Ibis (2004), **146** (Suppl. 2), 41–49

Conservation management of Lapwing *Vanellus vanellus* on lowland arable farmland in the UK

ROB SHELDON,[1]* MARK BOLTON,[1] SIMON GILLINGS[2] & ANDY WILSON[3]†
[1]*The Royal Society for the Protection of Birds, The Lodge, Sandy, Bedfordshire SG19 2DL, UK*
[2]*British Trust for Ornithology, The Nunnery, Thetford, Norfolk IP24 2PU, UK*
[3]*British Trust for Ornithology Scotland, University of Stirling, Stirling FK9 4LA, UK*

Lapwing *Vanellus vanellus* is known to be declining throughout much of its UK breeding range. The ecological requirements of the species are well known and a variety of mechanisms exist which can be implemented to help recovery. Arable options within agri-environment schemes can be used to provide breeding habitat throughout the species' UK range, and targeted recovery projects have been shown to have the potential to deliver increases in breeding pairs at the local level. The farming community need to be made aware of the requirements of Lapwing if agriculture and conservation needs are to be integrated.

In recent decades there have been widespread declines in the number and range of many bird species dependent on lowland farmland in Britain (Fuller *et al.* 1995, Siriwardena *et al.* 1998). A growing body of evidence suggests that these changes are linked to changes in agricultural practices (e.g. Chamberlain *et al.* 2000).

There have been a number of recent conservation successes; Corncrake C*rex crex*, Stone Curlew *Burhinus oedicnemus* and Cirl Bunting *Emberiza cirlus* have all increased in recent years (Aebischer *et al.* 2000, Peach *et al.* 2001). However, these species are scarce and have a limited range within the UK, thus lending themselves to targeted conservation management. How can the declines of common and widespread farmland birds be turned around? The Lapwing *Vanellus vanellus* offers an excellent opportunity for such a challenge to be met because:

(1) it is an extensively studied species with well understood ecological requirements,

(2) it is a non-contentious species, popular with both farmers and the general public,

(3) it is widespread throughout the UK, occurring in a variety of habitats, and

(4) there are a number of mechanisms that can be used to integrate agricultural needs and conservation requirements.

This paper reviews the current knowledge of Lapwing population trends and ecology and suggests some practical conservation measures.

REVIEW OF LAPWING POPULATION TRENDS AND ESTIMATES

The Lapwing population has fluctuated throughout the last two centuries (Gibbons *et al.* 1996). A general decrease in the 19th century was followed by a period of population recovery after the implementation of the 1926 Lapwing Act, which restricted the collection of Lapwing eggs (Holloway 1996). Recent population trends documented by the BTO/JNCC's (Joint Nature Conservation Committee) Common Birds Census (CBC) show relative stability until the early 1980s followed by a steep decline (Baillie *et al.* 2001).

In England and Wales, two national breeding surveys were carried out in 1987 (Shrubb & Lack 1991) and 1998 (Wilson *et al.* 2001), allowing a direct comparison of recent population estimates, trends and distribution. In 1998, the population estimate was 63 000 (95% confidence limits 55 268–74 499); this is an overall decline of 49% since 1987. Declines were common to all regions but were least in Yorkshire and Humberside (–28%) and greatest in southwest

*Corresponding author.
Email: robert.sheldon@rspb.org.uk

Present address: †School of Forest Resources, Pennsylvania State University, University Park, State College, PA 16802, USA

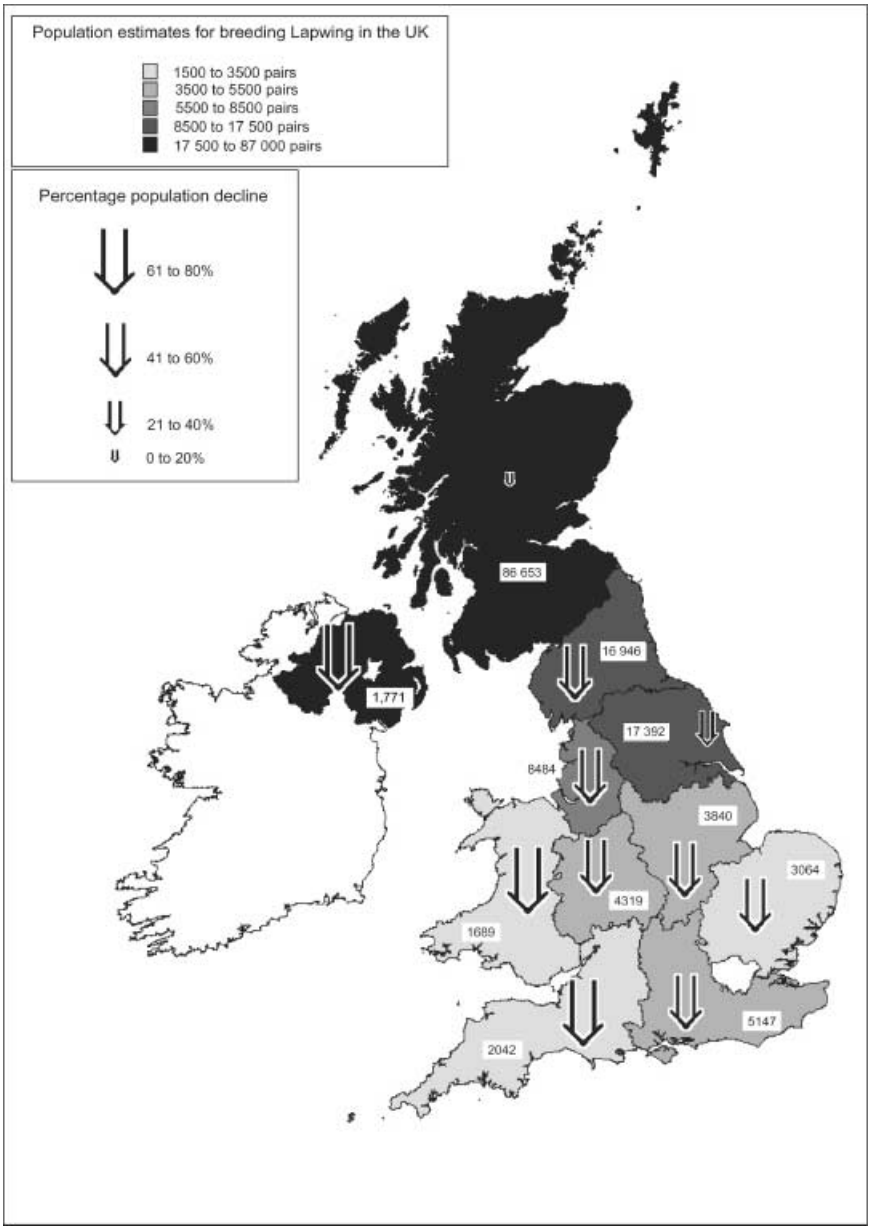

Figure 1. Population estimates and percentage population decline in breeding Lapwing in the UK. Data for England and Wales are for the period 1987–98 (Wilson *et al*. 2001), data for Northern Ireland are for the period 1987–99 (Henderson *et al*. 2002) and data for Scotland are for the period 1992–2000 (O'Brien *et al*. 2002).

England (–64%) and Wales (–77%) (Fig. 1). The North England region and Yorkshire and Humberside held more than 50% of the total population of breeding Lapwing in England and Wales (Fig. 1). A reduction in site occupancy was also evident, with only 29% of randomly selected tetrads holding breeding Lapwings compared with 39% in 1987.

Recent surveys in Scotland suggest that numbers of breeding Lapwing on 'farmed' land are relatively stable. Repeat surveys between 1992 and 93 (O'Brien 1996) and 1997/98/2000 (O'Brien *et al*. 2002) recorded a non-significant population decline of 8%. The most recent population estimate was about 87 000 pairs, more than half of the UK breeding population. Despite overall stability, there are suggestions that there are some large local declines. In the mid 1980s

the arable area of the Carse of Stirling (Stirlingshire) held up to 162 pairs of breeding Lapwing (Galbraith 1988). A survey in 2002 found only ten breeding pairs (M. O'Brien pers. comm.).

In Northern Ireland the breeding population has declined from an estimated 5250 pairs in 1987 (Partridge & Smith 1992) to 1771 pairs in 1999 (Henderson *et al.* 2002), a decline of 66% in 12 years. In some counties the range contraction has been staggering; in Antrim and Down, pairs were recorded in four out of 38 tetrads surveyed in 1999, an occupancy rate of 10%, compared with 70% in 1987.

Data from the Winter Atlas (Lack 1986) from the early 1980s suggested 1.5–1.75 million individuals in Britain and Ireland. There is no extensive monitoring on which to assess winter trends, which are affected by fluctuations induced by cold weather. Nonetheless, the increasing numbers using coastal sites hints at some changes in distribution which are borne out by the current distribution of large Lapwing flocks, a high proportion of which fall in the arable zone of lowland Britain (Gillings 2003a).

REVIEW OF LAPWING HABITAT REQUIREMENTS ON ARABLE FARMLAND

In both the 1987 and the 1998 surveys of England and Wales about 40% of breeding pairs were found on arable farmland. In Scotland, Galbraith *et al.* (1984) showed that about 50% of Lapwing pairs were associated with arable land, and in Northern Ireland a habitat preference for arable habitats was identified (Henderson *et al.* 2002).

The timing of tillage is of utmost importance, with spring tillage being preferred and autumn tillage being avoided (Shrubb & Lack 1991, Wilson *et al.* 2001). Indeed, the trend is of increasing selection for spring tillage with increased avoidance of autumn tillage. This increased avoidance of autumn tillage is probably linked to intensification of crop management, resulting in improved early crop growth and structural homogeneity, rendering the habitat unsuitable for the Lapwing anti-predator defence, which relies on good all round vision. The main management changes in autumn-sown cereals have been the introduction of tramlining techniques, the use of autumn herbicides, early nitrogen dressings on wheat crops and the use of foliar fungicides. The most important impact of these changes has been to increase the density and evenness of plant stands in the early stages of the growing season, which coincides with the Lapwing breeding season (O'Connor & Shrubb 1986). There is a strong correlation between the CBC farmland index for Lapwing and the decreasing amount of spring-sown cereal (Shrubb 1990).

Within arable landscapes the variety of crop types grown can be important in determining the length of the Lapwing breeding season. Lapwings generally avoid fields once the vegetation reaches a certain height, with thresholds varying among crop types (Sheldon 2002).

Within arable fields Lapwings are particularly vulnerable to agricultural operations such as ploughing, rolling and chemical applications. Reviews of published studies of Lapwing nesting success show that nest failure rates are relatively high, but that the causes vary. In an agricultural context, farming operations are always important and predation can be significant (Hudson *et al.* 1994, Sheldon 2002). To reduce the likelihood of predation Lapwings select open habitats, distant from suitable predator perches and linear features, such as field boundaries, pylons and roads (Reijnen *et al.* 1996, Milsom *et al.* 2000). Nest survival has been shown to increase when nests are placed further away from predator perches and/or boundary features (Berg *et al.* 1992, O'Brien 2000, Sheldon 2002). Lapwings also adopt a semi-colonial nesting strategy that has been shown to enhance nest survival through co-operative defence (Berg *et al.* 1992). Furthermore, Goransson *et al.* (1975), Elliot (1985), Baines (1990) and Berg (1996) all recorded lower losses of artificial nests placed within Lapwing colonies compared with those placed outside. However, Berg (1996) questions the validity of using artificial nests for measuring predation rates of real nests. Conversely, Galbraith (1988) and Sheldon (2002) found no relationship between colony size and nest survival (using observations of real nests). In populations where nest loss is primarily due to agricultural operations it may be a disadvantage to nest in colonies as all nests are likely to suffer the same fate.

Lapwings have an eclectic diet including a wide range of taxonomic groups (Wilson *et al.* 1996), although a number of studies have shown that earthworms can be particularly important during the prelaying period (Högstedt 1974), territory formation (Berg 1993) and in the selection of adult foraging habitat throughout the breeding season (Galbraith 1989, Blomqvist & Johansson 1995). Earthworms have also been shown to be an important component of chick diet; indeed as chicks develop they depend on a diet rich in earthworms to maintain growth rates and body condition (Beintema *et al.* 1991, Sheldon 2002).

Suitability of nesting fields is increased if they are near, or adjacent, to pasture (Galbraith 1988) or damp areas (Berg *et al*. 1992), which are used as brood rearing areas. Brood survival has been shown to be negatively correlated with the distance between nest-sites and chick foraging areas (Blomqvist & Johansson 1995). A comparison of brood movements showed that in Cambridgeshire, an area characterized by less diverse cropping patterns and large fields, broods moved greater distance than in Shropshire (Sheldon 2002). In the 1998 Lapwing survey, Wilson *et al*. (2001) showed that Lapwing express a strong selection for spring-tilled fields that are adjacent to grass fields. This ideal combination represents the key habitat types for the two major components of the Lapwing breeding cycle, i.e. nesting and brood rearing habitat. As agricultural systems have become increasingly specialized and mixed farming has declined this combination of habitat types is likely to have declined throughout the UK.

In winter, Lapwing are widely distributed throughout both arable and pastoral systems of lowland Britain (Lack 1986). Wintering Lapwing are known to feed on grassland, particularly permanent pastures (Tucker 1992). However, the recent BTO/JNCC Winter Farmland Bird Survey found only 25% of birds and flocks on pastures compared with up to 50% on crops, stubbles and bare tillage. Whether this reflects a change in preference or is merely a reflection of more birds wintering in eastern Britain is unclear. However, at least one study shows that within intensively managed arable landscapes of eastern England Lapwings concentrated diurnal feeding activity on cereal crops, sugar beet stubbles and harrowed/drilled fields and virtually avoided the available grass pastures (Gillings 2003b).

During winter the Lapwing's diurnal diet on arable fields consists of earthworms and arthropods, including carabid and staphylinid beetles (adults and larvae) and millipedes (Gillings 2003b). Although they only accounted for 13% of items, earthworms probably accounted for the majority of biomass. On average, permanent pastures support the greatest earthworm densities, with lower densities in winter cereals and the least in row crops (Edwards & Bohlen 1996). So arable fields might be expected to provide poor foraging opportunities to Lapwings and it may be that frequent nocturnal feeding is the only means by which Lapwings can balance energy budgets (Gillings 2003b). One study of nocturnal feeding showed strong preference for feeding on sugar beet stubbles and much reduced night use of cereal crops and bare tillage (Gillings 2003b). Therefore, at least in some areas, the presence of sugar beet stubble fields may be important to Lapwings.

The available evidence suggests that overwinter survival may be less important in driving the population decline than breeding success, especially a reduction in the number of breeding attempts (Peach *et al*. 1994, Catchpole *et al*. 1999).

CONSERVATION MANAGEMENT

Agri-environment schemes

The principal schemes in the UK at the time of writing are the Environmentally Sensitive Area (ESA) scheme, Countryside Stewardship Scheme (CSS), in England, Tir Gofal in Wales, Countryside Management Scheme (CMS) in Northern Ireland and the Rural Stewardship Scheme (RSS) in Scotland. (Agri-environment schemes are currently under review in England.)

ESA prescriptions have been shown to be successful in maintaining or increasing numbers of breeding Lapwings on lowland wet grassland (Ausden & Hirons 2002) although this is not universally true (Wilson *et al*. 2004). Similar success in arable habitats is likely to have been limited due to a lack of suitable prescriptions. Only four out of 22 ESAs have any suitable arable prescriptions for breeding Lapwing. The South Downs, West Penwith, Breckland and The Cotswolds Hills ESAs indirectly promote spring cropping through the retention of winter stubbles.

In 2002, arable options likely to have positive benefits for breeding Lapwing were incorporated into CSS in England. A detailed study of the benefits of overwintered stubbles followed by spring/summer fallow (prescription OS3) showed that they provided nesting habitat throughout the breeding season (Fig. 2), held higher densities of breeding Lapwing than other crop types, had higher nest survival rates compared with nests on other crop types and provided brood rearing habitat (Sheldon 2002). Further benefits of the new arable options will be the support of spring cropping through the retention of overwinter stubbles (prescriptions OS1 and OS2). Other UK agri-environment schemes offer a range of prescriptions on arable land, which although not necessarily targeted at breeding Lapwing, may be of some benefit (Appendix 1). Over 36 000 ha of arable land are currently under agri-environment prescriptions that may offer varying degrees of conservation potential for breeding Lapwing.

The current agri-environment review in England will result in the Entry Level Scheme (ELS) being

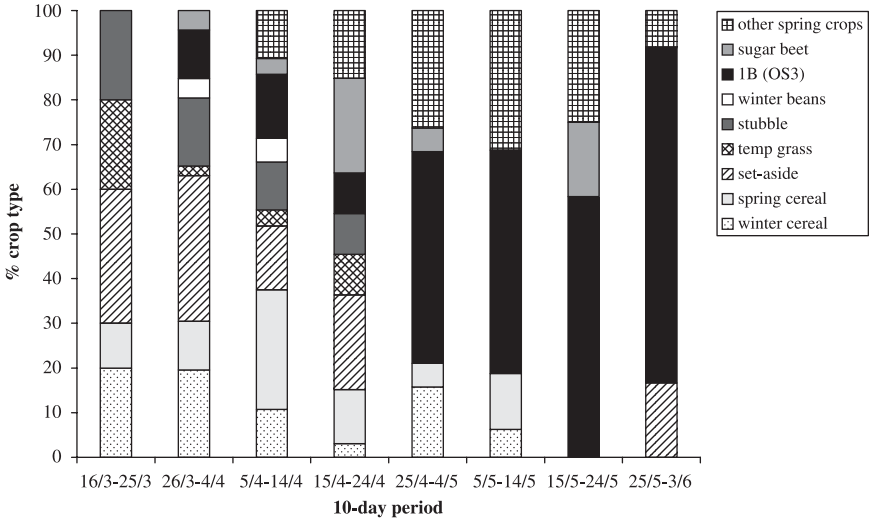

Figure 2. Distribution of Lapwing nests (n = 184) in relation to crop type and 10-day period in Shropshire and Staffordshire (R. Sheldon unpubl. data).

introduced across a much wider area of agricultural land, with a Higher Tier Scheme to deliver more intensive options at a smaller scale.

Owing to the relatively small land area that agri-environment schemes can influence with the current level of modulation, any effect on the wide-ranging wintering aggregations of Lapwing are likely to be limited. Arguably, however, the provision of winter habitat is less of a conservation priority than the provision of suitable breeding habitat.

Lapwing recovery projects

Since 1999, the RSPB has established 11 regional Lapwing Recovery Projects throughout the UK. Although specific actions vary according to local circumstances, all share the central objective of providing advice to land managers on how to produce habitat conditions that are beneficial to breeding Lapwing. In many cases Recovery Project staff assist site managers in producing a detailed site management plan for submission for agri-environment funding and some projects enlist volunteers to mark individual Lapwing nests to prevent destruction during agricultural operations.

Are Recovery Projects working?: a preliminary analysis of Lapwing recovery in Dorset

A tetrad survey conducted in Dorset in 1999 indicated that Lapwing had suffered a 51% decline in range since the previous survey, undertaken between 1989 and 1994 (Walker *et al*. 1999). In response to this decline the Dorset Recovery project was initiated by the RSPB in 2000. A Project Officer was employed to identify those areas that still held appreciable populations of breeding Lapwing, and to enlist and co-ordinate a team of volunteers to provide advice and assistance to land managers. Both recovery and control sites were monitored. Since the onset of the Recovery Project, the minimum number of Lapwing recorded breeding in Dorset has increased from 141 pairs in 2000 to 168 pairs recorded in 2003. This represents an annual population increase of 6% per year, compared with a decline during the decade to 1999 of the order of 9% per year.

Figure 3 shows the change in population size between 2000 and 2003 for sites that have undergone Lapwing management, and those where no management has been carried out, which were surveyed in both years. A generalized linear model of the number of pairs breeding in each of the two years showed a significant interaction between whether sites were managed or not and year ($\chi^2_1 = 5.72$, $P = 0.017$, colony = repeated measures subject), indicating that sites which were managed for Lapwing showed significantly greater population growth across the four years. Potentially, such an effect could have resulted from a biased selection of the more suitable sites for management, rather than any benefit of management *per se*. However, a planned contrast within the linear model showed that although there was a tendency for larger colonies to

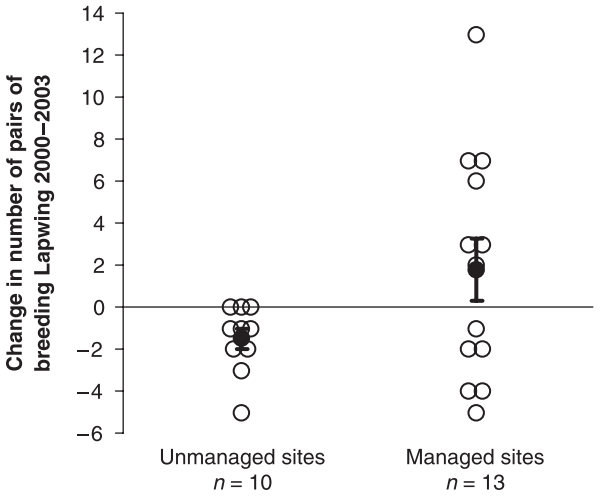

Figure 3. Number of breeding pairs of Lapwing on farmland sites in Dorset in 2000 and 2003 according to management. Each open circle represents a single site. The mean (± 1 se) is shown for each group.

be targeted for recovery measures, these differences were not significant ($\chi^2_1 = 1.53$, $P = 0.22$).

A further explanation for this result is that sympathetic management, such as the creation of suitable nesting conditions, may simply attract Lapwing from the surrounding area to breed on sites targeted by the recovery project, without necessarily increasing the reproductive success of those pairs. Indeed, such an effect could result in sites acting as a population 'sink'. Although the overall increase in population size at county level suggests that the increase in Lapwing nesting on managed sites was not simply due to a redistribution of breeding birds, the possibility remains that the additional birds may have been attracted to managed sites in Dorset from further afield.

General conservation advice

Not all landowners are willing to enter agri-environment agreements (Smallshire *et al.* 2004, Wilson *et al.* 2004), and/or may not be within an area targeted for a specific recovery project. However, there are a number of low/no-cost management practices that farmers can adopt for breeding Lapwing. Encouraging farmers to incorporate spring crops into the crop rotation, particularly cereals and root crops, will provide potential nesting habitat (although varieties of spring cereal that can be drilled in December or January should be avoided as they are likely to establish tall swards too soon). The value of such crops to breeding Lapwing are increased if these can be aimed at large, open fields, with few predator perches, that are adjacent to grazed pasture. Where Lapwing are known to breed, agricultural operations should be completed by late March. If later operations are unavoidable they should be completed within 10 days, and then the field left until the end of May, to avoid destroying potential replacement clutches. Lapwings are known to use rotational set-aside fields in which to breed if the sward conditions are suitable (Linsley 1999). In England, a derogation can be obtained from Defra to create fallow plots on set-aside fields, for the benefit of breeding Lapwing (R. Winspear pers. comm.). Again, placing set-aside adjacent to grazed pasture will provide optimum conditions for both the nesting and the brood-rearing phases. Promotion of manuring of grassland may be beneficial (Tucker 1992).

This generic, low-cost advice, based on the outcome of numerous scientific research projects needs to be easily accessible to the farming community to ensure maximum take up.

CONCLUSION

Lapwing are a relatively well-studied species for which we have a clear understanding of their ecological requirements. There is evidence that both agri-environment prescriptions and targeted conservation management through recovery projects can provide positive benefits to breeding Lapwing that may stem or even reverse recent population declines.

We are grateful to the numerous volunteers, especially John Selby, who collected Lapwing survey data as part of the Dorset Recovery Project, and to Dante Munns, Mia Misso and John Cromarty for compiling datasets and undertaking initial analyses. Paul Britten produced the map, and Lucy Haskins, Anne-Marie McDevitt, Dave Lamacraft, Jack Fleming, Richard Winspear and Ruth Gilpin all provided useful information and discussions on UK agri-environment schemes. Andy Evans, Dan Chamberlain and Rowena Langston constructively commented on the manuscript.

REFERENCES

Aebischer, N.J., Green, R.E. & Evans, A.D. 2000. From science to recovery: four case studies of how research has been translated into conservation action in the UK. In Aebischer, N.J., Evans, A.D., Grice, P.V. & Vickery, J.A. (eds) *Ecology and Conservation of Lowland Farmland Birds*: 43–54. Tring: British Ornithologists' Union.

Ausden, M.J. & Hirons, G.J.M. 2002. Grassland nature reserves for breeding wading birds in England and the implications for the ESA agri-environment scheme. *Biol. Conserv.* **106**: 279–291.

Baillie, S.R., Crick, H.Q.P., Balmer, D.E., Bashford, R.I., Beaven, L.P., Freeman, S.N., Marchant, J.H., Noble, D.G., Raven, M.J., Siriwardena, G.M., Thewlis, R. & Wernham, C.V. 2001. *Breeding Birds in the Wider Countryside: Their Conservation Status 2000*. BTO Research Report no. 252. Thetford: British Trust for Ornithology.

Baines, D. 1990. The roles of predation, food and agricultural practice in determining the breeding success of the lapwing (*Vanellus vanellus*) on upland grasslands. *J. Anim. Ecol.* **59**: 915–929.

Beintema, A.J., Thissen, J.B., Tensen, D. & Visser, G.H. 1991. Feeding ecology of Charadriiform chicks in agricultural grassland. *Ardea* **79**: 31–43.

Berg, A. 1993. Habitat selection by monogamous and polygamous Lapwings on farmland – the importance of foraging habitats and suitable nest sites. *Ardea* **81**: 99–105.

Berg, A. 1996. Predation on artificial, solitary and aggregated wader nests on farmland. *Oecologia* **107**: 343–346.

Berg, A., Lindberg, T. & Kallebrink, K.G. 1992. Hatching success of lapwings on farmland: differences between habitats and colonies of different sizes. *J. Anim. Ecol.* **61**: 469–476.

Blomqvist, D. & Johansson, O.C. 1995. Trade-offs in nest site selection in coastal populations of Lapwings *Vanellus vanellus*. *Ibis* **137**: 550–558.

Catchpole, E.A., Morgan, B.J.T., Freeman, S.N. & Peach, W.J. 1999. Modelling the survival of British Lapwings *Vanellus vanellus* using ring-recovery data and weather co-variates. *Bird Study* **46** (Suppl.): S5–S13.

Chamberlain, D.E., Fuller, R.J., Bunce, R.G.H., Duckworth, J.C. & Shrubb, M. 2000. Changes in the abundance of farmland birds in relation to the timing of agricultural intensification in England and Wales. *J. Appl. Ecol.* **37**: 771–788.

Edwards, C.A. & Bohlen, P.J. 1996. *Biology and Ecology of Earthworms*, 3rd edn. London: Chapman & Hall.

Elliot, R.D. 1985. The exclusion of avian predators from aggregations of nesting Lapwings (*Vanellus vanellus*). *Anim. Behav.* **33**: 308–314.

Fuller, R.J., Gregory, R.D., Gibbons, D.W., Marchant, J.H., Wilson, J.D., Baillie, S.R. & Carter, N. 1995. Population declines and range contractions among lowland farmland birds in Britain. *Conserv. Biol.* **9**: 1425–1441.

Galbraith, H. 1988. Effects of agriculture on the breeding ecology of Lapwings *Vanellus vanellus*. *J. Appl. Ecol.* **25**: 487–503.

Galbraith, H. 1989. Arrival and habitat use by Lapwings *Vanellus vanellus* in the early breeding season. *Ibis* **131**: 377–388.

Galbraith, H., Furness, R.W. & Fuller, R.J. 1984. Habitats and distribution of waders breeding on Scottish agricultural land. *Scottish Birds* **13**: 98–107.

Gibbons, D.W., Avery, M.I. & Brown, A.F. 1996. Population trends of breeding birds in the United Kingdom since 1800. *Br. Birds* **89**: 291–305.

Gillings, S. 2003a. Plugging the gaps – winter studies of Eurasian Golden Plovers and Northern Lapwings. *Wader Study Group Bull.* **100**: 25–30.

Gillings, S. 2003b. *Diurnal and nocturnal ecology of Golden Plovers* Pluvialis apricaria *and Lapwings* Vanellus vanellus *wintering on arable farmland*. PhD Thesis, University of East Anglia, Norwich.

Goransson, G., Karlsson, J., Nilsson, S.G. & Ulfstrand, S. 1975. Predation on birds nests in relation to antipredator aggression and nest density: an experimental study. *Oikos* **26**: 117–120.

Henderson, I.G., Wilson, A.M., Steele, D. & Vickery, J.A. 2002. Population estimates, trends and habitat associations of breeding Lapwing *Vanellus vanellus*, Curlew *Numenius arquata* and Snipe *Gallinago gallinago* in Northern Ireland in 1999. *Bird Study* **49**: 17–25.

Högstedt, G. 1974. Length of the pre-laying period in the lapwing *Vanellus vanellus* in relation to its food resources. *Ornis Scand.* **5**: 1–4.

Holloway, S. 1996. *The Historical Atlas of Breeding Birds in Britain and Ireland: 1875–1900*. London: T. & A.D. Poyser.

Hudson, R., Tucker, G.M. & Fuller, R.J. 1994. Lapwing *Vanellus Vanellus* populations in relation to agricultural change: a review. In Tucker, G.M., Davies, S.M. & Fuller, R.J. (eds) *The Ecology, Conservation of Lapwings Vanellus vanellus*: 1–33. Peterborough: Joint Nature Conservation Committee.

Lack, P.C. 1986. *The Atlas of Wintering Birds in Britain and Ireland*. Calton: T. & A.D. Poyser.

Linsley, M.D. 1999. *The effects of intensive agriculture on the breeding ecology of the Lapwing* Vanellus vanellus. PhD thesis, Liverpool John Moores University.

Milsom, T.P., Langton, S.D., Parkin, W.K., Peel, S., Bishop, J.D., Hart, J.D. & Moore, N.P. 2000. Habitat models of bird species' distribution: an aid to the management of coastal grazing marshes. *J. Appl. Ecol.* **37**: 706–727.

O'Brien, M. 1996. The numbers of breeding waders in lowland Scotland. *Scottish Birds* **18**: 231–241.

O'Brien, M. 2000. *Factors affecting breeding wader populations on upland enclosed farmland in northern Britain*. PhD thesis, Edinburgh University.

O'Connor, R.J. & Shrubb, M. 1986. *Farming and Birds*. Cambridge: Cambridge University Press.

O'Brien, M., Tharme, A. & Jackson, D. 2002. Changes in breeding wader numbers on Scottish farmed land during the 1990s. *Scottish Birds* **23**: 10–21.

Partridge, J.K. & Smith, K.W. 1992. Breeding wader populations in Northern Ireland, 1985–87. *Irish Birds* **4**: 497–518.

Peach, W.J., Thompson, P.S. & Coulson, J.C. 1994. Annual and long-term variation in the survival rates of British lapwings *Vanellus vanellus*. *J. Anim. Ecol.* **63**: 60–70.

Peach, W.J., Lovett, L.J., Wotton, S.R. & Jeffs, C. 2001. Countryside Stewardship delivers Cirl Buntings (*Emberiza cirlus*) in Devon, UK. *Biol. Conserv.* **101**: 361–373.

Reijnen, R., Foppen, R. & Meeuwsen, H. 1996. The effects of traffic on the density of breeding birds in Dutch agricultural grasslands. *Biol. Conserv.* **75**: 255–260.

Sheldon, R.D. 2002. *Factors affecting the distribution, abundance and chick survival of the Lapwing* (Vanellus vanellus). PhD thesis, HarperAdams University College.

Shrubb, M. 1990. Effects of agricultural change on nesting Lapwings *Vanellus vanellus* in England and Wales. *Bird Study* **37**: 115–127.

Shrubb, M. & Lack, P.C. 1991. The numbers and distribution of Lapwing *Vanellus vanellus* nesting in England and Wales in 1987. *Bird Study* **38**: 20–37.

Siriwardena, G.M., Baillie, S.R., Buckland, S.T., Fewster, R.M., Marchant, J.H. & Wilson, J.D. 1998. Trends in the abundance of farmland birds: a quantitative comparison of smoothed Common Birds Census indices. *J. Appl. Ecol.* **35**: 24–43.

Smallshire, D., Robertson, P. & Thompson, P. 2004. Policy into practice: the development and delivery of agri-environment schemes and supporting advice in England. In *Ecology and*

Conservation of Lowland Farmland Birds II: The Road to Recovery. Ibis **146** (Suppl. 2): 250–258.

Tucker, G.M. 1992. Effects of agricultural practices on field use by invertebrate-feeding birds in winter. *J. Appl. Ecol.* **29**: 779–790.

Walker, J., Day, J. & Lock, L. 1999. *Dorset Farmland Bird Survey 1999.* Unpublished Report. Sandy: Royal Society for the Protection of Birds.

Wilson, J.D., Arroyo, B.E. & Clark, S.C. 1996. *The Diet of Bird Species of Lowland Farmland: a Literature Review*. Report to the Department of the Environment. London: Defra.

Wilson, A.M., Vickery, J.A. & Browne, S.J. 2001. Numbers and distribution of Northern Lapwings *Vanellus vanellus* breeding in England and Wales in 1998. *Bird Study* **48**: 2–17.

Wilson, A.M., Ausden, M. & Milsom, T.P. 2004. Changes in breeding wader populations on lowland wet grasslands in England and Wales: a review of causes and potential solutions. In *Ecology and Conservation of Lowland Farmland Birds II: The Road to Recovery. Ibis* **146** (Suppl. 2): 32–40.

Appendix 1. A summary of relevant arable prescriptions in UK agri-environment schemes and their likely impact on breeding Lapwing.

Prescription	Code	Scheme	Area (ha)[a]	Potential benefit to breeding Lapwing
Overwintered stubbles followed by a spring crop	OS1	CSS	9 715	Potential nesting habitat in the following spring crop
Overwintered stubbles followed by a low-input spring cereal	OS2	CSS	1 838	Potential nesting habitat in the following spring cereal Enhanced food availability in the following spring cereal
Overwintered stubbles followed by a spring/summer fallow	OS3	CSS	10 624	Potential nesting habitat Enhanced nest survival Potential brood-rearing habitat
Overwintered stubbles	Various	Various ESAs	5 442	Potential nesting habitat in the following spring crop
Unsprayed cereal, rape, or linseed crops	24	Tir Gofal	1 879	Potential nesting habitat if the crop is spring-sown
Retain winter stubbles	25	Tir Gofal	1 699	Potential nesting habitat in the following spring crop
Undersown spring cereals	26	Tir Gofal	1 394	Potential nesting habitat
Grow unsprayed root crops followed by winter grazing	27	Tir Gofal	1 512	Potential nesting habitat in the spring-sown root crop Potential nesting habitat in the following spring crop
Retention of winter stubble		CMS	1 480	Potential nesting habitat in the following spring crop
Conversion of improved grassland to spring cereals[b]		CMS	16	Potential nesting habitat
Introduction or retention of extensive cropping	24	RSS	1 083	Potential nesting habitat although late cultivation needs to be avoided
Management of cropped machair	25	RSS	2[c]	Potential nesting habitat although late cultivation needs to be avoided

[a]All figures supplied by the relevant country agricultural department.
[b]This current option is only available on improved and semi-improved grassland, but is currently being considered for arable habitats.
[c]Prescription only introduced in 2003.