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Experimental assessment of release methods for the re-establishment of a red-listed galliform, the grey partridge (*Perdix perdix*)

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ABSTRACT

Large-scale declines of grey partridges *(Perdix perdix)* since the 1980s have led to local extinctions in the species' range. As part of a UK recovery programme, we aimed to identify the best methods of re-establishing grey partridges through releasing in areas of extinction where a suitable environment has been restored. In East Anglia and southern England we followed the fates and breeding success of radio-tagged (one site per region) and colour-ringed birds (12 sites per region) of individuals released using five different techniques. The average resighting rate after the first 6 months post-release was 20% for bantam-reared and artificially-reared fostered young, 7% for unfostered young, 10% for full-grown birds in autumn-released coveys and 9% for spring-released adults. For birds that survived the first 6 months, the percentage resighted after a second 6-month period averaged 35%. Across both regions, 65% of grey partridge losses were due to predation of which 58% were killed by mammalian predators and 37% by raptors. Of birds still alive during the breeding season, 88% established their breeding territory within 1.5 km of the release location. There were no detectable differences in breeding success between release methods, but the proportion of females with broods among released birds was a third lower than among wild birds. We recommend re-establishing grey partridges by first releasing autumn coveys, followed by fostering. However, where wild birds are still present, the conservation focus should be on habitat improvements and predation control.

1. Introduction

Worldwide, the order Galliformes has one of the highest proportion of threatened species in any bird order (Rands, 1992; Fuller et al., 2000; Birdlife International, 2000). To counteract local extinctions, it is important to have adequate tools for re-establishment in accordance with IUCN guidelines (IUCN, 2004; WPA/IUCN, 2009). Projects involving re-introductions have become increasingly popular in the past 30 years and there is now a recognisable field of re-introduction biology (Seddon et al., 2007). However, only 8% of 454 papers reviewed by Seddon et al. (2007) used an experimental approach, the vast majority (59%) being retrospective studies. In order to improve the success of releases as well as to understand the general biological mechanisms involved in this field of conservation biology, more experiments are needed to evaluate releasing techniques (Kleiman et al., 2000; Meretsky et al., 2001; Seddon et al., 2007).

In this paper, we take the grey partridge *Perdix perdix* (red-listed as Vulnerable, BirdLife International, 2004) as a model species because its biology and critical needs are particularly well researched and understood (a pre-requisite for re-introductions; IUCN, 2004). In the past, restocking attempts have generally been fragmented and ad hoc. In France alone, over 237,000 partridges have been released since 1960 using a wide range of techniques, with no measurable national population recovery (Bro and Mayot, 2006).

Up to the early 20th century, the grey partridge (*P. perdix*) was one of the most common farmland bird species in Europe (Potts, 1986; Birkan and Jacob, 1988). However, over the last 50 years the grey partridge has declined severely in abundance and range throughout its natural range and is a species of European conservation concern (Hagemeijer and Blair, 1997; BirdLife International, 2004). In the UK, numbers of grey partridge have declined by over 75% during the last 20 years (Baillie et al., 2007) and in many parts of the country, the species has become locally extinct (Gibbons et al., 1993). The grey partridge is a priority species under the UK Biodiversity Action Plan whose targets are; to restore numbers from 70–75,000 pairs in 2000, to 160,000 pairs nationally by 2020, and to expand its 1990 range (Aebischer, 2009).

The causes of the species decline have been well investigated (e.g. Potts, 1980; Putaala and Hissa, 1998; Bro et al., 2000), and are mainly linked to the intensification of agriculture and predation. Further work has shown that improved habitat management

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in combination with predator management and feeding are effective measures to increase low-density partridge numbers (Aebischer and Ewald, 2004). However, in many areas grey partridge numbers have now either gone extinct or reached levels where management improvements alone are unlikely to trigger recovery owing to the high natural mortality and low dispersal rate of the species (Potts, 1986). In these cases re-establishment through releasing is likely to become an important conservation tool in the future and arguably the only way to restore local grey partridge numbers to self-sustainable levels.

Grey partridge releasing practices date back to the 19th century and predominantly served to supplement partridge numbers for shooting. Several largely historic methods included some form of fostering chicks to failed wild breeders (overview in Browne et al., 2009). The standard releasing practice on shoots across Europe is the release of game-farm-reared juveniles, usually in groups of 15–100 at an age of 10–12 weeks in late summer. Apart from occasional cases where released juvenile birds were spontaneously adopted by wild grey partridges that failed to produce their own young, these birds have been shown to have very low survival, high dispersal rates and very low breeding success (Birkan, 1977; Rands and Hayward, 1987; Browne et al., 2009), so do little to bolster the wild breeding stock. The main reason for the high post-release mortality is the lack of appropriate anti-predator behaviour, which is not only genetically determined but also learnt from the parents (Beani and Dessì-Fulgheri, 1998; Dowell, 1990; Beck et al., 1994). This behavioural deficiency and hence reduced post-release survivorship is a common problem among captive-reared species (McPhee, 2003). One consequence is that many more captive-reared individuals are required for successful re-establishment than if wild-like animals were used (McPhee and Silverman, 2004). Additionally, captive-bred animals typically have reduced post-release breeding success compared to their wild counterparts. There is wide consensus that the translocation of wild adult individuals results in the highest re-introduction success rates as all individuals involved already have normal anti-predator behaviour, leading to high survival and breeding success (Church, 1993; Sarrazin and Barbault, 1996; Stanley Price and Fairclough, 1997; Reed, 1999). However, in many re-introduction projects wild individuals are not available because of the very scarcity that made the re-introduction necessary in the first place. This is the case in the grey partridge, owing to their fast-declining numbers.

Fostering captive-bred juveniles to wild parents who failed to produce their own brood has the advantage that young learn from experienced parents (Dowell, 1992; Buner and Schaub, 2008). These juveniles could be reared by their own parents (parent-reared), reared by a bantam *Gallus domesticus* (bantam-reared) or hatched in an incubator (artificially-reared). Where partridges have become locally extinct, however, fostering is not an option. In those cases an adult founder population needs to be established first. Where translocated birds are unavailable, the most promising options for grey partridges in this scenario are the release of family groups in autumn or of pairs in spring (Browne et al., 2009). Partridge families (coveys) stay together until pairing starts in late winter (Potts, 1986). In the covey juveniles learn survival skills from their parents, so releasing birds as a covey makes use of their natural behaviour. Releasing birds as spring pairs on the other hand has the theoretical advantage of avoiding a peak of predation losses in February–March (Watson et al., 2007).

In accordance to the demand for evidence-based conservation (Sutherland et al., 2004) this study aims to identify the most practical and successful release method for grey partridges as part of a national research programme striving to meet the UK Biodiversity Action Plan targets. It takes into account numerous previous grey partridge release studies across Europe (e.g. Birkan and Damange, 1977; Putaala and Hissa, 1998; Meriggi et al., 2002; Bro and Mayot, 2006; Buner and Schaub, 2008) together with non-peer-reviewed publications and experience gained by practitioners (Browne et al., 2009). We therefore tested only the most promising release methods that were also relatively simple to adopt by those wishing to re-establish the species on their land. In particular, we compare survival rates, dispersal distances and breeding success of full-grown birds released as family groups in autumn, and pairs released in spring, and bantam- and artificially-reared juveniles fostered to failed free-living breeders.

2. Materials and methods

2.1. Experimental design and study sites

Where too few wild grey partridges exist for fostering, only the releases of full-grown birds released in autumn (‘autumn coveys’) or pairs released in spring (‘spring pairs’) is feasible. Accordingly, the experimental design is based on two types of study site, one ‘with’ partridges (at least 4 pairs/km^2), where fostering was applicable immediately; and sites ‘without’ partridges (in practice under 4 pairs/km^2), where adult birds needed to be established before fostering was practical. The experiment took place over 2 years. In the first year, two fostering techniques (one of bantam-reared juveniles, and one of artificially-reared juveniles) were randomly but equally allocated to six sites ‘with’ partridges. Two methods using full-grown birds were allocated in the same way to six sites ‘without’ partridges. In the second year, each of the three sites that had received the same method in Year 1 were randomly allocated one of the remaining three methods. This way, in each year, releases of adults took place on half the sites, and releases of juveniles on the other half (Table 1). In addition to these 12 sites (hereafter termed ‘extensive sites’), all four release methods were implemented simultaneously in both years at a further ‘intensive site’. This design was replicated across two regions (Fig. 1), East Anglia, where predator densities are relatively low and grey partridges are still widely distributed, and southern England, where predator densities are relatively high and grey partridges occur mainly at low densities (Gibbons et al., 1993). In accordance with the ‘IUCN Re-introduction Guidelines’ (IUCN, 2004; WPA/IUCN, 2009), release sites were selected such that on at least 4 km^2, at least 3% of the area was farmed in a way that provided grey partridge nesting habitat (mainly tussocky grass margins along hedgerows) and foraging habitat (game crops, weedy strips and set-aside). In both regions the farmers mainly grew winter wheat, oilseed rape, maize and winter beans; in East Anglia also sugar beet. All farms grew at least three different crops in rotation.

Additionally there had to be no intention to shoot or release additional grey partridges during the experiment and no intensive releasing and shooting of other gamebirds. In East Anglia all 13 sites had full-time gamekeepers and released some red-legged partridges (*Alectoris rufa*) and pheasants (*Phasianus colchicus*) for

Table 1
Experimental layout of releasing methods at extensive sites in relation to presence of wild grey partridges, site and year. A1 = autumn release of adult birds (as coveys), A2 = spring release of adult birds (as pairs), J1 = Bantam-reared fostered juveniles, J2 = artificially-reared fostered juveniles. Sites without wild grey partridges = under 4 pairs/km^2, sites with wild grey partridges = around 4 pairs/km^2.

Sites without wild grey partridges						
Site	1	2	3	4	5	6
Year 1	A1	A1	A1	A2	A2	A2
Year 2	J1	J2	A2	J1	J2	A1
Sites with wild grey partridges						
Site	7	8	9	10	11	12
Year 1	J1	J1	J1	J2	J2	J2
Year 2	A1	A2	J2	A1	A2	J1