Breeding birds on organic and conventional arable farms

Kragten, S.

Chapter 6

The effectiveness of volunteer nest protection on the nest success of northern lapwings *Vanellus vanellus* on Dutch arable farms

Steven Kragten, Jan C. Nagel & Geert R. de Snoo

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Lapwing egg destroyed by an agricultural operation

Abstract

Clutches of ground-nesting farmland birds are often destroyed by farming operations, resulting in insufficient reproductive success and subsequently declining populations. The aim of this study was to investigate whether volunteer nest protection can enhance nest success of ground-nesting birds. The study compared nest success of protected and unprotected northern lapwing *Vanellus vanellus* nests over two years on arable farms in the Netherlands. Because of different crop management, nest success of ground-breeding birds might differ between organic and conventional arable farms. The effectiveness of volunteer nest protection was therefore investigated on both farm types. Although nest protection significantly reduced nest loss due to farming operations, there were no significant differences in total clutch survival of protected and unprotected nests. However, sample sizes of unprotected nests, and protected nests on organic farms, were relatively small, which may have reduced statistical power. There were indications that protected nests were predated or deserted more often. We recommend exploring different ways to improve the effectiveness of volunteer nest protection through a further reduction of nest loss due to farming operations and predation.

Keywords: Agriculture; Organic farming; Arable; Predation; Desertion

Introduction

Over recent decades, changes in agricultural practice have led to a decline in the populations of several bird species characteristic of agricultural landscapes in Western Europe (Chamberlain *et al.*, 2000; Donald *et al.*, 2001, 2006; Robinson and Sutherland, 2002; Wretenberg *et* al., 2006). One species that has suffered from these changes is the northern lapwing *Vanellus vanellus*. Declines in lapwing populations have been reported in several countries, including the Netherlands, the UK, and Sweden (BirdLife International, 2004; Wretenberg *et* al., 2006), with low reproductive success cited as the most likely mechanism (Peach *et al.*, 1994). One factor responsible for reducing reproductive success is intensified farming operations which can result in high nest losses (Baines, 1990; Shrubb, 1990; Berg *et al.*, 1992).

Previous studies have shown that lapwings reach higher densities on organically managed than on conventionally managed arable farms (Christensen *et al.*, 1996; Kragten and de Snoo, 2007). However, the use of agrochemicals is prohibited on organic farms and therefore these farmers are restricted to using non-chemical methods of weed control. These methods include harrowing and hoeing which can lead to even higher nest losses compared to conventional crop management (Kragten and de Snoo, 2007).

In an effort to improve the nest success of lapwings and other ground-nesting farmland birds, Landschapsbeheer Nederland started a Volunteer Meadow Bird Protection programme, which has been in place on large tracts of farmland in the Netherlands for over a decade now. The aim of this study is to investigate the effectiveness of volunteer nest protection for lapwings on organic and conventional arable fields. To this end, we compared the nest success of protected and unprotected nests on both farm types. Protected and unprotected nests differ in a number of ways. First of all, the location of protected nests is communicated to the farmer which should reduce the risk of the nest being destroyed by farming operations. Additionally, the nests are marked in the field with two large bamboo canes (approximately 1 metre high) relatively close to the nest (approximately 3-5 metres). Marking of the nests is intended to reduce nest destruction by farming operations, but might also attract predators or increase nest desertion (Götmark, 1992). We therefore measured failure rates due to farming operations, predation and nest abandonment for both protected and unprotected nests.

Materials and methods

Study area

This study comprises data on lapwing nests collected in 2005 and 2006 in two large-scale agricultural areas in the Netherlands: Noordoostpolder and Oostelijk Flevoland (approximate location 52°36’29.65” N, 5°38’52.08” E). These are two relatively young, neighbouring polders of marine origin, reclaimed during the 1930s and 1950s, respectively. Their landscapes are similar: very open with a few vertical landscape elements (tree lines, wind turbines, power lines). Land use is mainly arable, but there is also some dairy farming. In both polders, the predominant crops are potatoes, cereals (both winter and spring), sugar beet, onions and vegetables. Because the majority of crops are spring-sown, most farming operations coincide with the lapwing breeding season. In the study area, lapwings reach densities of approximately 5-8 territories per 100 hectares on conventionally managed arable farms, and around 13 breeding pairs per 100 hectares on organic farms (Kragten and de Snoo, 2007).

As the landscape within both polders is uniform, farms with nest protection and farms without nest protection were similar in terms of surrounding landscape. All farms consist of one or more parcels of approximately 25 hectares, bordered by ditches. Vertical landscape structures, such as tree lines are only present around farms and along some main roads and larger waterways. Organic farmers in general had a more diverse crop rotation and grew more spring cereals than conventional farms, while conventional farms grew winter cereals and relatively more potatoes. Conventional farmers used pesticides and artificial fertiliser, while organic farmers used organic manure and applied non-chemical methods such as mechanical weeding to reduce weed burdens, and the use of natural enemies to control insect pests. Mechanical weeding is generally carried out using big machinery for harrowing and hoeing. Weeds may also be removed by hand.

Data collection

As protected nests, we used those found by the Volunteer Meadow Bird Protection programme. In the study area, 171 and 155 volunteers were active on 8314 and 8658 hectares of arable land in 2005 and 2006 respectively. In 2005, 121 arable farms participated in the volunteer nest protection programme, and in 2006 113 farms. Since nearly all of these farmers managed their land conventionally, the majority of protected nests were found on conventionally managed land (Table 10).

Table 10 Number of protected and unprotected nests used in this study. NOP = Noordoostpolder, OF = Oostelijk Flevoland, Org = organic farms, Conv = conventional farms.

	2005						2006					
	NOP		OF		Total		NOP		OF		Total	
	Org	Conv	Org	Conv	Org	Conv	Org	Conv	Org	Conv	Org	Conv
Protected	20	523	28	282	48	805	35	443	17	296	52	739
Unprotected	39	12	41	29	80	41	31	17	35	25	66	42

In 2005 and 2006, volunteers found respectively 853 and 791 lapwing nests which could be included in the analyses. Once found, these protected nests were marked with two bamboo poles (approximately one metre high) placed 3-5 metres away from the nest and farmers were informed of their location by pointing out the nests on a map of the farm. In this way, nests could be spared by farming operations. In 2005, protected nests were found and marked between 11 March and 17 June. In 2006, the first nest was marked on 25 March and the last on 17 June.

Unprotected nests were those found for a study comparing the nest success of lapwings on organic and conventional arable farms (Kragten and de Snoo, 2007). These nests were found on 20 organic and 20 conventional farms, comprising 720 hectares of organically managed and 809 hectares of conventionally managed land. These areas did not overlap with areas covered by volunteers. In 2005, 121 nests were found which could be included in the analyses and in 2006, 108 nests were found. Because half of the farms in this study were organic, the number of nests was more equal across the two farm types than was the case for the sample of protected nests (Table 1). The unprotected nests were not marked, and nor were farmers informed of their presence. In order to be able to relocate these nests, their location was recorded using a GPS device. In 2005, unprotected nests were found between 31 March 31 and 2 June. In 2006, the first unprotected nest was found on 5 April, and the last on 20 June.

In order to determine nest success, all nests were visited. Because volunteers did not always register all their visits, the visit frequency could not be determined for protected nests. However, for all nests included in the analyses, the finding (and marking) date and the day of the last visit were noted, so the number of nest days could be calculated and thus nest success could be calculated. Unprotected nests were checked by visiting them at one-week intervals. All volunteers and professional researchers were instructed in order to be able to determine the fate of a nest. Nests were recorded as successful when at least one egg hatched. Eggs were assumed to have hatched when small remnants of eggshell were present in the nest. Nests were assumed to have failed when no eggs hatched. If a nest was found empty, without small remnants of eggshells, or with larger pieces of eggshell nearby, the nest was recorded as predated. Nest predation was defined as the predation of a whole clutch. If there were signs of recent farming operations, and remnants of the nest were found, the nest was recorded as failed due farming activities. When a nest was found containing cold eggs, the nest was recorded as deserted. To verify this, one egg was arranged in the nest with its pointed end facing outwards and if the position of the egg remained the same at the next visit then nest desertion was confirmed.

Data analysis

The nest success of protected and unprotected nests was compared on organically and conventionally managed farms. Nest success was estimated using the Mayfield method (Mayfield, 1961, 1975). Differences in nest success of protected and unprotected nests were analysed at different levels. First, an overall test was carried out using a Generalised Linear Model with binomial error and logistic link (Aebischer, 1999), including all data. Additionally, likelihood-ratio tests were used to analyse the effects of year, farm type and polder (Aebischer, 1999). For example, in order to test for the effects of nest protection on organic farms in 2005 only nests found in this year and on this farm type were involved. Relative nest loss due to farming operations, predation and desertion was analysed and compared between protected and unprotected nests using a technique similar to a baseline hazard approach (Kleinbaum, 1996). In this approach, only nests that failed due to a specific cause are considered as failed. For example, the nest failure rate as a result of farming operations was calculated by defining failed nests as only those nests that failed due to farming operations. Nest failed due to other causes were considered as not failed and were included only until they were either lost from other causes or hatched.

Results

Effectiveness of nest protection

Table 11 gives an overview of the number of nests failed due to a specific cause. The overall test in which data of both years, study sites (polders) and farm type were combined showed no effect of volunteer nest protection on the nest success of Lapwings (GLM, $F_{1, 1886} = 1.22$, $P = 0.269$). When we analysed the data per year and per farm type, in all cases the daily nest survival rate (DSR) of protected nests seemed to be a little higher than that of unprotected nests, but differences were not significant (Organic: 2005 $D = 1.459$, df 1, $P = 0.0227$; 2006 $D = 0.085$, df 1, $P = 0.770$; Conventional: 2005 $D = 0.963$, df 1, $P = 0.326$; 2006 $D = 2.645$, df 1, $P = 0.104$) (Figure 6A). When we analysed the data per polder, it was only on organic farms in Noordoostpolder in 2005 that the DSR of protected nests proved higher than that of unprotected nests ($D = 8.952$, df 1, $P = 0.003$).

Lapwing nests mainly failed as a result of farming operations, predation or desertion (Table 11). Daily nest loss rates due to farming operations were significantly higher for unprotected nests on both organic and conventional farms and in both years (Organic: 2005 $D = 22.910$, df 1, $P < 0.001$; 2006 $D = 35.140$, df 1, $P < 0.001$; Conventional: 2005 $D = 6.744$, df 1, $P = 0.009$; 2006 $D = 11.880$, df 1, $P < 0.001$) (Figure 6B). This means that protected nests failed less often due to farming activities. On organic farms with nest protection, no nests failed owing to farming operations.

Table 11 Number (%) of successful nests and nests failed due to different causes.

	Protected nests				Unprotected nests			
	Organic		Conventional		Organic		Conventional	
	2005	2006	2005	2006	2005	2006	2005	2006
Total number of nests	48	52	805	739	80	66	41	42
Successful	33 (69%)	19 (37%)	584 (73%)	461 (62%)	41 (51%)	25 (38%)	27 (66%)	19 (45%)
Failed								
Farming operations	0 (0%)	0 (0%)	30 (4%)	69 (9%)	26 (33%)	28 (42%)	6(15%)	13 (31%)
Predation	5 (10%)	16 (31%)	99 (12%)	106 (14%)	11 (14%)	7 (11%)	7 (17%)	8 (19%)
Desertion	8 (17%)	3 (6%)	51 (6%)	67 (9%)	2 (3%)	2 (3%)	1 (2%)	2 (5%)
Other causes	0 (0%)	0 (0%)	2 (0%)	1 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Unknown	2 (4%)	14 (27%)	39 (5%)	35 (5%)	0 (0%)	4 (6%)	0 (0%)	0 (0%)

On organic farms in 2006 daily nest predation rates were higher for protected nests compared to unprotected nests.(D = 5.167, df 1, P = 0.023) (Figure 6C). However, in the other cases the tendency was opposite, though not significant (Organic: 2005 D = 0.122, df 1, P = 0.727; Conventional: 2005 D = 0.581, df 1, P = 0.446; 2006 D = 0.521, df 1, P = 0.471). Possible difference in predator abundance between the two polders could have an effect on the effectiveness of nest protection. Therefore, we analysed whether there was a difference in nest predation rates between the two polders. In 2006 nest predation rates were higher in Oostelijk Flevoland compared to Noordoostpolder for both protected and unprotected nests (Protected: D = 21.362, df 1, $P < 0.001$; Unprotected: D = 8.104, df 1, P = 0.004). As this polder effect was similar for both protected and unprotected nests, it is not likely that this has influenced the effectiveness of nest protection.

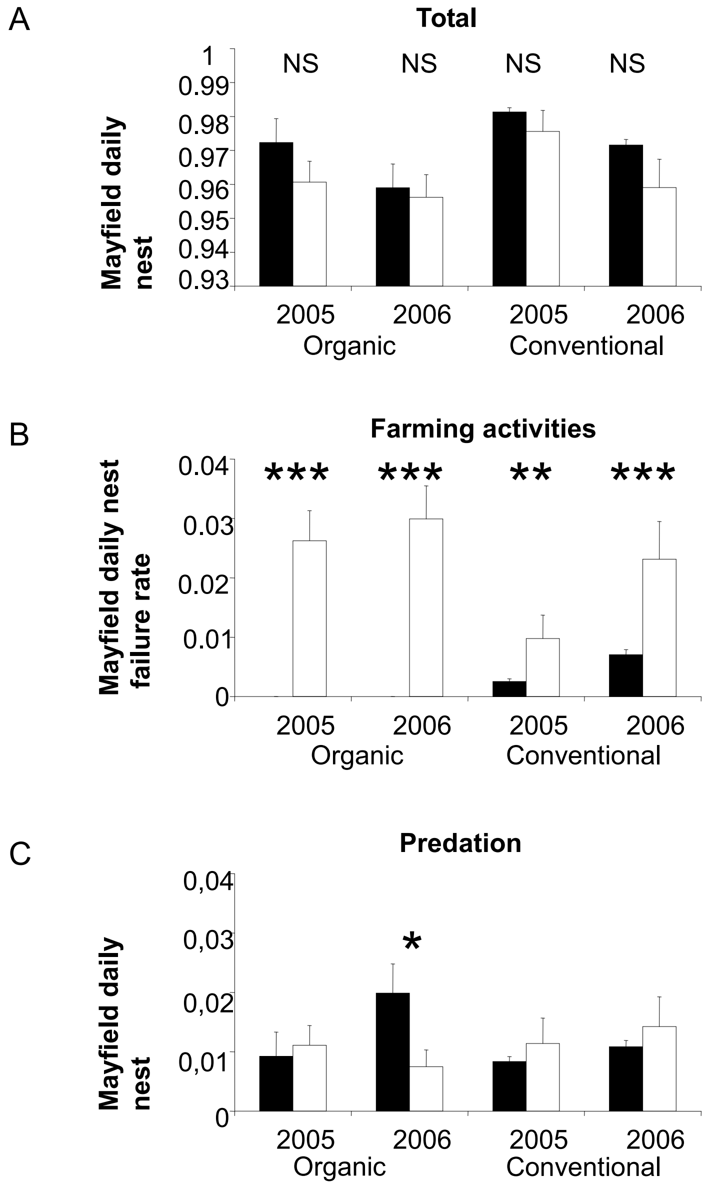

Figure 6 Total daily nest survival rates (A) and daily nest failure rates due to different causes of nest failure (B, C, D) (± SE) of protected (filled bars) and unprotected (open bars) lapwing nests on organic and conventional farms. Sample sizes are given in Table 10. Figures 6B, 6C and 6D show nest failure rates as a result of farming activities, predation and desertion respectively. * = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.005$.

D

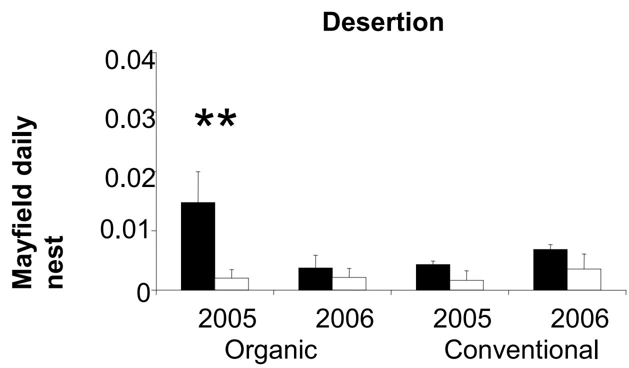

Figure 6 Continued

Additionally, on organic farms in 2005 nest desertion occurred more when nests were protected (*D* = 8.430, df 1, *P* = 0.004), but again in all other cases no significant differences were observed although here the tendencies were all in the same direction (Organic: 2006 *D* = 0.381, df 1, *P* = 0.537; Conventional: 2005 *D* = 1.297, df 1, *P* = 0.255; 2006 *D* = 1.035, df 1, *P* = 0.309) (Figure 6D). Hypothetically, if nest marking triggers nest desertion, nest desertion will happen immediately after nests are marked. Therefore, we compared the average nest days of deserted nests with nest lost due to other causes. The average number of nest days of deserted nests was not lower compared to other nests (Deserted: 11.5 days; Other causes: 10.0 days), so it was unlikely that nest marking resulted in immediate nest desertion.

Although for most nests the cause of nest failure could be determined, there were also nests for which this was not possible. Of the protected nests, the cause of failure could not be determined for 25% (2005) and 22% (2006) of the failed nests. Of the unprotected nests, these percentages were only 2% and 6%, respectively. Because of this, we analysed two scenarios to test the robustness of our findings presented in figure 6: (1) all nests with an unknown cause of nest failure failed because of farming activities, and (2) all nests with an unknown cause of nest failure were predated. We did not carry this analysis out for nest desertion, as nest desertion is easy to determine in the field, and therefore not likely to be missed. In the first scenario, the nest loss rate of protected nests remained significantly lower in most cases (Organic: 2005 $D = 12.616$, df 1, $P < 0.001$; Organic: 2006 $D = 4.916$, df 1, $P = 0.027$; Conventional: 2005 $D = 1.290$, df 1, $P = 0.256$; 2006 $D = 5.814$, df 1, $P = 0.016$) (Figure 7A). This reinforces the conclusion that nest protection reduces nest loss due to agricultural practices. When we applied the second scenario, differences in nest predation rates between protected and unprotected nests were still only significant on organic farms in 2006 (Organic: 2005 $D = 0.098$, df 1, $P = 0.754$; Organic: 2006 $D = 12.525$, df 1, $P < 0.001$; Conventional: 2005 $D = 0.003$, df 1, $P = 0.955$; 2006 $D = 0.001$, df 1, $P = 0.973$) (Figure 7B). This indicates that the effects of nest protection on predation might be limited.

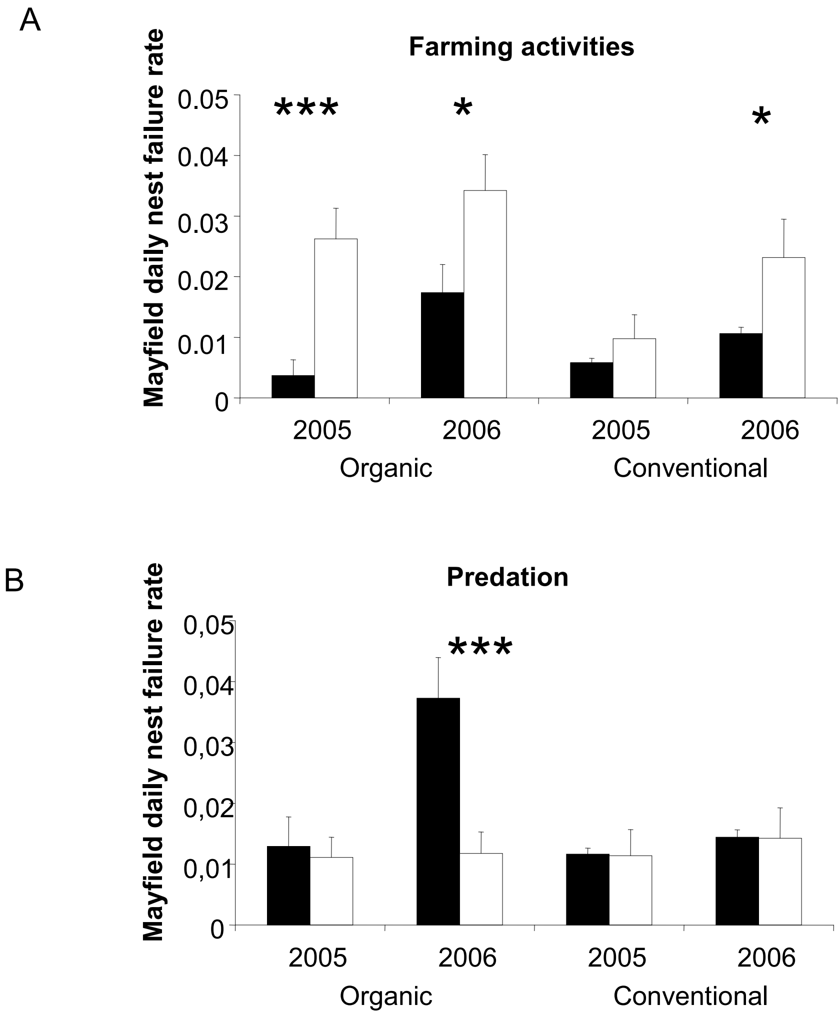

Figure 7 Daily nest failure rates (± SE) of protected (filled bars) and unprotected (open bars) lapwing nests on organic and conventional farms when failed nests with an unknown cause of nest failure are assigned to farming activities (A) or predation (B). Sample sizes are given in Table 10. * = $P < 0.05$, *** = $P < 0.005$.

Discussion

Even though protected nests failed significantly less often as a result of farming activities, total nest success of lapwing nests was not significantly enhanced by volunteer nest protection. However, sample size of unprotected nests, and protected nests on organic farms, were relatively small and this may have reduced statistical power (Hensler and Nichols, 1981). If we could have obtained similar-sized samples for these groups it is likely that that nest protection would be shown to have a small beneficial effect on nest success of lapwings. Despite these small sample sizes, limited evidence was found for higher predation and desertion rates of protected nests. In 2005, desertion rates of protected nests were higher on organic farms and in 2006 more protected nests on organic farms were predated. Furthermore, protected nests failed more often due to unknown circumstances. When all nests that failed through unknown causes were assigned to farming operations as a cause of failure, protected nests still failed less often through farming activities in three of the four cases. This reinforces the finding that volunteer nest protection indeed reduces nest loss due to farming activities.

Marking and visiting nests

Limited evidence was found that protected nests suffer from higher predation and desertion rates. Marking and visiting of nests and their effects on nest survival have always been topic of discussion (e.g. Götmark, 1992). Several studies have investigated the effects of nest marking or visiting on the outcome of lapwing nests. No effects of nest visiting on clutch survival have been found in these studies (Galbraith, 1987; Fletcher *et al.*, 2005). In our study volunteers often checked whether the nest was still present by observing it from a distance, without actually approaching the nest. On the other hand, unprotected nests were approached at weekly intervals. It is therefore likely that, on average, protected nests were visited less frequently than unprotected nests. So it is improbable that the higher nest predation and desertion rates of protected nests were a result of nest visiting. With respect to nest marking, Galbraith (1987) found no differences between the number of successful marked and unmarked nests. However, in Galbraith's study nests were marked inconspicuously compared to the protected nests in our study. It is possible that the conspicuous markings used in the Volunteer Meadow Bird Protection programme enhanced nest predation in some circumstances.

This study only found indications that marking of lapwing nests might increase nest predation or desertion rates. To examine formally whether nest marking does increase nest predation or desertion, an experimental study design should be used. In this design, nests should be left unmarked for a certain amount of time and then be marked. Nest survival rates over marked and unmarked periods can then be compared with control nests that remain unmarked throughout (Berg *et al.*, 1994).

How to improve nest protection programmes?

The effectiveness of volunteer nest protection could be enhanced in two ways. First, especially on conventional farms, marked nests were still destroyed by farming operations. Nest loss due to farming operations could be reduced by paying farmers for successful clutches on their land. This has been proven to be effective for breeding waders on dairy farms in the Netherlands (Musters *et al.*, 2001), as farmers spare the nests during their work. The second possibility would be to experiment with different nest marking methods, which might reduce nest predation. Currently, volunteer nest protection takes place by placing large poles relatively close to the nest and this study found limited evidence that this might increase nest predation rates. Galbraith (1987) found that lapwing nests which are inconspicuously marked at a larger distance did not suffer from higher predation rates compared to unmarked nests. However, marking of the nests should happen in such a way farmers still notice the nests, so nests should not be marked too inconspicuously. Field-experiments should point out the best method. As well as the type of marking, the timing of nest marking could be changed to reduce nest loss due to predation. Currently, nests are marked immediately after they have been found. As marking could increase clutch predation, the period a nest is marked should be reduced as much as possible. In other words, nests should ideally be marked just before farming operations will be carried out. It is questionable whether this will be practicable as this requires volunteers to be available at short notice during the breeding season.

In general, nest protection programmes generally aim at larger species, such as northern lapwing, black-tailed godwit *Limosa limosa,* Montagu's harrier *Circus pygargus* and stone curlew (e.g. Musters *et al.*, 2001; Koks and Visser, 2002). However, ground-nesting songbirds such as skylark *Alauda arvensis* and whinchat *Saxicola rubetra* still suffer from high nest loss rates due to farming operations (Vickery *et al.*, 2001; Müller *et al.*, 2005). Therefore, in the future nest protection programmes could aim more at these species as well, although the nests of these species are in general more difficult to find.

Volunteer conservation programmes could be a useful instrument in farmland bird conservation, as they can involve many people and consequently raise awareness of population declines of farmland birds. It is therefore of high importance that such programmes, which potentially have a large social impact, are designed in such a way that they really work.

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