species. In Estonia, the target species for supplementary feeding are the wild boar and, to a lesser extent, the European roe deer (*Capreolus capreolus*), the latter being a frequent visitor at wild boar feeding sites as well. Wild boar feeding sites are also visited by raccoon dogs (*Nyctereutes procyonoides*) and this habit enhances their winter survival especially in the presence of thick snow cover. Additionally, supplementary feeding sites are attractive to small seed- and fruit-eating mammals, which in turn attracts raccoon dogs and red foxes (*Vulpes vulpes*). However, the main changes in the flora and fauna of the feeding sites are caused by the wild boar.

Wild boars are omnivores whose diet largely depends on the phenology and availability of food objects. The diet consists mainly of vegetable matter, whereby the amount of animal matter is very low (Baubet *et al.* 2004, Schley and Roper 2003). Some earlier studies have shown that foraging wild boars may come across and depredate the nests of ground-nesting birds, causing thereby ecological and economical damage (Schley and Roper 2003). For example, in the USA the nesting success of wild turkeys (*Meleagris gallopavo silvestris*) improved in response to feral hog control from 0% to 25% (Lopez *et al.* 2005). In Estonia, 10 out of 40 wild boar stomach analyses contained bird foetuses (unpublished data by Valdmann). The red fox and some species of the weasel family (*Mustelidae*) are considered to be the main predators of gallinaceous birds (Wegge and Kastdalen 2007), but in Estonia ground nests may also be depredated by raccoon dogs. The latter is a nocturnal (Kauhala *et al.* 2007) and omnivorous species belonging to the *Canidae* family and feeding on small rodents, plants,

insects, birds and bird eggs (Zhang *et al.* 2009). Wegge and Kastdalen (2007) have noted that predatory losses of the gallinaceous bird nests were more often caused by mammalian predators (mostly by red fox and weasels) than by other birds.

Material and methods

In order to estimate the effect of supplementary feeding sites of wild boar to attracting predators of the nests of ground-nesting birds, an artificial nest experiment was carried out in Võnnu hunting district (approx 8000 ha, 6 feeding sites) in Tartu County. Feeding sites contained flour, grain and potatoes. One of the sites also contained carrion (domestic pig). During fieldwork, hazel grouse was observed in the vicinity of one of the supplementary feeding sites. It has been suggested that compared to natural nests, artificial nests are easier to be detected by predators, on account of which artificial nests may experience a higher predation pressure compared to real nests (Roper 1992, Zanette 2002). To ensure the comparability of sites with different feeding intensity, only the data from artificial nests experiment is used (Moore and Robinson 2004). The data does not allow comparison of predation rate between artificial and natural ground-nesting bird nests.

On May 15th, 2010, artificial nests were arranged around six supplementary feeding sites (diameter 3–5 m) of different feeding intensity. The quantity of supplemental food within the high and low intensity feeding sites was at least 50 kg and less than 25 kg, respectively. Additionally, nests were arranged in three control areas where no supplementary feeding had been carried out before. Control sites were chosen to be similar with feeding sites. A similarity in forest type, distance from main paths and forest edge was sought (Saniga 2002, Thurfjell *et al.* 2009). In order to ease locating nests, the closest tree or bush was marked either with tape or an incision. The artificial nests used in this study contained three quail eggs, placed in a concavity on the ground. In order to impede raptors locating the nest and thereby interfering with the study results, the nest was covered with natural materials (leaves, moss and grass) found in the vicinity (Saniga 2002).

Nine artificial nests were placed in each study plot and arranged in a square shape (Storch 1991). All of them were 30 m apart (Fig. 1). In supplementary feeding sites the distance of the central nest from the feed was 3–7 m. A total of 81 artificial nests were established, and they were checked after two and three weeks, on 9th and 16th June, respectively. The experiment duration was comparable to the length of the incubation period of gallinaceous birds, which is 25–26 days (Jönsson *et al.* 1991), and 23–25 days for the black grouse in Estonia (Viht 1987). The nests were checked between 11 a.m. and 15 p.m. because mid-day visits to them may have the least influence on attracting predators (Bayne and Hobson 1997). The nests were considered depredated when at least one egg was missing (Purger and Mészáros 2006), as the predator may visit the same nest repeatedly (Schaefer 2004). In case an egg had rolled out of the nest it was placed back, yet depredated nests were not replaced. The number of depredated nests was given separately for each study plot and ANOVA was performed in order to compare supplementary feeding sites with control sites. T-test was applied to reveal how fast nest predation occurred, by collating the numbers of depredated nests in two and three weeks time after establishment. Statistical analysis was performed using Statistica 7.0.

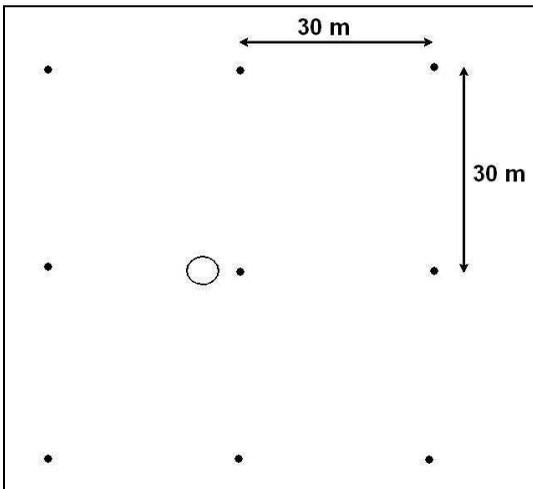


Figure 1. Experimental plot design. Dots indicate artificial nests, circle indicates supplementary feeding site.

Results

Out of 81 artificial nests, 46 (57%) were depredated, a half of which (23 nests) were located at supplementary feeding sites of high feeding intensity, 18 (39%) at feeding sites of low feeding intensity and 5 (11%) at control sites (Table 1). Comparing the number of depredated nests at feeding sites and at control sites revealed a significantly higher predation rate at feeding sites compared to control sites ($F_{1,7} = 32.5, p = 0.0007$). In two weeks, more nests were depredated at feeding sites of high feeding intensity than in sites of low feeding intensity ($t_4 = 10.00, p < 0.001$). In three weeks, the number of depredated nests in the two feeding sites of different feeding intensity did not differ significantly ($t_4 = 1.89, p = 0.132$). Three weeks after the establishment of the artificial nests, the number of depredated nests in feeding sites of low feeding intensity was higher than it had been a week before ($t_4 = -3.50, p = 0.025$), yet the latter relationship did not appear neither in feeding sites of high feeding intensity ($t_4 = -1.00, p = 0.374$) nor in control sites ($t_4 = -1.79, p = 0.148$; Fig. 2). Thus, nests around feeding sites of high feeding intensity were depredated sooner than at the sites of low feeding intensity.

Table 1. The number and percentage of depredated artificial nests in control sites and in the vicinity of supplementary feeding sites 15 and 22 days after placing. A1, A2, A3 – sites of high feeding intensity; B1, B2, B3 – sites of low feeding intensity; C1, C2, C3 – control sites.

Sites	15 days	22 days
A1	7 (78%)	7 (78%)
A2	7 (78%)	9 (100%)
A3	7 (78%)	7 (78%)
B1	3 (33%)	6 (67%)
B2	4 (44%)	5 (56%)
B3	4 (44%)	7 (78%)
C1	1 (11%)	3 (33%)
C2	0	1 (11%)
C3	0	1 (11%)

In most cases, the nests' predators could not be identified. Relying on physical evidence, the predator species could be identified in 24

cases only, which makes up 52% of all the depredated nests. Wild boar damage was usually identified by rooting and hoof prints, whereby extensive rooting damage in the nest site usually resulted in complete destruction, leaving no traces of the nest. In three cases, there were wild boar trails bypassing the nest, leaving the nest intact, which means that nests were discovered accidentally. Red fox and raccoon dog predation was distinguished by nest damage and eggshells scattering around the nest concavity. Half of the nests (12 nests) were probably depredated by wild boar and 5 (21%) nests either by raccoon dog or red fox. Small mammals were considered to be predators if one or two eggs were missing from the nest while the rest remained untouched – a total of 5 (21%) nests. Two (8%) nests were depredated by birds – one in a control site and the other at a supplementary feeding site of high feeding intensity. Bird predation was distinguished by a hole in the eggshell while most of the content was left inside the shell. At this point, the current data reflects a low rate of avian predation compared to mammalian predation.

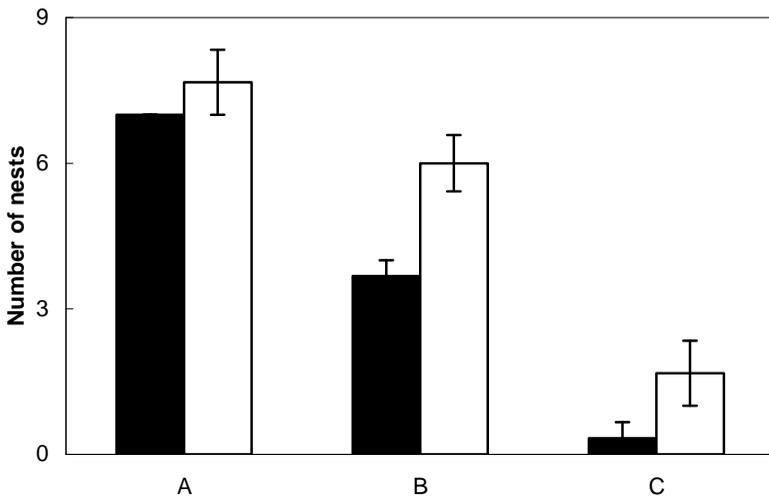


Figure 2. The mean number of depredated artificial nests (\pm standard error) 15 (black columns) and 22 (white columns) days after placing in the vicinity of supplementary feeding sites of high (A) and low (B) feeding intensity and in control sites (C).

Discussion

The results of the current study demonstrate that predation on artificial nests is greater near supplementary feeding sites than on control sites. These results are in accordance with previous studies (Cooper and Ginnett 2000, Lambert and Demarais 2001). Thus, supplementary feeding sites attract nest predators of ground-nesting birds. Moreover, the feeding sites of high feeding intensity attract more animals than feeding sites of low feeding intensity, and at the former sites the artificial nests were also depredated sooner. Checking the nests in two and three weeks' time after placing revealed that the maximum number (the limit at which no more nests were damaged) of depredated nests was reached sooner at feeding sites of high feeding intensity. The same limiting number of depredated nests would be reached at sites of low feeding intensity, if enough time has passed. However, the timeframe of three weeks in the current experiment was essential in consideration of the incubation period of gallinaceous birds (Jönsson *et al.* 1991). Higher regional predator densities are responsible for a higher nest predation probability (Kurki *et al.* 1997), yet the number of nests depredated by different species depends on their relative densities in the region as well (Angelstam 1986). Hence, one species may be a considerable nest predator at supplementary feeding sites – like the wild boar in Estonia – but not in some other areas where its density is lower.

As small mammals are capable of damaging eggs of only small gallinaceous birds (Maxson and Oring 1978), they do not directly affect the reproductive success of larger gallinaceous birds, such as the black grouse and the western capercaillie. Autumnal catches of small rodents in the experimental region showed that supplementary feeding sites not only attracted wild boars but also small mammals (compared to control sites in the distance of 150 m, outside their home range). The reason may probably lie in better food availability at supplementary feeding sites. All the catches included species, which either prefer or often feed on seeds and grain – a common component in the supplementary feed for the wild boar. Locally increased population density of small rodents may indirectly affect the nesting success of gallinaceous birds by

attracting potential predators of ground-nesting birds, such as the raccoon dog and the red fox (Purger *et al.* 2008).

During the experiment raccoon dogs were observed on two supplementary feeding sites of high feeding intensity. One of the feeding sites also included carrion (domestic pig), which may account for the frequent visits of predators (red fox, raccoon dog) to the site. This feeding site was the only one where all artificial nests were depredated. Such phenomenon hints that predation pressure on ground-nesting birds may vary at supplementary feeding sites depending on the feed provided at the site – whether it attracts predators that use scent for locating nests (Saniga 2002). However, it is not considered effective for the predators to specialize on active nest search because nests are available during a short period (Angelstam 1986). A negative relationship has been found between small mammal abundance and nest predation frequency, being a possible result of predators switching to an alternative food source in case the main food is insufficient (Šalek *et al.* 2004). But on the contrary, local increase in small mammal abundance may cause an increased nest predation in case predators moving towards a supplementary feeding site chance upon a bird nest, and depredate it.

The experiment showed that the wild boar does not have any specific nest-searching skills and predation was incidental, as also suggested by some earlier studies (Angelstam 1986, Henry 1969, Vickery *et al.* 1992). However, this data relies on experiments with artificial nests only, and wild boars could be a lot more successful in locating natural bird nests. For instance, the flush of a bird off the nest could attract the attention of a wild boar and hence ease locating the nest. From the assumption that locating nests is an incidental event, it proceeds that the higher wild boar densities in an area is, the higher proportion of ground-nesting birds' nests is depredated by wild boars in this area. Henry (1969) demonstrated that other nest predators may avoid the area due to the presence of wild boars, yet high densities of this species do not necessarily add additional predation to the nests of ground-nesting birds. However, the current experiment showed that apart from the wild boar, supplementary feeding sites also attracted

other potential nest predators and that an increased population density of wild boar does not keep other nest predators away.

Contrary to expectations, the circumstances with respect to the breeding success of gallinaceous birds were worse in areas close to supplementary feeding sites of low feeding frequency. Namely, gallinaceous birds breeding in Estonia can lay replacement clutches after the loss of a clutch, and an earlier nest-initiation (or re-nesting) is known to result in a higher nesting success (e.g. Storaas *et al.* 2000, Ludwig *et al.* 2010b). The artificial nest experiment demonstrated that by the end of the incubation period most of the nests at both types of supplementary feeding sites were depredated. Nevertheless, predation of nests around feeding sites of low feeding intensity occurred over a longer period of time, on account of which replacement clutches could be initiated later. Consequently, supplementary feeding of wild boar should be completely avoided in the vicinity of nesting territories of gallinaceous birds. Reducing the feeding intensity alone is insufficient.

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