

1 **Use of microsatellite-based paternity assignment to establish**  
2 **where Corn Crake *Crex crex* chicks are at risk from**  
3 **mechanised mowing**

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8 **APPENDIX S3**

9 **ASSESSMENT OF THE POTENTIAL EFFECTS OF UNCERTAINTY AND FAILURE OF**  
10 **ASSUMPTIONS ON THE CONCLUSIONS OF THE STUDY**

11

12 **Principal sources of uncertainty**

13 We identified the following potential sources of uncertainty which might affect the  
14 robustness for our conclusions as they apply to conservation practice.

15 (1) Difference between the location of a brood before the disturbance involved in drive  
16 catching and the assumed location at the centre of the drive area.

17 (2) Uncertainty about paternity assignment.

18 (3) Error in estimating the position of singing males.

19 (4) Uncertainty about the identity of the male at a singing location.

20 (5) Error in the identification of the singing location on or about the time of clutch  
21 initiation.

22 (6) Difference between ecological conditions in the study area and the main UK range of  
23 the Corn Crake in Scotland where most conservation practice might be affected.

24 We consider each of these in turn in the following sections.

25

26 **Difference between the location of a brood before the disturbance involved in drive**  
27 **catching and the assumed location at the centre of the drive area**

28 We report a simple assessment of the sensitivity of our conclusions to the assumption about  
29 brood location in the main text by repeating our analyses with broods assumed to be as near  
30 to and as far from the assigned father as possible, within the drive area where the brood was  
31 captured. We found that some broods were further from the father than the 250 m threshold  
32 beyond which mowing was formerly thought to be safe even when we adopted the extreme  
33 assumption that all broods were located at the nearest point to the father before being  
34 disturbed by the drive. We consider that is highly unlikely that this extreme scenario is  
35 close to the real situation. Hence, we think that our conclusion is robust against failure of  
36 assumption locating broods at the drive centre.

37

38 **Uncertainty about paternity assignment**

39 Paternity of young was assigned to a particular sampled adult male if the estimated  
40 probability of paternity was  $\geq 0.80$ . Whilst it is possible that another male was the father, it is  
41 unlikely that any of the other sampled males present in the hatching year was the father  
42 because the highest paternity probability for the highest ranking alternative sampled  
43 potential father was  $>0.20$  lower in all cases. We also note that the distance rank of the  
44 assigned father of unfledged young was most frequently the nearest sampled male to the  
45 brood and never more than the third ranked male (see Main text and Table 2). This relative

46 proximity, compared with other potential fathers, would be unlikely to occur if there were  
47 errors in paternity assignment. Finally, we would expect that, if paternity assignment errors  
48 occurred, they would be more likely for brood-father assignments with paternity  
49 probabilities between 0.80 and 0.90 than for assignments with probabilities  $\geq 0.90$ . In that  
50 case, we would expect the distance ranks of assigned fathers to be lower (i.e. closer) for the  
51 brood-father assignments with probabilities  $\geq 0.90$ . However, the mean distance rank for  
52 broods with paternity probabilities  $\geq 0.90$  was slightly higher (father further away: mean  
53 rank = 2.4; range 1-5;  $N = 8$ ) than for those with paternity probabilities between 0.80 and 0.90  
54 (mean rank = 2.0; range 1-6;  $N = 6$ ). We conclude that errors in paternity assignment are  
55 unlikely to have occurred and are therefore unlikely to affect the robustness of our  
56 conclusions.

57

### 58 **Error in estimating the position of singing males**

59 We determined the singing positions at night, but singing male Corn Crakes can be  
60 approached to within about 10 metres without disturbing them and we approached on foot  
61 to check locations and used hand-held GPS devices and landmarks such as ditches and  
62 gateways (see main text Methods) to map positions. Six of the singing places of assigned  
63 fathers on the date nearest to the clutch initiation date involved capturing the male by  
64 placing a mistnet close to ( $< 10$  m) the singing place. We consider that the accuracy of  
65 location of all the singing places of assigned fathers on the date nearest to the clutch  
66 initiation date was within 20 m. This distance is small compared to the mean brood-father  
67 distance, so we conclude that this potential source of error is unlikely to have biased our  
68 results significantly.

69

70 **Uncertainty about the identity of the male at a singing location**

71 We captured the male and applied or read his ring for six of the singing places of assigned  
72 fathers on the date nearest to the clutch initiation date, so there is no doubt about the  
73 identity of the male singing at that location in those cases. For the remaining cases we used  
74 the rules described in the main text of the Methods to infer which male was present at the  
75 singing site. Whilst we cannot exclude the possibility that a singing record was attributed  
76 the wrong male, we think that this is highly unlikely, based upon experience of capturing  
77 much larger numbers of singing males in areas of Scotland where the same record  
78 attribution rules were used. Another way in which such errors could have occurred would  
79 be if our method for determining the total number of singing males present from the night-  
80 time survey results had been inaccurate and had led to fewer males being assumed present  
81 than were really there. In that case, one of the 'missed' males could actually have been  
82 present at a singing location which we attributed to a sampled male. However, the section  
83 of Appendix S1 'Validation of estimated numbers of singing males' indicates that our  
84 estimates of total numbers of males were not in error to any substantial extent. Hence, we  
85 conclude that errors caused by misattributing singing records to sampled individual males  
86 are unlikely to have occurred and are therefore unlikely to affect the robustness of our  
87 conclusions.

88

89 **Error in the identification of the singing location on or about the time of clutch initiation**

90 We calculated the probable clutch initiation date of a brood using estimates of chick age and  
91 calculated brood-father distances using the singing record closest in time to that date. The  
92 methods used to make the age estimates are accurate to within a few days when applied to a  
93 single young bird. In our study, we used measurements from up to four young to determine

94 the average age of brood-mates in unfledged broods and this is likely to likely to have  
95 further increased accuracy. However, the nearest date of an available singing record of the  
96 assigned father of a brood to its estimated initiation date might well differ from the brood's  
97 true clutch initiation date by up to a few days. This might sometimes lead to the estimated  
98 brood-father distance being larger or smaller than the true distance. We do not think that  
99 there is a straightforward formal way to quantify the potential magnitude of such errors.  
100 However, inspection of the maps in Appendix S2 reveals three instances in which the  
101 location of an unfledged brood is more than 250 m from any of the singing locations of the  
102 assigned father within a ten day period centred on the clutch initiation date. We also note  
103 that our results are intended to be applied to practical conservation management in which  
104 managers decide where to offer protection from mowing risk in relation to locations of  
105 singing males recorded on their night-time surveys. They usually conduct two or three  
106 surveys per season compared with the 24-27 surveys conducted per season in our study.  
107 Therefore, many of the night-time singing locations known to conservation managers, being  
108 many fewer per male, are likely, by chance, to be much nearer or much further from the  
109 position of the nearest brood than the distribution of true brood-father distances, if they  
110 were known. For this reason, our proposal to extend protection from mowing risk to areas  
111 within 500 m of the nearest singing male is not likely to lead to frequent erroneous and  
112 unnecessary protection of areas where broods are absent. Taking all these factors into  
113 account, we conclude that error in the identification of the singing location on or about the  
114 time of clutch initiation is unlikely to affect the robustness of our conclusions about  
115 conservation management.

116

117 **Difference between ecological conditions in the study area and the main UK range of the**  
118 **Corn Crake in Scotland where most conservation practice might be affected.**

119 Ecological conditions within the range of the Corn Crake in Scotland vary substantially from  
120 area to area, as do Corn Crake population densities. Hence, we cannot exclude the  
121 possibility that brood-father distances in some areas of Scotland are larger or smaller than  
122 those we estimated at the Nene Washes. However, we note that the brood-father distances  
123 for broods up to 20 days old were as was expected from the results from previous radio-  
124 tracking studies of nest locations and dependent brood locations in Scotland. This makes a  
125 large discrepancy due to our study site being in southern England rather than Scotland  
126 unlikely. In several respects, the Nene Washes grasslands are broadly similar to those in  
127 many parts of the Corn Crake's range in Scotland. They are divided up into fields by ditches  
128 and some fields are grazed by livestock so that they have vegetation too short for Corn  
129 Crakes, whilst others have livestock excluded to produce hay or silage crops so the  
130 vegetation is sufficiently tall. If anything, the Nene Washes grasslands have a greater  
131 proportion with tall enough vegetation for Corn Crakes than most parts of the Corn Crake  
132 range in Scotland, principally because grass growth is more rapid in the south. This would  
133 lead us to expect that Corn Crake broods might need to move less far from the nest to find  
134 safe foraging areas at the Nene Washes. If that was the case, the safe distances between  
135 singing male sites and areas of mowed grassland might need to be larger in Scotland than  
136 the 500 m we suggest based upon our study in England. However, given that we are  
137 already proposing that the threshold distance should be doubled, we suggest that evidence  
138 from further research in Scotland would be needed before adoption of a larger safe distance  
139 would be justified.

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