AN ASSESSMENT OF THE USE OF CROPPED HABITATS BY BIRD SPECIES REPRESENTED IN THE UK SPECIAL PROTECTION AREA NETWORK

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INTRODUCTION

Many species of bird are ecologically dependent on cropped habitats *inter alia* arable, grass and planted tree crops. However, conservation of many of these species typically fails to address the issue of cropped habitat protection; whether there is a need to preserve and manage these habitats and if so the best mechanisms to do so. In particular, within the UK, as in many other countries, the inclusion of cropped habitats within protected sites is unusual.

In 2001, the Joint Nature Conservation Committee published a review of the UK Special Protection Area (SPA) network (Stroud *et al.* 2001; UK SPA Review). SPAs are sites designated for the conservation of rare and vulnerable, and migratory birds within the European Union, in accordance with the EU Council Directive on the conservation of wild birds (79/409/EEC; Birds Directive). In the UK, SPAs have been selected according to principles laid out in the *Selection Guidelines for Special Protected Areas* (JNCC 1999), which were developed by the UK Government in response to the lack of detailed European guidance for selecting SPAs in the Birds Directive. These guidelines provide a two-stage procedure for assessing the suitability of areas for classification as SPAs, and provide guidance on both site selection and boundary determination. Whilst, application of the guidelines should result in boundary selection that delimits areas providing for the conservation requirements of a species, one of the guiding principles relates to naturalness of habitats, with more natural habitats favoured for selection. This has resulted in a UK SPA network that comprises largely natural and semi-natural habitats with very little coverage of cropped habitats. However, the Birds Directive does not specify that habitat protection in support of its objectives should relate solely to more natural habitat types.

The Birds Directive was transposed into national law through the Wildlife & Countryside Act 1981 (as amended), Wildlife (Northern Ireland) Order 1985 and Environment (Northern Ireland) Order 2002, which provide for the designation of Sites of Special Scientific Interest (SSSI) in Britain and Areas of Special Scientific Interest (ASSI) in Northern Ireland. Such designation provides a mechanism for management and protection of any overlapping SPA, and further SPA protection is provided by both the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) and Conservation (Natural Habitats, &c.) Regulations (Northern Ireland) 1995 (as amended). The Wildlife & Countryside Act 1981 does not provide guidance for selecting SSSIs; this was developed for Great Britain and published as the *Guidelines for Selection of Biological SSSIs* (NCC 1989). This guidance predates that for SPAs and has been highly influential in developing the latter. Many of the selection principles within the SSSI guidelines themselves originate from the development of the national 'areas of special interest' network which began in the 1940s (under the National Parks and Access to the Countryside Act 1949) and which evolved into the SSSI network. The development of international site selection guidelines was also influential on the SSSI guidelines, especially those relating to the Convention on Wetlands (Ramsar 1971).

The main emphasis of SSSI notification is to protect remnant natural and semi-natural habitats, which typically support a greater diversity of species; this emphasis arose out of a period when British conservation priority was very much focussed on the critical need to halt the further loss and degradation of these typically fragmented habitats. The *Guidelines for Selection of Biological SSSIs* (NCC 1989) does not preclude the designation of non-natural (highly modified) habitats, but they emphasise that such designation should be exceptional and only where a high diversity of native species is present. In relation to birds, the guidelines specify that feeding and roosting areas on croplands should not usually be selected

since birds are rarely restricted to special parts of such areas, the significance of which may alter with a change of crop.

Recent recognition of the role of cropped habitats for conservation of some species has led to a small number of SPA classifications that have included such habitats, notably short-sward, unimproved grassland and arable crops for Stone-curlew and mature plantation forestry for Capercaillie. However, coupled with the lack of recognition of the role of cropped habitats in maintaining biodiversity has been the generally held belief that site-based protection is not the best mechanism to secure this resource. Other land management mechanisms associated with national policies (agricultural and forestry) are considered by some as the most appropriate way to ensure cropped habitats meet biodiversity needs. While such policies make some provision for biodiversity maintenance and enhancement, they may not yet adequately consider the conservation requirements of the full range of species that have an ecological dependence on these habitats.

The UK is not alone in its lack of inclusion of cropped habitats in SPAs; it is also reflected in the EU15 networks of SPAs. Whilst, habitat data are lacking for four Member States (which have not submitted habitat data for SPAs on Natura 2000 Standard Data Forms), the only significant inclusion of cropped habitats in SPAs for non-breeding swans and geese occurs in Denmark and Austria (based on data to 2001; European Topic Centre for Nature).

Country	#SPAs for non-breeding geese/swans	#SPAs with cropped habitats included	Total area of cereal (ha)	Total area of improved grassland (ha)	Total area of other arable crops (ha)
Austria	16	14	9,150	5,400	47,350
Denmark	60	57	19,120	0	53,430

In contrast, just three of 185 SPAs in Finland, one of 28 SPAs in Ireland, two of 15 in The Netherlands and 22 of 108 SPAs in Sweden classified for non-breeding swans and geese contained cropped habitats. In Denmark, inclusion has been guided by SPA selection principles based on habitat use and aggregation of relevant species (T. Fox, *pers. comm.*); these selection principles have much in common with the approach to SPA selection in the UK. There appear to be no published evaluations of the requirement or value of inclusion of cropped habitats in the EU SPA network. Exclusion of this habitat does not appear to have been rationalised across Europe through any scientific approach.

In response to the publication of the UK SPA Review, the non-governmental conservation organisations criticised the Government for not including within SPAs what they perceived to be suitable areas of cropped habitats. For example, SPAs for non-breeding geese were focussed on roost sites and did not typically include feeding areas that were in cropped habitats. However, Important Bird Areas (IBA; BirdLife International) in the UK also generally lack inclusion of cropped habitats for relevant species and so an existing inventory of such sites and a scientific rationale for defining boundaries is absent. In 2001, the UK Government established a scientific consultative group to aid it in further developing the UK SPA network, including consideration of issues raised by the use of cropped habitats by Annex I and migratory species: the SPA & Ramsar (avian) Scientific Working Group (SPAR SWG). The SPAR SWG identified the need for a review of knowledge of the ecological requirements of a range of species that make significant use of cropped habitats. In response, the Joint Nature Conservation Committee (JNCC) established the *Cropped Habitats*

Information Project (CHIP) and commissioned species reviews to assist it. This paper presents the results of CHIP, which can inform any policy review of the need to include cropped habitats in SPAs for the species concerned. The SPAR SWG has been consulted several times on the content of the paper, and has endorsed the species reviews and summaries of ecological needs, but it should be noted that any views expressed on policy influencing the protection of cropped habitats are those of the authors only.

METHODS OF EVALUATION

The working definition of cropped habitat established by the SPAR SWG was that:

> A cropped habitat is one used for harvesting seeds, roots, leaves, or other plant parts that are of commercial value to humans, *inter alia* formed by the planting of plants in cultivated (prepared) ground, by the regular application of fertilisers, manures or through other management. Such habitats include semi-improved and reseeded grasslands, cereals, brassicas, potatoes, other root crops, fruit and forestry (deciduous and conifer), as well as set-aside.

A list of UK bird species thought to have some ecological dependence on cropped habitats and already represented within the UK SPA Network, or in review by the SPAR SWG, was developed. This extensive list was then prioritised according to conservation status and the perceived importance of cropped habitats to each species. On this basis, reviews of cropped habitat use were carried out for a large number of species, but not all originally listed.

The aim of the species reviews was to provide a general overview of the ways in which species make use of cropped habitats and to identify the main conservation issues arising from this. In order to develop the format of the species reviews, a pro-forma was developed using the Greenland White-fronted Goose *Anser albifrons flavirostris* as an example (Appendix 1). Central to this was describing the species functional unit system in the relevant season(s): those habitats that provide the overall ecological or behavioural requirements of a population, or part of it. The evaluation of how each seasonal functional unit system contributes to overall population maintenance is clearly a related, but separate area of conservation science. Building from the description of the functional unit system, we identified the need for review of information available on cropped habitat usage (types, temporal and spatial), and assessment both of the possible vulnerability of these habitats and implications for the species of change in them.

Just Ecology was contracted by JNCC to complete a pro-forma for each of 47 species/populations – this was phased over two years - and the SPAR SWG was consulted on each of the completed reviews. The reviews were developed further by JNCC based on consultation responses and further review of the literature, especially any published since the initiation of the project.

RESULTS OF THE REVIEW

The individual species/population reviews are not reproduced in full here; we provide summaries in loose species groupings, related to season and ecology, in Appendix 2.

Of the 47 species reviewed by the project, some were found to have little ecological reliance on cropped habitats and these species were not considered further, although comments on some species are included for context. They were Shelduck, Gadwall, Shoveler, Pochard, Coot, Bar-tailed Godwit, and Dartford Warbler.

For many species it is difficult to describe fully the functional unit system in any season due to lack of knowledge. In particular, temporal and/or spatial ecology has been studied infrequently in relation to feeding behaviour, especially outside of the breeding season, for many species. This significantly limits the conclusions that can be drawn about the ecological importance of different crop types and the vulnerability of populations that arises from habitat change or loss. However, for most species there is sufficient information to be able to draw general conclusions about important cropped habitats and their spatial character (Table 1). This has allowed us to generalise key conservation requirements in relation to cropped habitats for each of these species and recommend suitable approaches to identifying which habitats should be maintained in order to ensure population maintenance.

Table 1. Summary of cropped habitat requirements of birds in the UK SPA network, key conservation requirements and recommendations for identifying important areas of cropped habitats to maintain.

Species	S[1]	Cropped habitats required	Key conservation requirements	Recommended approach
Barnacle goose	NB	Improved pasture, over-wintered stubbles and autumn-sown cereals. Highly faithful to feeding areas; travel 2-5 km from roost depending on location.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat based on local evidence of regular field usage.
Bean goose	NB	Wet and damp pastures (both improved and unimproved). Field choice highly variable.	Maintain open, pastoral landscape.	Maintain suitable feeding habitat based on local evidence of regular field usage.
Bewick's swan	NB	Improved pasture, autumn-sown cereals, over-wintered stubbles, sugar beet and oil seed rape. Feed within 10 km of roost, but no other spatial information.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat within 10 km of roost based on local evidence of regular field usage.
Black-headed gull	B	Damp, improved pastures. No spatial information.	Insufficient information.	Insufficient information.

[1] S = season in which cropped habitat used: B = breeding; NB = non-breeding (outside of breeding season). It should be noted that not all species were reviewed in both seasons under CHIP, but this does not necessarily mean that the species does not have ecological dependence on cropped habitats in both seasons.

Species	S[1]	Cropped habitats required	Key conservation requirements	Recommended approach
Black-headed gull	NB	Feed primarily in improved pasture. No spatial information.	Insufficient information.	Insufficient information.
Capercaillie	B/ NB	Mature conifer forest. Leks and home ranges used in successive years. Complex spatial ecology.	Maintain mature regularly used forestry.	Maintain mature conifer plantation based on evidence of regular presence.
Chough	B/ NB	Pastures all year round, and over-wintered stubbles and root crops in winter. Site faithful. Forage 1-3 km from nest, and in winter within 5-8 km of roost.	Maintain specific pasture types at field level.	Maintain suitable grassland habitats within 1 km of the nest, and outside of the breeding period on the basis of local evidence of regular field usage (recommendation already accepted by the Natura 2000 Steering Committee)
Common gull	B	Damp, improved pastures. No spatial information.	Insufficient information.	Insufficient information.
Common gull	NB	Improved meadows/silage grasslands, ploughed fields, improved pastures, autumn-sown cereals. Feed up to 30 km from roost, field choice very variable.	None.	Maintenance of specific areas not necessary.
Common snipe	B	Wet meadows and pastures. No spatial information.	Maintain suitable hydrological management of grasslands.	Insufficient information.
Corn crake	B	Meadows and rough, low-intensity pastures. Home ranges very variable: males 4 to 50 ha, females up to 30 ha.	Maintain mixture of low-intensity grassland types.	Maintain suitable feeding habitat within regularly occupied ranges, either based on a generic 30 ha range size or on basis of local evidence of regular field usage.
Curlew	B	Pastures (rough and improved), 1 km from moorland edge.	Maintain open moorland/pasture interface.	Maintain all pastures within 1 km of moorland edge, either by generic approach or on basis of local evidence of regular field usage.

Species	S[1]	Cropped habitats required	Key conservation requirements	Recommended approach
Curlew	NB	Improved and rough grasslands, arable fields. Feed up to 15 km inland, field choice variable.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat based on local evidence of regular field usage.
Dark-bellied brent goose	NB	Improved pasture, autumn-sown cereals and oil-seed rape. Feed within 5 km of roost.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat within 5 km of roost based on local evidence of regular field usage.
Dunlin	B	Wet and damp machair and blackland grassland. No spatial information.	Insufficient information.	Insufficient information for identifying important feeding areas away from nesting areas.
Golden plover	B	Improved, close-grazed pastures, 2 km from moorland edge.	Maintain open moorland/pasture interface.	Maintain improved pastures within 2 km of moorland edge, either by generic approach or on basis of local evidence of regular field usage.
Golden plover	NB	Roost on ploughed fields. Feed primarily in improved pasture. No spatial information.	Insufficient information.	Insufficient information.
Greylag goose (Iceland population)	NB	Improved pasture, over-wintered stubbles, autumn-sown cereals, waste root crops. Feeding areas generally within 12 km of roost.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat based on local evidence of regular field usage.
Hen harrier	B/ NB	Young conifer plantation for nesting and foraging. Rough grasslands for foraging. In NI, also mature conifer plantation for nesting and foraging. Home ranges used in successive years. Most foraging is within 2-3 km of nest and roost.	Maintain open moorland/pasture interface and pasture type. In NI, also maintain mature conifer forests used regularly.	Maintain grassland feeding habitats within 2-3 km of nests in regularly used home ranges and regularly used communal roosts. In NI, also maintain mature conifer forest within 2-3 km of nests in regularly used home ranges.

Species	S[1]	Cropped habitats required	Key conservation requirements	Recommended approach
Honey-buzzard	B	Mature conifer and mixed forest. Territories used in successive years. Males feed up to 2 km and females 1 km from nest.	Maintain mature conifer and mixed forests used regularly.	Maintain mature woodlands used regularly, including all woodland within 2 km of each nest site.
Lapwing	NB	Roost on ploughed fields. Feed primarily in improved pasture – old pasture preferred. No spatial information.	Insufficient information.	Insufficient information.
Light-bellied brent goose (East Atlantic population)	NB	Improved and unimproved pasture, autumn-sown cereals. Field choice has been studied at single UK site.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat based on local evidence of regular field usage.
Light-bellied brent goose (East Canadian High Arctic population)	NB	Improved and unimproved pasture and autumn-sown cereals. No spatial information.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat based on local evidence of regular field usage.
Mallard	NB	Over-wintered stubbles, autumn-sown cereal, waste root crops. Feed typically within 2 km of roost, but no other spatial information.	Maintain open arable landscape close to roost areas.	Maintain suitable feeding habitat within 2 km of roost based on local evidence of regular field usage.
Marsh harrier	B	Open cropped habitats within 2 km of nest used for foraging.	Maintain open, mixed pastoral/arable landscape adjacent to nesting areas.	Maintain open cropped habitats within 2 km of nesting areas.

Species	S[1]	Cropped habitats required	Key conservation requirements	Recommended approach
Merlin	B/ NB	Both young and mature conifer forest for nesting and foraging. Rough grasslands for foraging. Home ranges used in successive years. No spatial information.	Maintain open moorland/pasture interface and pasture type. Also maintain mature forest used regularly for nesting.	Maintain grassland feeding habitats within 2 km of nests in regularly used home ranges (based on minimum Hen Harrier requirements). Also maintain mature conifer forest within 2 km of nests in regularly used home ranges. Insufficient information for identifying important feeding areas outside of breeding season.
Montagu's harrier	B	Nests in arable habitats, and grasslands. Not site-faithful. Females forage within 2 km of nest, males up to 12 km.	Maintain open arable landscape featuring some low-intensity open habitats.	Not possible to identifying regularly used important feeding areas.
Nightjar	B	Young conifer forest, coppiced woodland. Forage within 1-3 km of nest.	Maintain a mosaic of stand ages in forestry, and coppice management.	Maintain conifer forest and coppiced woodlands used regularly for nesting.
Osprey	B	Mature conifer forest for nesting. Nests re-used over long period and adopted by successive pairs. No information on required nesting woodland characteristics and disturbance limits.	Maintain nest sites and surrounding forest character to avoid nest abandonment.	Insufficient information.
Oystercatcher	B	Pastures (rough and improved). No spatial information.	Insufficient information.	Insufficient information.

Species	S[1]	Cropped habitats required	Key conservation requirements	Recommended approach
Pink-footed goose	NB	Large, open, rough pasture for resting. Improved pasture, over-wintered stubbles, autumn-sown cereals, waste root crops for feeding. In one study, feeding areas within 5-6 km of roost, but known to range frequently up to 40 km. Complex pattern of field usage.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding and resting habitat based on local evidence of regular field usage.
Pintail	NB	Only a single study – probably similar behaviour to Mallard.	Maintain open arable landscape close to roost areas.	Insufficient information.
Red kite	B/ NB	Conifer forest – mature for nesting and young plantings for foraging. Forages over wide variety of cropped and other habitats. Home ranges used in successive years. Most foraging within 3 km of nest.	Maintain mature conifer forest used regularly for nesting.	Maintain mature conifer plantation used regularly for nesting. Insufficient information for identifying regularly used important feeding areas outside of breeding season.
Redshank	B	Rough (unimproved), wet and damp meadows and pastures. No spatial information.	Maintain suitable hydrological management of grasslands, and mix of grassland types.	Insufficient information.
Ring ouzel	B	Pasture. Forage within 450 m of nest.	Maintain good moorland management and open moorland/ pasture interface.	Maintain suitable grassland habitats within 0.5 km of regularly used nesting areas.
Ringed plover	B	Dry, cultivated machair. No spatial information.	Insufficient information.	Insufficient information for identifying important feeding areas away from nesting areas.
Scottish crossbill	B/ NB	Mature conifer plantation, especially of Scots Pine. No spatial information.	Maintain mature conifer plantations used regularly for nesting.	Maintain mature conifer plantations used regularly for nesting by the species.

Species	S[1]	Cropped habitats required	Key conservation requirements	Recommended approach
Short-eared owl	B/ NB	Young conifer plantation for nesting and foraging. Rough grasslands for foraging. No spatial information.	Maintain open moorland/pasture interface and pasture type.	Insufficient information. Will benefit from maintenance of cropped habitats for Hen Harrier and Merlin.
Stone-curlew	B	Close-grazed, unimproved pasture and spring-sown arable crops. Feed within 3 km of nest, but no other spatial information.	Maintain close-grazed, low-input pastures and suitable crop sowing regimes.	Maintain suitable feeding habitat within 3 km of nesting areas, either by generic approach or on basis of local evidence of regular field usage.
Teal	NB	Over-wintered stubbles, autumn-sown cereal, waste root crops, especially flooded fields. No spatial information.	Maintain open arable landscape close to roost areas.	Insufficient information.
Twite	B/ NB	Unimproved meadows, rough pastures and machair during the breeding season. Over-wintered stubbles and root crops in winter. Forage within 2.5-3.5 km of nest. No spatial information for winter.	Maintain open moorland/grassland interface and suitable grassland types.	Maintain suitable grassland habitat within 2.5 km of nesting areas, either by generic approach or on basis of local evidence of regular field usage. Insufficient information for identifying regularly used important feeding areas outside of breeding season.
Whimbrel	B	Ploughed or harrowed areas and reseeded grasslands. No spatial information.	Insufficient information.	Insufficient information.
White-fronted goose (Baltic/North Sea population)	NB	Wet and damp pastures. Feeds within 10 km of roost, but no other spatial information except at Slimbridge, where flock feeds within 1 km of roost.	Maintain open pasture landscape close to roost areas.	Maintain suitable feeding habitat based on local evidence of regular field usage.
White-fronted goose (Greenland population)	NB	Pasture, over-wintered stubble, waste root crops. Highly faithful to feeding areas.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat based on local evidence of regular field usage.

Species	S[1]	Cropped habitats required	Key conservation requirements	Recommended approach
Whooper swan	NB	Improved pasture, autumn-sown cereals, over-wintered stubbles, sugar beet and oil-seed rape. Feed within 3-5 km of roost, but no other spatial information.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat within 5 km of roost based on local evidence of regular field usage.
Wigeon	NB	Wet and damp pasture, autumn-sown cereals. Feed typically within 2 km of roost, but no other spatial information.	Maintain open, mixed pastoral/arable landscape close to roost areas.	Maintain suitable feeding habitat within 2 km of roost based on local evidence of regular field usage.
Wood lark	B/ NB	Conifer plantation and rough grasslands. Forage within 400 m of nest.	Maintain a mosaic of stand ages in forestry and suitable grasslands within and adjacent to forests.	Maintain conifer forest used regularly for nesting and rough grasslands within 0.5 km of nesting areas.

DISCUSSION

This discussion is structured to explore both technical and policy information related to the use of cropped habitats by birds represented in the UK SPA network and how these habitats might be maintained in the landscape. We initially review understanding of the ecological importance of cropped habitats to those bird species covered by the project, drawing on the species reviews, and present summarised recommendations on identifying cropped habitats that should be maintained for each. We then provide a brief overview of recent changes in cropped habitat extent and draw conclusions on the vulnerability of those habitats. Currently available mechanisms for maintaining or protecting cropped habitats are reviewed briefly, followed by an overview of the legal requirements of the Birds Directive. In concluding, we draw out a number of principles that we recommend are adopted to ensure continued appropriate management of cropped habitats that have a significant role in maintaining the populations of species already represented in the UK SPA network.

Functional importance of cropped habitats to birds represented in the UK SPA network

CHIP did not cover all species initially identified and may have also missed others of relevance, but the results of the project can inform generic recommendations that may be applicable to a wider range of species. Several species reviewed were deemed to have little reliance on cropped habitats and are not considered further.

The project clearly demonstrates that many species have a high functional reliance on cropped habitats, typically in association with semi-natural habitats used for other ecological or behavioural functions or at other times of the year. The functional unit system can be considered in terms of the functions of habitats and their temporal and spatial use. For most of the species reviewed there is sufficient information on the types of habitats used and the

functions provided, such as feeding, to identify those habitats that are important for maintaining populations. However, the availability of information required to define the functional unit system of individual species is very varied (summarised in Table 1).

A wide variety of different cropped habitats are used by the species reviewed. Many utilise a number of different cropped habitats, typically in seasonal succession in response to food availability, but some species use primarily just one type of cropped habitat. The latter, which could be considered habitat specialists, may be more vulnerable to landscape-scale changes in availability of cropped habitats, irrespective of habitat type, and documented declines in many of them provides good evidence to support this conclusion. In particular, the progressive loss of low-input grasslands and changes in management of those remaining has driven declines – for example in Stone-curlew (Green & Taylor 1995) and Corn Crake (see Brown & Grice 2005). In contrast, agricultural intensification has benefited many of the more adaptable species and contributed to population increases, for example in some swans and geese (see for example Madsen *et al*. 1999).

Whilst species dependent on one particular habitat could be described as specialists, this term needs to be qualified by habitat character to provide an understanding of the mechanisms that might influence population status. Habitat character is dependent on the management system in place. Some specialist species, like Chough and Wood Lark, depend on very specific management of a particular habitat for that habitat to remain functionally suitable, *i.e.* have precise ecological requirements. In general, low-input and/or low-intensity management systems have become rare and those specialist species that depend on them have typically also become rare: specialised species highly dependent on low-input and/or low-intensity management systems are highly vulnerable. In contrast, some habitat specialists have benefited from agricultural intensification. Some species, like breeding Golden Plover, Common Gull and Black-headed Gull, are dependent on short-sward pastures and may have benefited from the conversion of these to higher-input, re-seeded grasslands due to subsequent increases in prey availability.

In contrast to our relatively good understanding of the use of cropped habitats for certain functions by species, both the temporal and spatial aspects of functional unit systems are typically little studied, except at larger scales, and hence poorly known. This presents a significant gap in our understanding of the ecological requirements of birds and currently hinders our ability to make scientifically informed decisions in relation to conservation approaches for some species, especially site-based conservation measures. For those species for which there is spatial and temporal information on habitat use, this information typically comes from just a few studies. Locally, habitat availability as well as other factors, such as weather, will influence spatial and temporal use of cropped habitats. Defining a generic functional unit system for an individual species using a limited number of studies may not always be appropriate, depending on the quality of those studies, but may be a useful and precautionary option for conservation purposes. We present highly summarised descriptions of generic functional unit systems for each species in this review (Table 1), noting limits of understanding. In our recommendations for identifying which cropped habitats require maintenance we make a distinction between species for which a generic (modelled) approach may be suitable and those for which, due to either uncertainty in understanding of habitat needs or the scale involved, a site-specific approach may be more appropriate.

It is important to emphasize that lack of information should not preclude action to further the conservation of species that have an ecological dependence on cropped habitats. For some of

the species in this review there is sufficient information to allow for targeted habitat conservation that will contribute to the maintenance of populations. However, for others the lack of information should be addressed through research, prioritised according to species population status, ecology and threats to relevant cropped habitats.

We have commented that the UK SPA network frequently excludes habitats that are essential components of qualifying species' functional unit systems, and described why this may have arisen in the introduction. Effective species conservation requires the maintenance of all elements of a species' functional unit system – take away any part in sufficient extent and it will have a negative impact on the population. For this reason, the maintenance of cropped habitats is essential for a number of species, but the exact nature of the appropriate management required will vary according to habitat type, its vulnerability and those species' ecological requirements. Whilst an obvious solution would be to extend SPAs to include all required cropped habitats for qualifying species, site-based conservation is not the only mechanism that can ensure the maintenance of habitats in the landscape. In this respect, we do not use the term maintenance to automatically mean statutory site designation; rather we use this term to indicate that there is a clear requirement for some form of preservation of cropped habitats in relation to existing SPAs.

Having identified the cropped habitats that are of ecological importance for many of the species represented in the UK SPA network, and made recommendations on which habitats should be maintained, we believe that there is a need for review of policy on the maintenance of cropped habitats in support of the birds protected by the SPA network. There are a number of technical and legal considerations that could be taken into account in assessing whether existing policy continues to be appropriate, and to facilitate any policy review we discuss these briefly in the following sections.

Recent changes in cropped habitats in the UK and vulnerability to future change

Different species have responded to changes in the agricultural landscape in different ways, due to differing ecological requirements and adaptability, and past experience shows that differing types of habitat protection and management regimes are necessary. Some species, such as Chough, require highly specific management of cropped habitats at the local level coupled with generic landscape character maintenance. Others require general preservation of a large-scale management system without specific local management of crop type, but again coupled with generic landscape character maintenance, such as some geese in the non-breeding season. Other species require intermediate approaches. In order to develop the optimal approaches to habitat maintenance it is necessary not only to understand species ecological requirements, but to also understand the pressures within functionally important habitats. To do this it is worth considering both the historical patterns of change in agricultural landscapes and current drivers of future change.

Landscape Change

The Countryside Surveys of 1990 and 1998, and previous ecological surveys of rural Britain in 1984 and 1977/78, provide an overview of the changes in the countryside over the last 25 years (www.cs2000.org.uk). These give some idea of gross change in broad habitats – both types and areas, but also provide valuable insights on changes in the six broad environmental zones defined for Great Britain. Between 1984 and 1998, there was little change in most

habitats, but a fairly consistent feature across all but the Scottish upland environmental zones has been loss of improved grassland and gains in built land and gardens. In the Scottish lowlands, there have been significant declines in the area of acid grassland and bogs and gains in neutral grassland (unimproved and semi-improved), broadleaf, mixed and yew woodland, and bracken. In the Scottish uplands, there have been significant gains of improved grassland, possibly due to conversion from neutral grasslands.

In Scotland, the change in land cover between the 1940s and 1980s has been described in detail by Mackey *et al*. (1998). Significant increases in the areas of conifer plantations (620%), arable (11%), semi-improved grassland (15%), and the built environment (46%) have taken place. Alongside these increases have been significant declines in the areas of improved grassland (-11%), and rough grassland (-10%). The patterns of change are broadly: conversion of heather moorland and mire to forestry and rough grassland; rough grassland to forestry and semi-improved (intermediate) grassland; and improved (smooth) grassland to arable.

Over the last ten years (1993 to 2004), changes in agriculture in the UK have been more subtle (Defra 2004). The total area of arable land has declined by 2.8%, whereas the total area of grassland, excluding rough grazing, has increased by 5%. Sole-right rough grazing has declined by 10.4%, but common rough grazing has remained relatively stable. The total area of arable and horticultural crops has remained relatively stable, but there have been significant changes to the drop types being grown. Changes to livestock numbers have taken place with the total cattle herd gradually declining through the period and down by 11% and the sheep herd down by 18%. The Countryside Survey 2000 provides further detailed breakdown of these changes by environmental zone and an insight into changes in forestry over the period 1990 to 1998. In most of the UK's environmental zones there has been little change in forestry, but there has been some increase in conifer area in the marginal uplands of Scotland (Zone 5) corresponding to losses in heath, mire and neutral grasslands.

Description of gross changes in the agricultural landscape suggests that relatively subtle changes have taken place in the last two decades and that the overall availability of different cropped habitats may be generally stable. Of most concern is the continuing loss of rough grasslands in the uplands. However, the gross patterns of change mask important localised changes, which in some areas have been demonstrated to affect bird populations; for example, the loss of rough grassland has been partly responsible for localised decline of Hen Harriers in Orkney. Statistics on change in extent of habitat types also offer nothing in terms of understanding the impacts of changes in management on the characteristics of any given type of cropped habitat. Livestock stocking levels have been in decline though the 1990s, which is likely to continue under changes to the Common Agricultural Policy. The total area of grassland also declined over the same period, so it is difficult to know what impact the decline in livestock has had, if any, on pasture characteristics. In future, livestock numbers may continue to decline due to the switch to a whole-farm payment method of subsidy. This may result in changes in pasture character and there is a possibility that the area of rough pasture might increase, although total grass area may also continue to decline due to conversion to other uses. Whilst a gain in rough pasture is likely to be beneficial to a number of species, such as breeding waders in the uplands, it may disadvantage those species that require short-sward grasslands, such as Chough.

The descriptions of gross habitat change also provide little understanding of the effect of agri-environment schemes on cropped habitats. Whilst such schemes occur over relatively limited

areas, this is changing: in England, the Entry Level Stewardship scheme is anticipated to bring a significant proportion of agricultural land into management that will benefit a range of farmland birds and other biodiversity. This is likely to bring benefits to species that prey on small passerines and small mammals (most of the reviewed birds of prey), as the areas of less-intensively managed habitats will increase and are likely to enhance populations of these types of prey species.

Future Change

It is difficult to predict how the agricultural landscape might change over the next few decades and further into the future; this uncertainty needs to be considered in developing approaches to cropped habitat maintenance for birds. All habitats are vulnerable to change and changes will affect different species in different ways. Habitat loss to birds can come about through both subtle changes in management, such as change in livestock stocking levels or seasonality of stocking that may result in unfavourable sward height at the key time, to more obvious changes such as conversion of grassland to forest or arable crops, or from loss to built development. Loss may also occur through changes in use of areas adjacent to important crops for birds.

It is likely that current EU policies in relation to agriculture will bring about significant changes to both the area of different cropped habitats grown and the associated landscape character over the next few decades, especially with the wider implementation of agri-environment schemes. However, other drivers, such as energy policy, may also have a significant and widespread affect.

Biofuels are one source of biomass energy, originating from both some existing agricultural wastes and from new crop types. Current EU targets for renewable energy and the underpinning implementation policies (*e.g.* Biomass Action Plan (2005), Strategy for Biofuels (2006)) are driving change in financial incentives (including via CAP) that are likely to result in significant changes to types of crops grown in the UK, with potential large-scale increases in certain oil-bearing and cellulosic (including woody) crops. Whilst marginal lands, including set-aside, are most likely to be selected for novel biofuel crop production this will depend on the constraints of crop types, soils and climate, and associated economics. Not only might biofuel production cause loss of cropped habitats for birds through direct changes in crop type, but also through indirect affects of changing landscape structure. For example, the replacement of pasture with woody biofuel crops like willows in non-breeding goose foraging areas will not only directly reduce the available grazing area because of crop replacement but may also lead to abandonment of retained pastures due to change in landscape character.

Mechanisms available to maintain cropped habitats

Given the differing requirements of species, it is possible that for some the existing legal and policy framework already adequately ensures that important areas of cropped habitats will be maintained. While this may mean that conditions are favourable for some species without the need for additional measures, there is a risk that policy might change in such a way as to remove favourable management: there are also legal considerations (see Legal requirements of the EU Birds Directive). However, a brief review of the mechanisms that are available to

maintain cropped habitats is worthwhile, these are: planned landscape use, land management policies, and statutory designations.

Landscape planning

UK planning laws require the development of local development or structural plans, which identify broad zones of permissible land use. There is general control of built development, but most individual projects undergo an application process and permission is granted after public consultation. While zoning has a strong influence on planning decisions, some developments are granted permission in areas zoned for other uses. We have already described the loss of a significant area of agricultural land to built development over the last 60 years; there continues to be intensive pressure to build new residential and commercial properties, and roads in the UK. However, under planning law some development is permitted without planning permission, for example agricultural buildings of certain types and size are exempt from planning permission, as are some types of temporary land-use for recreation. Some developments associated with forestry operations are also allowed under permitted development rights. The law is complex, and even under permitted development rights, many projects require a determination to be made by the local authority before projects can go ahead, but these are not open to public consultation.

Within this mechanism for land use control, the protection of areas of high nature conservation value is influenced by national planning statements (policies) and other laws, which place stricter levels of protection from built development on Natura 2000 sites (including SPAs), and other statutorily designated sites. The law also requires a broader assessment of the possible impacts of a planned development on an SPA even if the development is outside of the site.

A number of species reviewed are sensitive to disturbance and select feeding areas in the agricultural landscape partly on the basis of distance from buildings; suitable feeding areas close to buildings are avoided. **Whilst current control of built development is likely to reduce loss of feeding areas within cropped habitats, there remains a possibility that important areas could be lost by relatively minor increases in the number of buildings and associated access routes.** For many of the species reviewed we have highlighted that 'openness' of the landscape, i.e. areas with a high proportion of arable and/or pasture fields with low boundaries, is a key conservation requirement and current planning law may fall short of ensuring that important feeding areas are not lost to development. However, most of these species have benefited considerably from changes in agriculture during a period of significant growth in built development, and appear to have adapted well to changes in land use. For these species at least there seems to be little evidence to suggest that the current system of cropped habitat maintenance is not adequate.

Agricultural policy and agri-environment schemes

The type of management systems adopted in the agricultural landscape are not controlled under planning law, but are influenced by land type and a highly complex policy and economic framework. The financing, and therefore type, of agriculture is influenced by European policy (Common Agricultural Policy: CAP), and the specific implementation of this at the national level, as well as market forces. Coupled with technological advances (machinery, chemicals, and plant and animal breeding) agricultural policy, financing and markets have lead to significant long-term changes in agriculture. Forestry policy effectively

sits within agricultural policy. In recognition of the need for a sustainable approach to land management, European policy has changed over the last two decades, reflected in changes to CAP, and agri-environment schemes have become one tool for delivery of sustainability goals.

Environmentally Sensitive Areas (ESAs) were established in the mid 1980s, covering large areas of differing habitat types throughout Great Britain that were identified as having particular sensitivity to changes in agricultural management. Within an ESA, farmers were invited to voluntarily implement specific management approaches, for which they are financially compensated. ESA designations have made a significant contribution in some areas to maintaining low-input and/or low-intensity farm management systems, and hence securing certain types of cropped habitats in the landscape. However, a number of studies have demonstrated that despite good take-up and implementation of management prescriptions that the effect on bird populations has been limiting (Mathers & Woods 1989), although a recent review by Defra (2004) has shown that some species have benefited from ESA. Overall, the total area and take-up of ESAs in Britain remains relatively limited; for example, there are 615,000 ha in ESA in England, representing just 64% of the total area eligible (Defra 2004). ESA schemes have been superseded by broader agri-environmental schemes.

Other agri-environment schemes (A-ES) have provided some benefits to birds. Many of the prescriptions within agri-environment schemes are influenced by the needs of a variety of birds, but especially commoner species that have undergone significant declines since the 1980s. A-ES are voluntary and to-date are relatively limited in coverage: 400,000 ha in England in 2003 (Defra 2004). In an attempt to bring more land into agri-environment management, Defra launched Entry Level Stewardship in England in 2005. This scheme includes simple prescriptions to enhance biodiversity in primarily arable landscapes, but includes prescriptions for retaining moorland, rough grazing and rush pastures in Less Favoured Areas (LFAs). In Wales, Tir Gofal, has prescriptions designed to benefit non-breeding waterbirds and breeding waders, and provides prescriptions for adjusting grazing levels to benefit Chough in certain areas.

As part of some A-ES, special projects aimed at recovering certain species have been developed, for example for Cirl Bunting in England and Corn Crakes in Scotland. The Cirl Bunting project (linked to delivering BAP targets) has been very successful and some of the prescriptions developed under the project are now included more broadly within the English Environmental Stewardship Scheme. Stone-curlew plots, bare areas within cereal fields that provide suitable nesting opportunities for the species, have been in use for more than a decade, initially developed by the RSPB and recently included in the Higher Level English Environmental Stewardship Scheme.

In Scotland, Goose Management Schemes are another agri-environment approach, although their principal aim is to alleviate the possible financial burden of crop damage by non-breeding geese. Although providing conservation management for some species in some areas, these schemes are not focused on preserving or recreating habitats, and are therefore quite different from other A-ES. They are also expensive and very limited in geographical extent.

Agri-environment schemes are limited in their coverage and are entirely voluntary. The benefits of A-ES to maintaining species within SPAs that use adjacent cropped

habitats have not been evaluated, but are likely to be relatively minimal given the poor match between ESAs and SPAs, the limited coverage of current schemes and the current scope of targets in all of these schemes. There are legal issues associated with delivery of conservation requirements via voluntary means, although A-ES are typically highly successful in engaging land managers and getting near-complete coverage over their target areas, but such schemes would need to be considerably more extensive than at present and have new or modified prescriptions if they were to provide an effective means of maintaining cropped habitats for the species considered in this review. In addition, A-ES do not place any additional controls on planned development, and although they make retention of cropped habitats in certain form financially attractive they allow highly flexible land use management. However, A-ES, whether associated with SPAs or not, can be effective at maintaining low/input and/or low-intensity management systems and could be developed further for certain species (Table 2) as a policy for delivering conservation requirements.

Statutorily protected areas

Site-based statutory designation is one mechanism to ensure maintenance of habitats essential for the maintenance of bird populations. SSSI/ASSI designation provides for regulation of agricultural management with the aim of maintaining the features of interest, and operates via a system of consents based on the conservation objectives or management plan for the site. Management schemes can also be established to aid in achieving specific habitat characteristics, especially in situations where recovery of habitats has been identified within conservation objectives. Most SPAs are underpinned with SSSIs/ASSIs and benefit accordingly. However, a number of SPAs are not protected in this way, but are underpinned with special voluntary management schemes. Another significant generic benefit in statutory designation is regulation of planned development, either via specific legislation (e.g. for SPAs) or special status in planning policy. **Cropped habitats in statutorily designated sites are at considerably lower risk from loss to built development, afforestation, and conversion or loss through changed agricultural management.**

The legal requirements of the EU Birds Directive and the UK SPA Selection Guidelines

The overall objective of the Birds Directive is to achieve maintenance of populations of naturally occurring wild birds in the European territory of the EU at favourable levels (Article 2). Member States are required to preserve, maintain or re-establish a sufficient diversity and area of habitats to contribute to this objective, creating protected areas and managing habitats both inside and outside of these protected zones (Article 3). Special Protection Areas are a specific form of protected area, required amongst other measures to ensure the survival and reproduction of rare and vulnerable species (listed in Annex I) and migratory species across their area of distribution (Article 4). There is an obligation to manage SPAs in such a way as to avoid pollution or deterioration of habitats or disturbances to birds that would significantly affect the species for which the SPA provides protection. There is also an obligation to avoid pollution or deterioration of habitats outside of SPAs. The Birds Directive does not specify that different habitat types should be treated any differently in meeting its objectives.

The Birds Directive stipulates that the most suitable territories in number and size should be classified as SPAs for the conservation of Annex I and migratory species. In particular, for migratory species areas where species breed, moult, stage and winter should be selected, paying particular attention to wetlands of international importance (Article 4). There are no

more detailed criteria for selecting SPAs than those provided by Article 4 of the Directive and refinement of the methods of selection have been left to the discretion of the Member States (MSs) following early attempts to develop guidance (Stroud *et al*. 1990).

Legal interpretation of parts of the Birds Directive has been established through European case law and there are a number of judgements relevant to SPAs and cropped habitats. Fundamental is the ruling that Member States cannot take into account economic requirements when classifying SPAs (Case C-44/95 Lappel Bank, and others) and that, although MSs have some discretion with regard to the choice of SPAs, classification of areas is subject to the ornithological criteria specified in the Directive (Case C-355/90 Santona Marshes, and others). In addition, the obligation to classify SPAs cannot be avoided by implementing other conservation measures (Case C-3/96 *Commission vs. Netherlands*). A number of cases have found that the area of a specific SPA has been insufficient in meeting the requirements of Article 4 of the Birds Directive; a larger area than that classified has met the ornithological criteria specified in the Directive (e.g. cases C-96/98 Marais Poitevin and C-209/04 Lauteracher Ried). Finally, voluntary measures, such as agri-environment schemes, cannot meet the protective requirements of classified SPAs (C-96/98 Marais Poitevin).

At minimum, the obligation to classify SPAs to meet the objectives of the Birds Directive could be interpreted as being an area of habitat large enough to sustain a viable population of a species. In this respect, all habitats of functional relevance to a species should be considered for inclusion in the area of SPA classified if viability is to be ensured. With this interpretation in mind it follows that cropped habitats should be considered for inclusion in SPAs if those habitats are necessary for the survival and reproduction of the birds for which SPAs have been classified. However, the interpretation of whether these habitats are the 'most suitable' for classification as SPAs, *i.e.* meet the ornithological criteria set out in the Birds Directive, remains an important consideration.

In the UK, SPAs are selected using guidelines (JNCC 1999) that highlight the importance of areas that support more than 1% of a population, or an internationally important assemblage, or are of importance for other reasons; application of the guidelines results in identification of the most suitable areas for classification. We noted earlier that the UK guidelines place greater emphasis on the classification of natural and semi-natural habitats, an approach not necessarily supported by the Birds Directive. However, the guidelines do not preclude the inclusion of cropped habitats, but they do include a relevant definition on the suitability of an area for classification:

- Areas to be classified should be distinct in habitat and/or ornithological importance from the surroundings and have definable and recognisable character.

With respect to some cropped habitats, it would be relatively easy to demonstrate habitat distinctiveness and the characteristics that make the habitat important for the species concerned. However, scale is important and where cropped habitats are extensive this becomes more difficult. In extensive habitats of any type, the presence of birds can be, and often is, used as an indirect measure of habitat distinctiveness, given that birds respond to features of habitats that may not be readily apparent, and so, ornithological importance becomes an important measure in such habitats. Areas within extensive habitats that are used regularly by a qualifying number of birds, or a significant proportion of the birds for which a functionally linked SPA has been classified, may meet the definition of suitability for

classification. There is no guidance on what might represent a significant proportion of the birds within an existing SPA; an arbitrary threshold could be adopted. In extensive areas of cropped habitats, regularity of use might also need further definition as habitat choice is likely to vary considerably both within and between years, in part influenced by the mobility of certain cropped habitats (via rotation); guidance may be needed on the minimum amount of data that would be needed to confidently identify habitats that are of real functional importance (the loss of which would have a negative affect on the numbers within the SPA).

Conclusions: developing policy for maintaining cropped habitats for birds

Many of the species represented in the UK SPA network have a reliance on cropped habitats, much of which is not included in the SPA network (Stroud *et al.* 2001). The maintenance of suitable cropped habitats for these species is essential to ensure that populations are maintained at favourable levels, as is required under the EU Birds Directive.

Gross changes in the agricultural landscape over the last few decades have been subtle, but certain low-input/low-intensity cropped habitats, such as rough pasture in the uplands, continue to be lost. There is evidence that local losses in some cropped habitats have caused population declines in a number of birds, for example the decline of the Hen Harrier population in Orkney. It is extremely difficult to predict future patterns of change in cropped habitat extent and character, but sustainable development may bring about significant change. Of particular note are the affects that biodiversity conservation needs are having on agricultural practice, which is driving an increase in agri-environment provision, and the likely impact of growing renewable energy needs, which is driving the development of a biofuels sector. Policies for maintaining cropped habitats for birds that are represented in the SPA network need to take account of the likely affects of recent and future changes in agricultural policy.

There are a number of mechanisms already available for maintaining cropped habitats: planning law, agricultural policy and agri-environment schemes, and site-based statutory protection.

- Planning law minimises the risk of loss of cropped habitats to built development, but does not influence the types and patterns of crops grown. Many of the species that utilise open mixed pastoral and arable habitats have faired well over the last several decades, at a time when there was considerable growth in built development, suggesting that planning law may have been beneficial at least for these species at the landscape scale.

- Agricultural policy, including agri-environment schemes, has a strong influence on land use and the types and patterns of cropped habitats in the landscape. Agri-environment schemes are limited in coverage and voluntary, but they have made a significant contribution to the conservation of a number of species that are reliant on low-input and/or low-intensity management systems. Such schemes have an important role to play in delivering the conservation requirements of many species, but due to their voluntary nature are not risk-free.

- Site-based statutory protection is effective at limiting planned development and allows for regulation of cropped habitat management. It is the best mechanism available for ensuring that both specific cropped habitat characteristics and landscape

character are maintained for the species for which a site is designated, especially when management schemes are implemented to assist in achieving conservation objectives.

These mechanisms, at present levels of implementation, do not ensure maintenance of important cropped habitats for all of the species reviewed and hence do not currently deliver their conservation requirements. None of the mechanisms, either alone or in combination, are risk-free, but for some of the more adaptable species the combination of these mechanisms has proven beneficial. However, it is clear that some species, typically those with reliance on low-input and/or low-intensity management systems and that have undergone considerable historical declines, are being recovered only through highly targeted conservation management. We believe that there is a need to review policy on maintaining the cropped habitats that provide for the ecological needs of species in the SPA network. We have recommended species-specific approaches to identifying which cropped habitats are important (Table 1) and we recommend that these are used to develop policy. For some of the species reviewed there is no information on general ecological requirements and we recommend that research addresses this, prioritised by species status and vulnerability of the cropped habitats concerned.

We have discussed briefly the legal requirements of the Birds Directive and their interpretation through case law. Such case law suggests that there is little flexibility in adopting alternative measures to SPA classification for habitats of any kind that meet the ornithological criteria set out in the Directive. The UK SPA Selection Guidelines (JNCC 1999) were developed to aid in interpreting the ornithological criteria in the Directive and, hence, identify the 'most suitable' areas for classification as SPAs. If additional SPA provision is identified as a requirement to ensure that cropped habitats are maintained, then we recommend that additional guidance to assist in application of the guidelines is developed by the SPAR SWG, specifically in relation to determining the ornithological importance of extensive areas of relatively uniform cropped habitats. This guidance should indicate what constitutes a significant proportion of the numbers of any species in an SPA and regularity of use when there is variation in the use of different cropped habitats both within and between years. With the additional guidance, we suggest that application of the UK SPA Selection Guidelines to areas of cropped habitats will identify those, if any, that may be the most suitable for classification as SPAs.

It is likely that, in applying UK SPA Selection Guidelines and additional guidance on cropped habitats, new areas of cropped habitats will be identified as suitable for classification as SPAs. If this is the case, then the species-specific recommendations that we have made in Table 1 are relevant to aid boundary definition. For some species there is sufficient evidence to draw general conclusions about ecological requirements and a generic (modelled) approach to boundary determination may be appropriate. For example, the SPAR SWG recently recommended to the Government's Natura 2000 & Ramsar Steering Committee (the decision-making body on UK SPA policy) that SPA boundary determination for breeding Chough should be based on a generic model (inclusion of suitable habitat within 1 km radius of each nest location within an SPA), but that boundaries for the same species outside of the breeding season should be based on local evidence of habitat use. Generic approaches to defining boundaries are unsuitable for widely ranging species because large areas of unsuitable habitat will be included in a site. For these species, for example non-breeding swans, a location-specific approach will be more appropriate, but would be possible only if knowledge of field use was available. Such data are not typically available and new surveys

would be needed to be able to determine both the suitability of cropped habitats for SPA classification around existing SPAs and the boundaries of any that are then judged suitable.

Given the ecological requirements of the species in this review, and conservation priorities, we recommend that:

1. High priority should be given to ensuring that existing SPAs for all species dependent on cropped habitats arising from low-input and/or low-intensity management systems are adequate to meet the ecological needs of the birds for which the site was classified (Category 1 & 2 species in Table 2). If this leads to addition of habitats to SPAs then boundary determination should be based on either a generic (modelled) approach or on evidence of regular use. For such species, specific crop types and character need to be maintained and so the condition of any areas added to the SPA network should be secured through an appropriate mechanism, including targeted management.

2. Where existing SPAs support species dependent on cropped habitats arising from high-input and/or high-intensity management systems (Category 3 in Table 2) the maintenance of landscape character, and where relevant crop types, is secured through an appropriate mechanism. In the majority of cases such areas should be identified only from regular use by a significant proportion of the birds for which the site was classified.

Many other species use cropped habitats, including a large number of farmland passerines and a few others with SPA provision. For the former, landscape-scale approaches have been adopted to aid in conservation (various agri-environment schemes). For the latter, which includes species like Golden Eagle, the policies developed from this review will be relevant.

Table 2. Species/management system matrix to aid the development of policy for cropped habitat maintenance.

Cropped habitat management system	Species ecology[2]	
	Specialist	**Generalist**
Low-input habitats, where relevant with low-intensity stock management systems or low-intensity harvesting regimes	[Category 1[3]] Chough Curlew (B) Hen harrier (B) Merlin (B) Nightjar Short-eared owl (B) Stone-curlew Twite (B)	[Category 2] Corn crake
High-input habitats, and/or intensive management systems	[Category 3] Capercaillie Chough Golden plover (B) Hen harrier (B) Honey buzzard Merlin (B: NI only) Nightjar Red kite (B) Ring ouzel Scottish crossbill Wood lark	[Category 3] Curlew (NB) Non-breeding geese, swans and ducks Marsh harrier (B)

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[2] B = breeding, NB = non-breeding (outside of the breeding season)
[3] See text (page 22) for explanation

Appendix 1

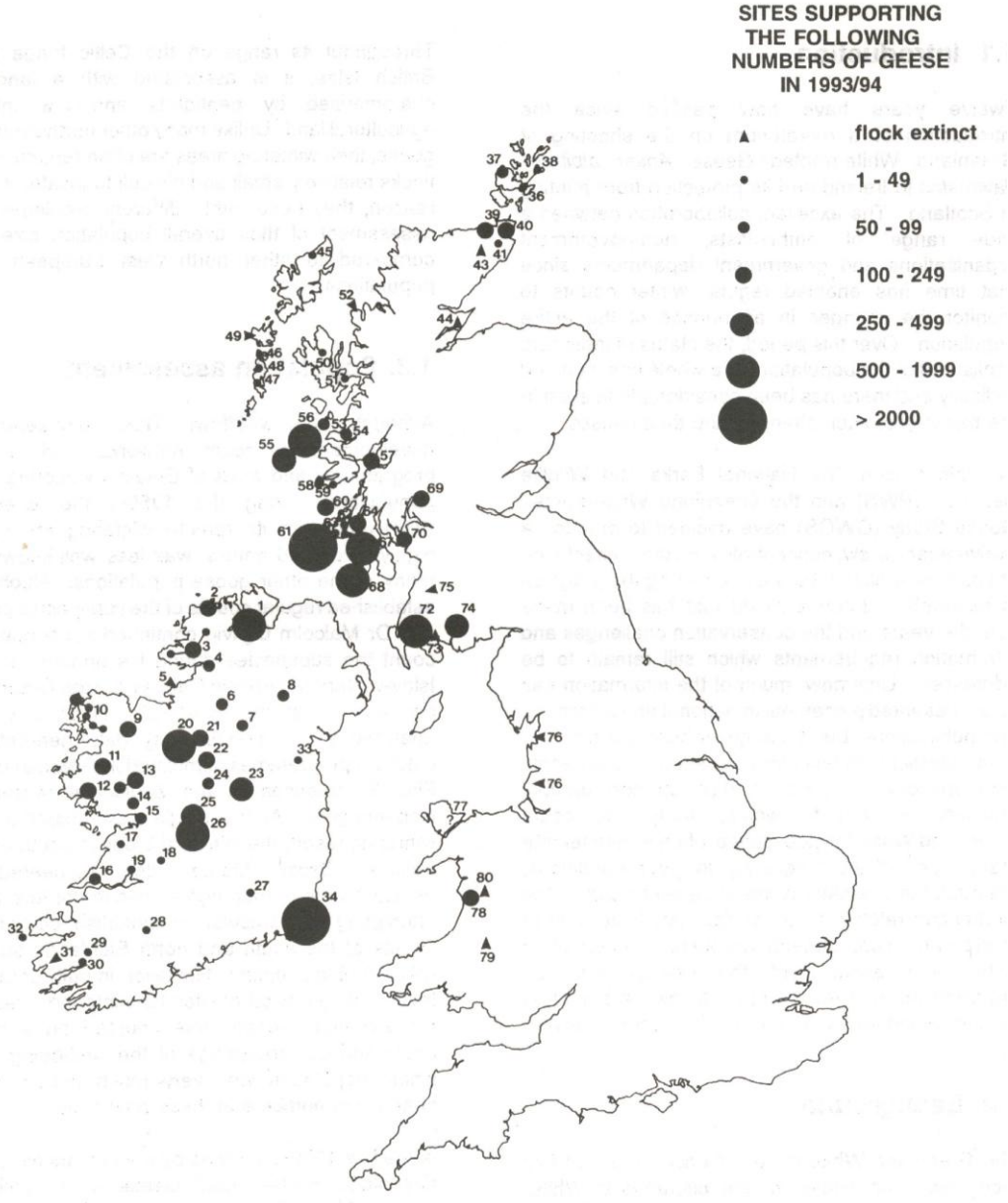
Species review pro-forma: an example using the Greenland White-fronted Goose (*Anser albifrons flavirostris*)

Cropped Habitats Information Project: draft pro-forma for Greenland White-fronted Goose

Context: range and distribution

The global distribution of Greenland White-fronted Geese in the non-breeding season is restricted to a few localities in the north and west of Britain and in Ireland (mainly the south and west) (Figure 1[1]). Sites used are traditional between years, and the gross extent of the range has been substantially stable over at least 100 years[2, 3]. There have, however, been a small number of new flocks established in the last 30 years and a significant number of flock extinctions, especially consequent on a major population decline between the 1950s and the late 1970s[3]. Notable flock extinctions have occurred at the edge of the range, in south-west Ireland, mid-Wales and north-west England[4].

Figure 1. Distribution of flocks of Greenland White-fronted Geese in Britain and Ireland 1993/94. Sites with a high probability of exchange of birds within a winter, unrelated to spring or autumn migration, are linked by lines.



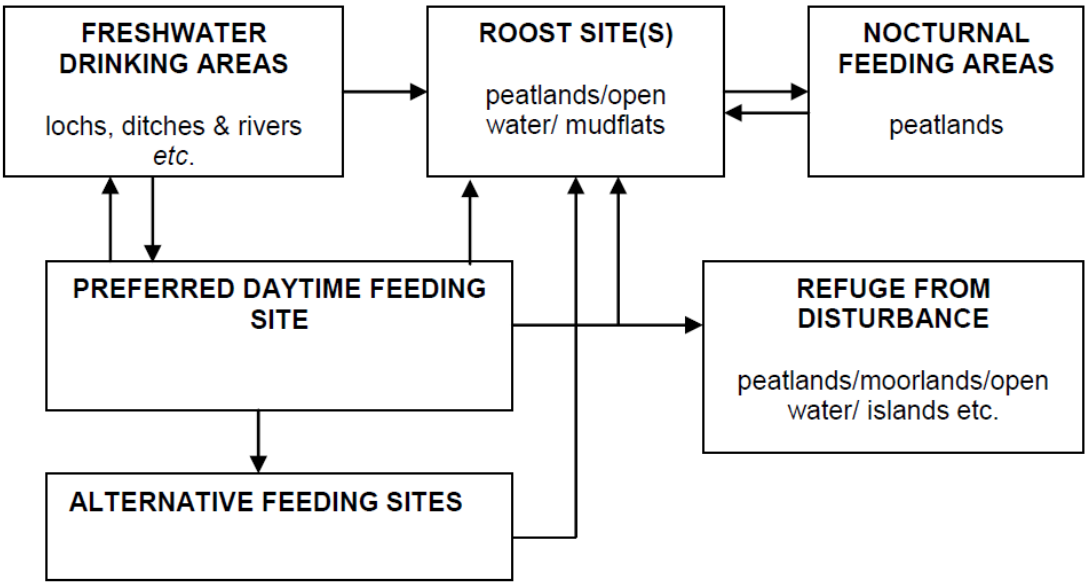
Cropped and other habitats used in the UK

Flock dynamics in relation to habitats - Functional Unit Systems

Typically, sites used by a flock of Greenland White-fronted Geese comprise one or more nocturnal roost sites, one or more separate feeding areas, and areas used for refuge in the event of disturbance during the day. Wilson *et al.*[5] described the use of traditional locations in terms of a 'Functional Unit System' (Figure 2) – a means of conceptualising the different functional components of the overall flock range.

The total area used by any one flock in winter is highly limited – often just a few tens of hectares (below).

Figure 2. Components important in the definition of Greenland White-fronted Goose functional unit systems. Arrows indicate movements between different components of flock 'home-range'.



Habitat descriptions

Greenland White-fronted Geese roost on peatlands, open waters (including moorland and other lochs) and at a few sites, on inter-tidal sands or saltmarshes[6]. Historically, feeding occurred probably exclusively on peatlands (the overall extent of the range closely mirrors the geographic extent of oceanic patterned blanket, and coastal raised, mires in Britain and Ireland). Today, significant nocturnal feeding on bog plants still occurs on these areas but the main diurnal feeding has changed, first to low-intensity grasslands of permanent (and sometimes semi-natural) character, and more recently (although only at some locations) to rotational grasslands under greater intensity management.

In some localities[5], flocks now feed on high intensity grassland, although without having changed locations: feeding fields formerly subject to low intensity management (and with high nature conservation value) have been reseeded and are now managed as rotational leys. The continued visitation of geese to these same fields now causes alleged damage, although on the part of the geese there has been no change in feeding location, just a change in intensity of agricultural management of areas continuously used.

The main cropped habitats used are thus grasslands. Throughout their range there is little winter cereal growing. Where autumn stubbles do occur however, (especially in Caithness, Coll, Tiree, Kintyre and Islay) they are used intensively on the arrival of geese in October, and consumption of split grain at this time is important in allowing the rapid recouping of body condition after migration from Iceland (and prior to mid-winter).

At Wexford in Ireland some use of carrots and sugar beet fields is regular[7], whilst topped forage beet is sometimes taken on Islay. Generally, root crops are available at some locations only, although where they do occur they are energetically very important, being highly digestible and with high energy content (as also stubble grains)[7].

Current SPA provision (sites and habitats)

The current SPA suite is as follows:

Site name	Site total	% of GB population	FUNCTIONS PROVIDED BY SPA		
			Nocturnal roost	Diurnal roost or loafing area	Feeding (cropped habitats)
Caithness Lochs	183	1.3%	Freshwater lochs	NO	NO
Coll	789	5.7%	Moorland lochs	NO	NO {although significant feeding areas lie within the Coll (Corncrake) SPA}
Dyfi Estuary	144	1.1%	Saltings and mudflats {raised bog excluded}	Saltings	NO
Kintyre Goose Roosts	2,323	17.0	Moorland lochs and lowland wet grassland	NO	NO {some limited feeding included at grassland roost area at Rhunahaorhine Point}
Loch of Inch and Torrs Warren	534	3.9	Inter-tidal sandflats	NO	NO
Loch Ken and River Dee Marshes	350	2.6	Three freshwater lochs and marshes	NO	Grassland managed at varying intensity
Loch Lomond	237	1.7	Freshwater loch	NO	Some limited feeding areas on wet grassland and marsh included
Sleibhtean agus Cladach Thiriodh (Tiree Wetlands and Coast)	783	5.7	Freshwater and moorland lochs	NO	Semi-natural wetland in one area otherwise NO
ISLAY					
Eilean na Muice Duibhe/Duich Moss, Islay	1,300	9.5	Blanket/raised mire	NO	NO {but some birds use Laggan SPA}
Laggan, Islay	300	2.2	NO {but some birds use Eilean na Muice Duibhe SPA}	NO	Grassland managed at high intensity
Rinns of Islay	1,600	11.7	Blanket mires	Freshwater loch	NO {but some birds use Gruinart SPA}
Gruinart Flats, Islay	1,000	7.3	NO {but some birds use Rhinns SPA}	Saltings	Grassland managed at varying intensities

There are a number of key points regarding the SPA suite in the context of the CHIP review:

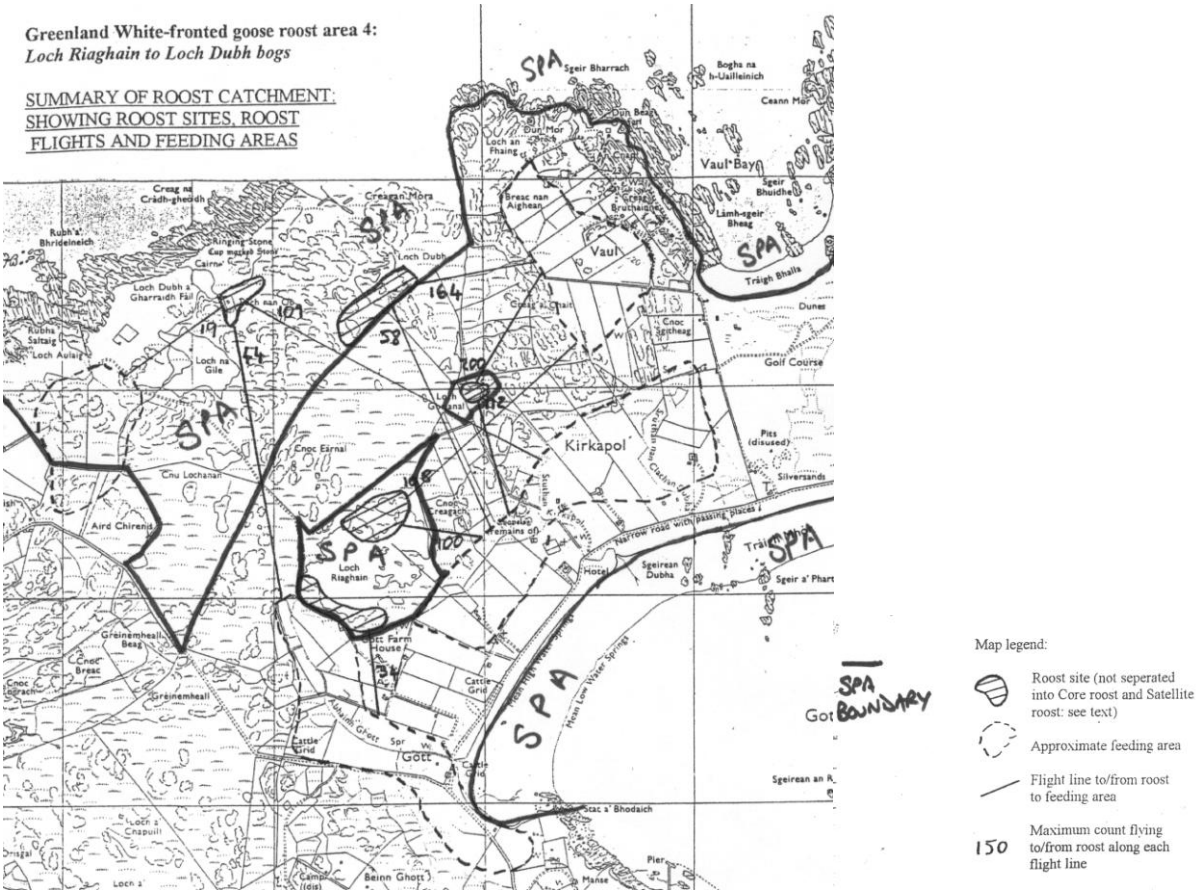
- For nearly all flocks, sites with the current SPA suite do not contain whole functional unit systems (all areas used by flocks). Generally sites just contain roosts, with feeding areas not subject to formal protection[8]. Some sites just contain feeding areas with no roosts.
- For two pairs of sites on Islay, there is at least partial coverage of both feeding and roosting areas. Most birds feeding on Laggan SPA probably roost on Eilean na Muice Duibhe/Duich Moss SPA (although the converse is not true). Some birds feeding at Gruinart SPA probably roost within the Rhinns SPA, although again the converse is not true, with the majority of Rhinns roosting birds feeding outwith the Rhinns and Gruinart SPAs.
- There are some sites on mainland Argyll qualifying at Stage 1[9] (holding numbers of European importance), which were not selected at Stage 2 of the SPA selection process. This was on the grounds that Loch Lomond contributed more to the coverage of range in the UK.

- There are other roost sites on Islay of at least national importance which were not considered by the SPA review because of lack of regular count data[10].

An example is given in Figure 3, which shows the use of habitats in an area of Tiree. Whilst all main roost areas of this part of Tiree are included within the SPA, the immediately adjacent feeding areas for these birds are excluded. These feeding areas are grasslands of various types, including cultivated leys, meadows and dune grasslands.

Figure 3a. Relevant area of Sleibhtean agus Cladach Thiriodh (Tiree Wetlands and Coast)

Figure 3b. Goose usage around a roost complex within part of Sleibhtean agus Cladach Thiriodh (Tiree Wetlands and Coast). Data from SNH contract surveys in January - April 1996[11].



Spatial change in availability of cropped habitats between years

There are few changes in either gross or local availability of grassland used by Greenland White-fronted Geese between years. Patterns of land-use in western and northern Scotland tends to be generally stable. Changes to local agricultural practice typically occurs either in response to new land-owners adopting more progressive farming systems, or in response to external factors (such as the recent abandonment of dairying on Islay which will probably have long-term implications for the intensity of grassland management on the island). Thus, local availability of grasslands to particular flocks is entirely predictable year-to-year and largely unchanging over long periods[12].

Within Scotland, the National Countryside Monitoring Scheme has quantified the general trend of intensification of grassland management from the 1940s to 1980s, although the extent of this change has been variable between regions[13].

Between-year site fidelity to specific cropped habitats

Greenland White-fronted Geese are highly site-faithful within and between years both on wintering areas and at areas in Iceland used on migration[5, 6, 14, 15]. Site-fidelity between winters has been estimated at 80% on Islay[22] and 85% at Wexford).

Flocks comprise groups of extended families, with long-lasting relationships between parents and offspring[16, 17]. Individual colour-marking[18] has shown that the same social groups repeatedly visit the same areas year after year. One bird is known to have used the same small number of fields on Islay every year for at least 19 years[19].

Extent of within-year/seasonal variability in use of habitats

Detailed ecological studies in Iceland[20, 21], have shown that small-scale patterns of between and within-field use are related to the need to maximise nutritional intake. Such fine-scale studies have not been undertaken on the wintering areas, but intensive survey work on Islay in the 1980s showed that local use of fields was predictable on a day-to-day basis.

Radio-tracking of marked geese on Islay by WWT in the 1980s demonstrated that individuals have discrete home –ranges of limited extent[22]. Specific grass fields used for feeding within these home ranges are linked to regularly used roost sites in a predictable manner. Cluster analysis of resightings of individually marked birds on Islay in 1991/2 and 1992/3 indicated an average home range extent of 195.7 ha and 488.3 ha respectively. However, some 80% of resightings occurred in areas of only 13.3 ha and 20.1 ha in the two winters. The 80% utilisation level is thought to represent core areas of the home ranges, with occasional resightings elsewhere representing some limited excursive activity[22].

Ridgill *et al.* (1994)[22] concluded:

i) *"that individual birds have a limited distribution, utilising a very small area in winter;*
ii) *that they make only patchy use of their home range, thus proving highly selective in their choice of sites on a field-by field basis; and*
iii) *that they show an exceptionally high level of winter site fidelity."*

Other importance of habitat to survival of species

Diurnal feeding areas (typically grasslands and stubbles) and nocturnal roosts/feeding areas (typically peatlands or freshwater systems) are the primary biotopes used by Greenland White-fronted Geese. Behavioural observations have shown that other areas are also of importance, in particular refuge areas used when geese are subject to high levels of disturbance. Refuge areas are of particular significance, with their loss at many sites being thought to be related to declining favourability of many sites, especially in Ireland[2, 23].

Freshwater lochs are also used for loafing and drinking typically in the middle of the day[24]. This habitat is of particular importance, probably in physiological contexts not fully understood. Birds will regularly travel significant distance during the day to drink, and access to water can result in considerable aggression - indicating its value as a resource to individuals. Consideration of freshwater resources (pools, ditches, lochs and rivers) seem thus to be an important element in the consideration of particular functional units and the conservation provision made for the particular components.

Significance of cropped habitats and implications of change

Analysis of patterns of changes in flock size in the last decade have shown that size, number and quality of feeding areas, level of disturbance, flock size and latitude are factors that all influence flock status[25]. Those flocks occurring in areas with fewest, poor quality, limited feeding ranges have shown the most serious declines and also now tend to be the smallest flocks. These national-scale findings are supported by more fine-grained analyses from Ireland[26].

The implication of this is that loss of one or more feeding sites at a traditional wintering locality will reduce, in the long-term, the favourability of that locality for geese. Thus conservation measures that address just roost areas will not secure the conservation status of Greenland White-fronted Geese – additional measures addressing conservation needs on feeding sites (and other components of the function unit system at each wintering site) are also needed.

Conclusions

The overall conclusions are that:

- analysis of trends of different local flocks over the last two decades shows that flocks with poorest status are those with fewest feeding areas associated with roost sites. By inference, loss of feeding areas at other sites will result in the quality of those areas declining (probably through mechanisms such as a lower ability of geese to maintain and acquire necessary condition crucial for successful breeding[16]). Thus conservation measures directed at roost sites alone will be insufficient to ensure the long-term favourable conservation status of wintering flocks; and
- given the stability of local patterns of agricultural land-use in areas used by the geese; the within and between year fidelity to sites used; and the limited extent of feeding areas exploited (*i.e.* a high degree of selectivity for just a few highly preferred areas), site-based protection measures are an appropriate means of delivering these conservation measures.

[1] From: Fox, A.D., Norriss, D.W., Stroud, D.A. & Wilson, H.J. 1994. *Greenland White-fronted Geese in Ireland and Britain 1982/83-1993/94 - the first twelve years of international conservation monitoring.* Greenland White-fronted Goose Study Research Report No. 8. GWGS, Aberystwyth & National Parks and Wildlife Service, Dublin. 55 pp.

[2] Gray, R. 1871. *Birds of the West of Scotland, including the Outer Hebrides.* Murray, Scotland.

[3] Ruttledge, R.F. & Ogilvie, M.A. 1979. The past and current status of the Greenland White-fronted Goose in Ireland and Britain. *Irish Birds* 1: 293-363.

[4] Ruttledge & Ogilvie (1979) documented 34 deserted sites in Ireland and three in Scotland up until 1979, and Fox *et al.* (1998) reported a further seven (five in Ireland) by 1994/95. Despite increase in numbers recently, a further five flocks remain close to extinction.

[5] Wilson, H.J., Norriss, D.W., Walsh, A., Fox, A.D. & Stroud, D.A. 1991. Winter site fidelity in Greenland White-fronted Geese: implications for conservation and management. *Ardea* 79(2): 287-294.

[6] Fox, A.D. & Stroud, D.A. 2002. *Anser albifrons flavirostris* Dalgety & Scott 1948, Greenland White-fronted Goose. *Birds of the Western Palearctic Update* 4(2): 1-22.

[7] Mayes, E. 1991. The winter ecology of Greenland White-fronted Geese *Anser albifrons flavirostris* on semi-natural grassland and intensive farmland. *Ardea* 79: 295-304.

[8] Although some feeding areas may be subject to management under ESA prescriptions, and on Islay some feeding areas have been and are within the Islay Goose Management Scheme.

[9] Danna/Keills & Lismore/Benderloch

[10] *e.g.* the roost at Loch Finlaggan - Stroud, D.A. 1985. A preliminary list of Greenland White-fronted Goose roost sites in Argyll. *The Second Argyll Bird Report:* 20-29.

[11] Young, J. 1996. *Greenland White-fronted & Greenland Barnacle Goose Roost survey. Isle of Tiree, Argyll.* Contract Report 48/F2A/669 to Scottish Natural Heritage. 15 Pp. & maps.

[12] Bignal, E.M., Curtis, D.J. & Matthews, J.L. 1988. *Islay: land types, bird habitats and nature conservation. Part 1: land use and birds on Islay.* Nature Conservancy Council Chief Scientist Directorate Report No. 809, Part 1. Peterborough.

[13] Mackey, E.M., Shewry, M. & Tudor, G.J. 1998. *Land Cover Change: Scotland from the 1940s to the 1980s.* The Stationery Office, Edinburgh. 263 pp.

[14] Warren, S.M., Fox, A.D., Walsh, A.J, Merne, O.J. & Wilson, H.J. 1992. Wintering site interchange among Greenland White-fronted Geese *Anser albifrons flavirostris* captured at Wexford Slobs, Ireland. *Bird Study* 39: 186-194.

[15] Fox, A.D., Hilmarsson, J.Ó., Einarsson, Ó., Walsh, A.J., Boyd, H. & Kristiansen, J.N. 2002. Staging site fidelity of Greenland White-fronted Geese *Anser albifrons flavirostris* in Iceland. *Bird Study* 49: 42-49.

[16] Warren, S.M., Fox, A.D., Walsh, A. & O'Sullivan, P. 1992. Age of first pairing and breeding amongst Greenland White-fronted Geese. *Condor* 94: 791-793.

[17] Fox, A.D. 2002. *The Greenland White-fronted Goose* Anser albifrons flavirostris*: the annual cycle of a migratory herbivore on the European continental fringe.* NERI/University of Copenhagen, Thesis.

[18] Greenland White-fronted Goose Study resighting database holding 50,000 resightings of individuals marked since 1979.

[19] Greenland White-fronted Goose Study unpublished.

[20] Nyeland, J. 2001. *Feeding behaviour and competitive interactions of the Greenland White-fronted Goose* Anser albifrons flavirostris *with special emphasis on spring staging areas in Iceland and moulting geese in Greenland.* PhD Thesis, Department of Population Ecology, University of Copenhagen.

[21] Kristiansen, J.N., Fox, A.D., Stroud, D.A. & Boyd, H. 1998. Dietary and microtopographical selectivity of Greenland white-fronted geese feeding on Icelandic hayfields. *Ecography* 21: 480-483.

[22] Ridgill, S.C., McKay, C.R. & Rees, E.C. 1994. *Greenland White-fronted Geese wintering on Islay*. Report to Scottish Natural Heritage, Wildfowl & Wetlands Trust, Slimbridge. 167 pp.

[23] Norriss, D.W. & Wilson, H.J. 1988. Disturbance and flock size changes in Greenland White-fronted Geese wintering in Ireland. *Wildfowl* 39: 63-70.

[24] Stroud unpublished.

[25] Fox, A.D., Norriss, D.W., Stroud, D.A., Wilson, H.J. & Merne, O.J. 1998. The Greenland white-fronted goose *Anser albifrons flavirostris* in Ireland and Britain 1982/83-1994/95: Population change under conservation legislation. *Wildlife Biology* 4: 1-12.

[26] Norriss, D.W. & Wilson, H.J. 1993. Seasonal and long-term changes in habitat selection by Greenland White-fronted Geese *Anser albifrons flavirostris* in Ireland. *Wildfowl* 44: 7-18.

Appendix 2

Summary of the CHIP species reviews

Breeding waterbirds

Many breeding waterbirds use cropped habitats adjacent to wetlands in which they nest, whilst others are associated with wet pastoral habitats, and some use cropped habitats away from water bodies. Information on cropped habitat use by waterbirds during the breeding period is lacking for many species, especially for ducks (Anatidae), and few conclusions can be drawn.

Within the gulls (Laridae), the Common (*Larus canus*) and Black-headed Gulls (*Larus ridibundus*) make greatest use of cropped habitats during the breeding season; both species have significant inland breeding populations in the UK. Inland breeding Common Gulls show a preference for foraging on improved pastures (Arbouw & Swennen 1985), taking primarily earthworms, but also a variety of insects, especially beetles (Coleoptera) (Arbouw & Swennen 1985; Vernon 1970 & 1972).

Soil moisture, influenced by field location and rainfall, significantly affects earthworm availability and field usage by Common Gulls (Arbouw & Swennen 1985). Black-headed Gulls use a variety of cropped habitats, but again pastures are important and coastal nesting birds will forage inland to make use of them (Gribble 1976; Vernon 1970 & 1972). For both of these species there are no studies on habitat use at the landscape scale, but since nesting colonies are used over many years there is likely to be some consistency in foraging activity around them and some predictable use of pastures. However, the widespread improvement of pastures, especially in the uplands where inland Common Gull colonies are located, is likely to have benefited both species. In terms of food availability, it is likely that the most important factor in maintaining breeding colonies is the continued presence of pasture, although the required spatial characteristics (area and distance from colony) are not known.

Breeding waders (Charadridae), in the uplands, lowlands and along our coasts, make significant use of cropped habitats. In the uplands, especially adjacent to moorland, pasture is a primary habitat for nesting and/or foraging for a number of species. Golden Plovers (*Pluvialis apricaria*) nest on short-sward moorland, but adults forage primarily in pastures close to nesting areas during incubation. Once travelling with a brood adults tend to restrict daytime foraging to moorland, and Tipulids are important food for both adults and chicks, but adults will still make nocturnal visits to favoured pastures. Improved, closely grazed pastures are favoured, and arable fields may also be used for foraging. Field choice is related to number of molehills (an indicator of earthworm abundance), distance from roads and uneveness of ground, and larger fields may be selected. Diet includes a variety of soil and ground living invertebrates, and earthworms and Tipulidae larvae are important. Individual birds show a high degree of fidelity to feeding areas, even if these change slightly in quality over time, although birds from the same pair may use a different selection of fields. Most fields used are within 4 km of the nest and 2 km from the moorland edge.

In one study, travel distance to feeding areas was on average 2.7 km, but some birds foraged up to10 km from the nest (O'Connell *et al*. 1996; Whittingham *et al*. 2000; Pearce-Higgins & Yalden 2003). Curlews (*Numenius arquata*) nesting on moorland make significant use of adjacent grasslands, selecting larger fields close to nests in which to feed. Most fields were

within 1-km of the nest, but birds ranged as far as 3 km. Grassland type did not appear to influence field choice, with both rough grazed and improved pastures being used (Robson & Percival 2002). Whimbrels (*Numenius phaeopus*) nest primarily in moorland, avoiding rough and improved pastures (Fisher & Richardson 1984); they are not regarded as a relevant species for this review. However, prior to nesting the adults used established pastures for feeding and during nesting most used ploughed or harrow reseeded areas (Grant *et al*. 1992a; 1992b). Tipulidae larvae and earthworms were primary foods in these habitats, and bird selected fields in accordance with Tipulidae biomass (Grant *et al*. 1992b). Most broods are raised for at least the first 10 days after hatching within the heath habitat where nesting takes place, remaining within 800 m of the nest. However, some broods and older broods are taken into ploughed or harrowed reseeded grasslands, although older pastures are avoided (Grant *et al*. 1992c).

Several other waders nest in a wider variety of habitats, including upland moorland and pastures, lowland pastures, arable habitats, stony ground, shingles and coasts. The Oystercatcher (*Haematopus ostralegus*) is one such species that nests in diverse habitats, including a number of cropped habitats, reaching its highest breeding density in the machair of the Western Isles (Galbraith *et al*. 1984). Both unimproved and improved grasslands are utilised, and birds nesting in adjacent habitats will feed in pastures, feeding primarily on earthworms (Heppleston 1979). Pasture improvements may have been beneficial to Oystercatcher in some areas due to resulting increase in earthworm biomass (Baines 1988). Each year adults return to broadly the same area, within 20 km of previous season's nest, and natal dispersal is typically less than 20 km (Wernham *et al*. 2002).

The machair habitat of the Western Isles is also an important cropped habitat for other waders. Machair is a distinctive type of coastal grassland that occurs on calcareous sand, especially where this is blown inland following periodic breakdowns of foredunes. It is managed through low-input rotation, with summer-rested pasture giving way to cereals (oats and rye) and potatoes. Ringed Plovers (*Charadrius hiaticula*) reach high densities in machair, showing a preference for dry and cultivated areas, and around a quarter of the British population nests in this habitat (Galbraith *et al*. 1984; Fuller *et al*. 1986; Prater 1989). They are highly site-faithful, with most adults returning to within 100 m of the previous season's nest and natal dispersal of typically less than 2.5 km (Jackson 1994).

A significant proportion of the UK's breeding Dunlin (*Calidris alpina schinzii*) population nests in machair and, as with several other waders, density is higher than in other habitats (Etheridge 1982). Dunlins prefer wetter machair grasslands and grasslands in the transitional zone between the machair and inland peatlands (known as blackland) (Fuller *et al*. 1986). Their diet comprises predominantly invertebrates at or near the soil surface (Snow & Perrins 1998). Dunlins are highly site-faithful; most adults return to within 100 m of previous nests and natal dispersal is on average less than 2 km (Jackson 1994).

Common Snipe (*Gallinago gallinago*) also have a high reliance on wet grasslands in the lowlands, although they also breed in abundance in the uplands, again utilising wet pastures, and in the machair of the Western Isles (Galbraith *et al*. 1984; Fuller *et al*. 1986; Baines 1988). They have a close association with damp and wet habitats, and when nesting in dry grasslands they do so in close proximity to wet features. Unimproved habitats are favoured, and improvement to grasslands by draining, fertilising and reseeding has been shown to reduce Snipe numbers (Baines 1988). Meadows are also preferred to pastures, especially wet meadows with a high water table, but without extensive flooding (Herbert *et al*. 1990; Green

et al. 1990). Nests are typically located in grass and rushes, but in moorland habitats heather is also used (Mason & MacDonald 1976). Diet comprises a wide variety of invertebrates, but especially insect larvae, earthworms and snails, which are taken both from the soil surface and by probing into the soil (Green 1988). Moist soils are essential for good breeding success and adults will travel some distance from the nest area in drier summers to find suitable feeding habitat (Green 1988; Green *et al*. 1990). There is no information on fidelity to breeding areas.

The Redshank (*Tringa totanus*) shares many similarities with Common Snipe in breeding habitat requirements, but in addition to utilising wet grasslands and machair also breeds in dry grasslands, arable areas and shingles (Galbraith *et al*. 1984; Fuller *et al*. 1986). However, like Snipe, when nesting in dry habitats Redshanks will preferentially feed in wetter habitats and wetland edges are important (Chandler & Walker 1985; Ausden *et al*. 2003). Unimproved grasslands are favoured and drainage, fertilising and reseeding of these reduces Redshank numbers dramatically (Baines 1988). Redshanks show a high degree of site-fidelity in all seasons; mean natal dispersal was typically less than 2 km and the majority of adults returned to within 100 m of the previous season's nest in the Western Isles (Jackson 1994; Thompson & Hale 1998; Wernham *et al*. 2002).

The Stone-curlew (*Burhinus oedicnemus*) nests in close-grazed unimproved grasslands (sward height of nesting areas is typically <2 cm), spring-sown arable crops and occasionally in other sparsely vegetated habitats, such as recently burnt heath and clear-felled forestry plantation. Habitat requirements are well known, and the loss of unimproved grasslands with appropriate grazing regimes (sheep and rabbit grazing) and the change to autumn sowing of arable crops has resulted in suitable habitat becoming rare and highly localised. Crops that exceed 10cm height and 10% cover by late May are avoided by nesting Stone-curlews, and birds will abandon nests if the vegetation height becomes too tall (Green & Griffiths 1994). Intensive management of spring-sown crops reduces suitability for the species and management and harvesting operations also place nests and young birds at risk.

As part of existing agri-environment schemes there are provisions that benefit Stone-curlews, such as retention of bare ground as nesting plots in arable areas and changes to management of set-aside to make this suitable for nesting. Pairs may use different habitats for successive broods in the same season or between years, but little is known about nesting area fidelity of adults. Diet comprises mainly ground-living invertebrates and earthworms, and adults will travel up to 3 km from the nest location to forage in suitable habitats, although patterns of use, including fidelity to specific areas has not been described (Green *et al*. 2000). Stone-curlews are migrants and are absent from Britain during the winter (Green 2002).

Male Corn Crakes (*Crex crex*) call from cover in meadows and pastures; early in the season *Iris pseudoacorus* beds in wetter pastures, along field margins, and in other marshy areas are used, but as the season progresses meadows and field margins become important as the vegetation height increases. Birds have also been recorded occasionally calling in cereals and potatoes. Birds occupy home ranges, which are varied in size, and utilise areas of taller vegetation within these ranges for foraging. Areas of short-vegetation, such as close-grazed improved grassland, are avoided.

Density of calling males is correlated with cover of tall herbage in spring, especially Iris, *Phragmites* or *Phalaris* (Green 1996). Nests are scrapes, typically lined with dead vegetation, on the ground in tall grasses, nettles, rushes, irises and other herbaceous plants,

but rarely in cereals. Most first clutches are laid in nests in tall herbage, primarily nettles, and tend not to be in meadows, but second clutches, which are frequent, are mostly in nests in meadows (Green *et al*. 1997). Diet comprises largely small invertebrates, with a wide variety taken, and some plant matter, including seeds.

Corn Crakes forage in taller grasses and herbaceous vegetation within meadows, low-input pastures, silage, gardens, field edges, and in cereal crops and potato fields. Foraging habitat changes during the season depending on vegetation height. Territorial males occupy ranges of varying size from 4 ha to over 50 ha, wandering through neighbouring territories while foraging, and some may be faithful to ranges between years. Females are non-territorial and will use feeding areas some distance from nest (up to 6.5 km once young can fly), but occupy ranges typically of less than 30 ha. Key threats to Corn Crake are loss of meadows and unsympathetic hay-cutting regimes. Summarised from Cramp *et al*. 1980, Stowe & Hudson 1988 and Stowe & Hudson 1991.

Non-breeding waterbirds

A large number of species, or biogeographical populations, of waterbird make use of cropped habitats outside of the breeding period, including swans, geese, ducks, waders and gulls. There have been many studies on feeding behaviour of swans and geese, especially in relation to semi-natural habitats like salt-marsh and also in relation to the conflict between farming and the heavy use of arable crops by these species. These studies provide a good overview of the dietary choices that these species make and how these are influenced by availability and depletion of different foods. However, there are relatively few studies of ranging behaviour and the mechanisms that operate to limit how these species use the landscape.

In the UK, designation of Special Protection Areas has been made for two populations of swans: NW Europe Bewick's Swan (*Cygnus columbianus bewickii*) and Iceland Whooper Swan (*Cygnus cygnus*). The status and ecology of these populations has been detailed in Robinson *et al*. 2004a and 2004b respectively - the details are not repeated here, but the following summary information is derived, except where indicated, from these publications.

Grasses are the main diet of Bewick's Swans and a wide variety is sourced from wet, species-rich to improved, reseeded grasslands. In addition to grassland, other crops are utilised, including sugar beet, winter cereals, waste potatoes, oil seed rape, and spilled grain in stubbles, although the importance of these habitats may be higher in the E England stronghold of the species. Seasonal changes in diet occur, probably in relation to food preference and availability; aquatic plants are important on first arrival in wintering areas, along with grain from stubbles and root crops, but on depletion of these there is increased grazing of winter cereals and grasslands, with the latter being predominant in spring (Dirksen *et al*. 1991; Laubek 1995).

At the main site in the UK, the Ouse Washes, birds have been recorded foraging in cropped habitats as far as 10 km from roosting areas. However, there are no studies of spatial patterns of crop use and the mechanisms that might determine them.

The majority of the Iceland breeding Whooper Swan population winters in Britain and Ireland, utilising a large number of sites. Like the Bewick's Swan and many of the wintering geese, they have increasingly made use of cropped habitats over the last 40 years, and around

15% had some reliance on arable crops in January 2000. Aquatic food plants are important in the diet when birds arrive at wintering grounds, but are soon depleted and birds then switch to grazing in a wide variety of grasslands, including flooded pastures. Many species of grass are eaten, as are the stolons of clover (*Trifolium* spp.). Where arable crops are available, use is made of stubbles, waste root crops, winter cereals, and oil seed rape, with similar seasonality to that shown by Bewick's Swans. At the Ouse Washes, birds have been recorded travelling up to 5 km from the roosts to forage in cropped habitats. In Scotland, birds switched roosts throughout the season depending on the proximity of favoured feed areas.

A study of birds on the Firth of Forth showed that most fields used for feeding were within 3 km of a roost (Brazil 1981 & 2003). Local studies of Whooper Swans exist and provide insight into localised patterns of habitat use – the intensive study of the Black Cart flock near Glasgow is a good example (unpublished SNH Reports).

Migratory geese on wintering grounds have been studied extensively and the history of both population and behavioural changes are well documented; all now make use of cropped habitats to some degree.

The Bean Goose (*Anser fabalis fabalis*) is rare in the UK and occurs in significant numbers in only two areas; Slamannan Plateau in C Scotland and Yare Valley in E England. In both of these areas, the birds are entirely dependent on pastures in which to feed, but the characteristics of the two areas differ. Birds in the Yare Valley feed on species-rich, wet pastures, selecting areas that are not intensively grazed. Grazing regime appears to be an important factor in field choice with short swards resulting from sheep grazed being less favoured (Allport 1991).

In contrast, birds at Slamannan feed in semi-improved and improved grasslands with short swards, selecting wetter fields with the least disturbance (Smith *et al*. 1994). Patterns of field use have been studied in both flocks and whilst the birds return to the same general area each year the choice of fields varies considerably within and between years, depending on sward characteristics and disturbance levels.

The Pink-footed (*Anser brachyrhynchus*) and Iceland Greylag Geese (*Anser anser*) are the most abundant of our wintering geese and frequently occur together at roost sites. Both species make considerable use of cropped habitats throughout the winter. Pink-footed Geese have complex functional unit systems (ranges), typically comprising multiple roosts, resting, feeding and bathing areas, and will travel considerable distances in utilising these elements. In Britain, birds will travel regularly up to 40 km from roosts (Hearn *pers. comm*.), but in one study, marked birds spent 90% of their time within 5-6 km of the roost. Total range size in this study was 100 km^2, but individuals occupied specific areas and used only around half of the total range area.

Birds move within a range in relation to roost choice, daily routine requirements, food availability and disturbance (Giroux & Patterson 1995). Field choice is influenced not only by crop type, but distance to roost, size, proximity to roads and buildings and slope; larger fields with good visibility, close to the roost, but away from sources of human disturbance (especially buildings) were favoured (Urquhart 2002).

Sequential use of fields within a foraging area takes place, with individual fields or groups of fields used until the food is depleted (Meire & Kuijken 1991), although such patterns of use were not shown for individual birds in one Scottish study (Giroux & Patterson 1995). Day-time resting areas tend to be more marginal habitats, such as rough pastures or moor, but are large, undisturbed, open areas. Such resting areas may be used in a more predictable way than foraging areas (Newton *et al*. 1973). Individual birds utilise several different roosts and associated feeding areas within each range, using a complex of ranges over the winter period and making considerable movements between them. A relatively high degree of fidelity to ranges has been demonstrated (Giroux 1991; Fox *et al*. 1994; Keller *et al*. 1997).

Pink-footed Geese graze on grasslands all through the winter, but their proportionate use increases in spring. Those roosting at the coast will also graze on saltmarsh. Spilled grain in stubbles is taken early in the winter, along with waste root crops, and winter cereals are used in the latter part of the winter (oil seed rape was not used); as with other waterfowl using cropped habitats, temporal patterns of use are related to availability (Newton *et al*. 1973; Bell 1988; Giroux 1991; Giroux & Patterson 1995; Gill *et al*. 1996). Birds that utilise improved grasslands achieve better body condition in spring and this may improve breeding success (Boyd & Fox 1995).

Greylag Geese are very similar to Pink-footed Geese in their behaviour and choice of cropped habitats, but they are more site-faithful and more tolerant of disturbance (Newton & Campbell 1973; Newton *et al*. 1973; Bell 1988; Bell *et al.* 1997; Urquhart 2002). Birds use more roosts within a range than Pink-footed Geese, moving between them more frequently. Ranging behaviour from roosts also differs, with Greylag Geese using fields mainly within 2-3 km of a roost (Urquhart 2002), although ranging frequently to 12 km and as far as 35 km (Bell 1988; Hearn *pers. comm*.). Summaries of the winter ecology of these species are found in Mitchell & Hearn 2004 and Hearn & Mitchell 2004. Some detailed local studies of habitat use have also been made, but are unpublished and not reviewed here.

Two different subspecies of White-fronted Goose (*Anser albifrons*) occur in the UK: the Baltic/North Sea population (*A. a. albifrons*), which breeds in N Russia, and; the Greenland population (*A. a. flavirostris*), which breeds in West Greenland.

A. a. albifrons feed mainly on permanent grasslands, typically grazing marshes, but do make some use of saltmarsh, stubbles and winter cereals; foraging areas are typically less than 10 km from roosts. At Slimbridge, one of the two principal wintering sites in the UK, management of permanent grasslands has led to a relatively sedentary flock that makes only minimal movements away from the site not exceeding 1 km (Hearn 2004). Detailed local information about field use may be available and Hearn (2004) provides a synopsis of which feeding areas may be regularly used by flocks at each nationally important site.

Greenland White-fronted Geese have been well studied and the species was used as a model for developing this project – the full account for this species is included as Appendix 1.

Barnacle Geese (*Branta leucopsis*) from two populations occur in the UK in winter: Greenland breeding Barnacle Geese winter primarily along the west coast of Scotland, and those breeding in Svalbard winter primarily in the Solway Estuary. The traditional habitats in these two wintering locations differed to a degree with extensive use of saltmarsh in the Solway Estuary – habitat that is largely absent from haunts of the species along the west coast

of Scotland. However, both populations show a high reliance on intensively cropped habitats, especially grasslands and cereals.

Most Greenland Barnacle Geese stage or winter on the island of Islay, where the species has been well studied for many years (Percival 1988, 1993; Percival & Houston 1992). Birds roost on inter-tidal flats and in bays, travelling up to 5 km to feeding in inland cropped habitats. Improved pastures, especially those reseeded and dominated by *Lolium perenne* and those heavily fertilised, are the primary feeding areas, with some use of cereal stubbles in autumn. Birds also occur on smaller, uninhabited islands where grazed maritime grasslands are the primary foraging habitat.

Barnacle Geese show a high degree of fidelity to foraging areas, visiting the same groups of fields repeatedly (Percival 1991). The Greenland Barnacle Goose population has increased substantially since the first census was done in 1959 (from 8,800 birds then to 54,100 in 1999) (Cranswick *et al*. 2001). This has increased pressure on habitats and a conflict arose between farmers and the conservation of the birds. As a result, much effort has been made in researching the impacts of geese on crop yields and seeking solutions to conservation (Percival 1993; Percival *et al*. 1997; Scottish Executive 2000). The outcome has been the establishment of a number of goose management schemes aimed at providing suitable, safe foraging areas for birds with compensation for losses in yield of crops (Douse 1998).

These schemes are not solely for Barnacle Geese and other species are included in other areas (the details of schemes are available at www.snh.gov.uk). Svalbard Barnacle Geese in the Solway Estuary roost on inter-tidal sandflats, rarely travelling more than 2 km to feeding areas (Roberts 1966; Owen *et al*. 1987). Grazed saltmarsh remains an important habitat, but in recent decades birds have made increasing use of cropped habitats, especially improved grasslands. In autumn, the geese also occasionally seek out spilled grain in cereal stubbles (Owen & Kerbes 1971). They are highly faithful to feeding areas and, as with Barnacle Geese on Islay, a management scheme with the same aims is currently operated (Black 1998).

Three populations of Brent Geese (*Branta bernicla*) occur in the UK: the Dark-bellied Brent Goose (*B. b. bernicla*), which breeds in northern Russia and winters along the coasts of southern and eastern England; the East Canadian High Arctic Light-bellied Brent Goose (*B. b. hrota*), which winters in Ireland and Northern Ireland; and, the East Atlantic population of Light-bellied Brent Goose (*B. b. hrota*), which winters primarily in NE England and in small numbers elsewhere along the east coast of Britain.

Dark-bellied Brent Geese have a closer association with coastal habitats than any other goose species, roosting on mudflats or coastal waters and foraging on algal beds and saltmarsh. However, they also have a heavy reliance on cropped habitats, grazing on pastures, cereals and oil-seed rape typically within 5 km of the coast (St. Joseph 1979; Summers & Critchley 1990). A sequential pattern of habitat use occurs, with a switch from intertidal and saltmarsh habitats to inland cropped habitats in early winter, as natural food is depleted (Summers & Critchley 1990; Vickery *et al.* 1995).

Typically birds feed on winter cereals in early winter, again switching to pasture in late winter and spring, and then back to saltmarsh prior to departure to breeding areas in spring (McKay *et al.* 1994). They are highly site-faithful, using the same part of an estuary from one winter to the next, but whether this is reflected in choice of fields is not known. Birds selected cropped fields for foraging that were characterised by low hedges, close proximity to

the sea, were unimproved in the case of pastures, and were without roads or paths nearby (McKay *et al*. 1996). The proximity of fresh water may also be critical in feeding field choice (Ward 2004). Pastures with moderate length swards are selected (6 cm) and longer swards are only chosen if fertiliser is added to boost nitrogen level (Hassall *et al*. 2001). Birds showed no preference for grass species, but had a strong preference for clover-rich swards (McKay *et al*. 2001).

The concept of Alternative Feeding Areas (AFAs) – the creation of specially managed areas to offset possible damage to crops – has been developed and McKay *et al*. (2001) suggest that clover-rich grasslands would be the best crop type to attract Dark-bellied Brent Geese. It has been suggested that specially managed set-aside and re-introduction of rotational clover leys could provide an opportunity to create AFAs for geese, but the siting of these would need to take into account field selection factors (McKay *et al*. 2001). Hassall & Lane (2001) also suggest that AFAs are fertilised just prior to use by birds to increase attractiveness.

East Canadian Light-bellied Brent Geese wintering throughout Ireland are also highly dependent on intertidal and saltmarsh habitats. Depletion of natural foods causes a switch to grassland feeding – predominantly improved grasslands, including recreational areas, but in some areas unimproved grasslands are important. In a few areas, birds also utilise cereal stubbles, spring-sown cereals and potatoes as they are available, but switch to intertidal and saltmarsh habitats in spring (see summary in Robinson *et al.* 2004).

East Atlantic Light-bellied Brent Geese occur in significant numbers at only one site in the UK: Lindisfarne, NE England. Denny *et al.* (2004) provide a summary of habitat use by the species around the Lindisfarne coastal roosting areas. Intertidal habitats are used exclusively during autumn and as these are depleted birds switch to feeding in saltmarsh, submerged eelgrass beds and to a lesser extent pasture (Percival & Evans 1997; Clausen & Percival 1998; Anderson 1999). In harsher winters, increased use is made of pastures and winter cereals (Percival & Anderson 1998). In the last decade, more regular use of pasture and winter cereals has developed at Lindisfarne.

A number of duck species utilise cropped habitats during the non-breeding period. Shelducks (*Tadorna tadorna*) occur primarily along the coast, with increasing numbers at inland sites. They make use of wet and flooded grasslands and autumn sown cereals close to roosts, but to only a minor extent (Patterson 1982). Of all the ducks, Wigeon (*Anas penelope*) is perhaps most associated with cropped habitats. They are sensitive to disturbance and feed close to water or in partially flooded fields, both during the day and at night (Mayhew & Houston 1989; Mudge 1989). The preferred feeding habitat is short-sward, improved grassland, although unimproved grasslands are also important. In addition, the use of autumn sown cereals, especially wheat, has become common during December to February.

In autumn, Wigeon may also accompany other ducks utilising cereal stubbles to feed on spilled grain, but this behaviour may be erratic within a season and variable between years (Owen 1973; Thomas 1976 & 1981; Owen & Thomas 1979; Madsen 1988; Mayhew & Houston 1998). In one study, birds used cropped habitats within 2 km of the roost, and generally may moved less than 10 km from any roost area (Thomas 1981), and in another it was concluded that most feeding was within 5 km of a roost site (Owen & Williams 1976). Birds show a high degree of roost site fidelity and may return repeatedly to specific feeding fields (Mayhew & Houston 1989; Mitchell *et al*. 1995).

Gadwall (*Anas strepera*) may graze in short-sward grasslands along the edges of water, but such use may be highly localised and relatively unimportant to the species (Thomas 1981).

Most of Britain's Teals (*Anas crecca*) occur at the coast, but the species is widespread inland using a wide range of wetland habitats and have been recorded foraging in arable fields close to wetlands. They feed primarily at dusk, during the night and at dawn, making it difficult to quantify feeding habits, but have been recorded during the day in cereal stubbles, potatoes and winter wheat, especially if flooded (Thomas 1982).

Mallards (*Anas platyrhynchos*) make extensive use of cropped habitats for foraging during the non-breeding period, regularly travelling up to 2 km from roosts and frequently up to 5 km. They are often associated with other ducks while feeding in fields, especially Wigeon and Pintail. Most field feeding is done at dawn and dusk, with more extensive use in certain areas or during severe weather when wetland habitats become frozen. Habitat choice is seasonal, depending on availability of foods. In autumn, cereal stubbles are used and birds show a preference for wheat stubble over barley. As waste potatoes become available, birds switch to using this resource and then in spring will graze autumn-sown wheat (Olney 1964; Olney 1967; Street 1975; Thomas 1978, 1981 & 1982). There are no studies of field choice or site-fidelity in the species.

Studies on Pintail (*Anas acuta*) are few and most knowledge of field feeding by the species comes from the studies at the Ouse Washes that have provided good information on Mallard. In this area they show extremely similar behaviour to Mallard, often associating the latter. They have also been recorded feeding in cereal stubbles around the Solway in autumn (Owen *et al*. 1986).

Golden Plovers and Lapwing roost on ploughed farmland and spend some time both pre- and post- roost in recently sown cereals. They forage in pastures, Lapwings showing a preference for old pastures (>25 years old), but Golden Plovers making use of both young and old pastures. Diet comprises almost entirely earthworms, which reach higher density and biomass in older pastures. However, field choice by Golden Plovers is also affected by field size and, whilst more birds occur in large, old pastures, a strong preference for large fields means that young pasture is also used. Field choice is also affected by presence of either species and a complex relationship between the two species, and Black-headed Gulls, has been described in detail, in particular Golden Plovers nearly always choose to forage in mixed flocks with Lapwings, selecting fields partly on the basis of Lapwing density (Barnard & Thompson 1985). There is no information on fidelity to roosts or to associated feeding area, or on the spatial characteristics of the functional unit system in these species.

A study of Curlew in the Tees Estuary demonstrated the importance of fields surrounding the estuary for foraging (Townsend 1981). Curlews fed on earthworms taken from pastures, but seasonal use varied in response to freezing, when birds could not feed, and water-logging, when earthworm availability increased. The relative importance of fields for foraging was shown by their use at some time by around half of marked birds, but individual strategies varied. Some individuals fed solely in fields all winter, some at certain times of the winter, while others rarely used fields preferring to feed on exposed inter-tidal substrates.

The majority of birds that relied on fields as foraging habitat were males, especially those making exclusive use of fields at certain times, while females tended to use fields only at high tide; both sexes made use of inter-tidal habitats. This difference between the sexes may

be explained by the males' inability to capture sufficient *Nereis* worms at low substrate temperatures on mudflats due to their shorter bill length – this forces them to seek alternative prey in the form of earthworms. In separate studies, from direct flight line observations, colour-ring sightings and radio tracking, birds roosting and feeding by night on Teesmouth SPA, departed at dawn to forage at least 15km inland (south, west & north) on pasture and arable fields, returning mid/late afternoon to the estuary (Ward *et al*. 2003). A study at Traeth Lafan, in Wales, also demonstrated that around half of the local Curlew population used fields for feeding at high tide. However, birds did not consistently use the same individual fields, but chose feeding locations within a broader network of fields in response to both disturbance and habitat suitability (Butler 2005).

Common Gulls have been shown to forage as much as 30 km inland from coastal winter roosts, utilising a range of cropped habitats, but spatial patterns of field usage have not been described (Vernon 1980). In a study of birds roosting on the Severn Estuary, 38% of all fields around the roost had been used by Common Gulls over the winter, but use was seasonal and in any season a small proportion of all fields available was used. In late summer, birds used cut hay-fields in which to forage, moving to freshly ploughed fields as they became available and then onto reseeded pastures. By October, birds were feeding in autumn sown cereals, but only until sward height exceeded 15 cm, thereafter switching to short-sward pastures and occasionally using root crops such as kale. Primary prey was earthworms and invertebrates; the larvae of Tipulidae were especially important. Common Gulls may show a preference for pastures with high earthworm loads (Vernon 1980). Black-headed Gulls forage in pastures during the winter, often in association with Lapwings and Golden Plovers, on which they are kleptoparasites – stealing earthworms from these plovers (Barnard & Thompson 1985). However, there is little information on winter feeding habits of either species of gull.

Raptors and owls

Seven species of raptor and one owl were considered in this review. Ospreys *Pandion haliaetus* make use of planted forestry, in which many of the UK's nests are located. Nest-site fidelity is high and young birds show a preference for using existing nests (Dennis 1987). Nest tree choice is influenced by the characteristics of the forestry around the site, but several tree species have been used (Dennis 1987). However, nesting densities are low in the UK and the species is not colonial, although some forests have several nests in relatively close proximity due to high quality local fisheries (see Stroud *et al*. 2001). Commercial management of planted forests may place nest sites, which are not protected when unoccupied or outside of the breeding period, at risk. Whilst, localised loss of nesting habitat may not affect population status, and single pairs may adapt relatively quickly to loss of a nest (nest site availability is not limiting; Dennis 1987), extensive losses could drive a population decline or significantly reduce the rate of population recovery.

Both the Honey-buzzard (*Pernis apivorous*) and Red Kite (*Milvus milvus*) make use of planted forestry, but the majority nest in mixed and deciduous woodlands. Studies in Continental Europe suggest that Honey-buzzards have a distinct preference for nesting in mature conifers within mature mixed woodland, and in close proximity to water (Bijlsma 1986; Amcoff *et al*. 1994; Gamauf 1999).

In the UK, nests were located in conifer woodlands at a similar frequency to other types, but in the uplands the majority of nests were in conifer forests, probably in response to

availability (Roberts *et al*. 1999). Choice of woodland may be correlated with the abundance of small passerines, which are important prey early in the breeding season (Amcoff *et al*. 1994). Information on nest-site fidelity is lacking, although a large proportion of territories was occupied each year and some nests were re-used between years (Bijlsma 1986). Home ranges were small and correlated with abundance of wasps (Hymenoptera); males are territorial and foraged mainly within 2 km of the nest, while females are not territorial and foraged much closer to the nest (typically within 1 km). Most foraging took place within woodland, arable areas were avoided, and the main prey was small passerines and wasps, especially *Vespula* spp. (Gamauf 1999).

The loss of mature woodland may be detrimental to Honey-buzzards, but the greatest vulnerability probably relates to mature conifer forests in the uplands, some of which may be under commercial management. However, considerable secrecy surrounds the majority of nesting locations of Honey-buzzard in the UK (Ogilvie *et al*. 2002) due to the possibility of persecution and this makes assessment of both population vulnerability to habitat loss and conservation approaches difficult.

Red Kites were once common and widespread throughout Britain, but due to persecution the population was reduced to less than 20 pairs by 1900, located in central Wales. Since then, changes in the law and active protection have led to a recovery in the Welsh population, and re-introduction projects have successfully returned the species to England and Scotland. In Wales, Red Kites nest mainly within remnant native oak (*Quercus* spp.) woodland, but use a variety of other woodlands, including occasionally conifer plantations, showing a preference for building nests in oak trees. Areas with a high proportion of plantation forestry were avoided by Red Kites for nesting (Newton *et al*. 1996).

Nests may used in successive years, depending on breeding success, but alternative sites, up to 3 km from the previous year's nest, are also selected within a home range. Home ranges may be occupied year after year, either by the same pair or by successive pairs (Walters Davies & Davis 1973; Davis & Newton 1981). Birds forage typically up to 3 km from the nest, but occasionally to 7 km (Davis & Davis 1981), over a variety of largely open habitats, including pastures and young forestry. Prey includes a wide variety of insects, birds and mammals, and carrion is especially important, including sheep carrion in winter and spring (Walters Davies & Davis 1973; Davis & Davis 1981; Davis & Newton 1981). Availability of suitable habitat is not thought to be limiting the population in Wales (Davis & Newton 1981). Outside of the breeding season, Red Kites roost communally in traditional sites.

The same open habitats are used for foraging during the non-breeding period, with many birds remaining associated with their home ranges, but ranging further a field, and diet is again varied (Walters Davies & Davis 1973). Studies of the Welsh Red Kite population suggest that landscape-scale changes in land use have had no detrimental affect on the population (David & Newton 1981; Newton *et al*. 1981 and 1996).

Three upland species are considered together due to broad similarity in habitats used.

The Hen Harrier (*Circus cyaneus*) breeds in upland moorlands and associated forestry throughout the UK and forages over moorland and associated habitats, such as rough pastures, moorland rides in forests, clear-felled areas and young forestry. Some moorland supports relatively high densities of birds, but across much of the suitable habitat area nesting is more dispersed. While territories may be used year after year, nest sites are infrequently

used more than once. The diet of breeding Hen Harriers throughout much of the species range is dominated by just a few key prey species: Meadow Pipits (*Anthus pratensis*), small mammals (especially Short-tailed Vole *Microtus agrestis*), young Lagomorphs and Red Grouse (*Lagopus lagopus*) (Picozzi 1978; Redpath *et al*. 2001). Whilst, much of the prey is taken from moorland habitats, small mammals and other prey are also taken from pasture and young forestry.

In Northern Ireland, Sky Larks (*Alauda arvensis*) and Starlings (*Sturnus vulgaris*) are key prey species in addition to Meadow Pipits (Mellon *et al.* 2005), and while open moorland habitats are important foraging areas, birds forage frequently in young forests, including second-rotation forestry, and have also been recorded hunting over the canopy of mature forestry. In Orkney, the population is particularly dependent on the Orkney Vole (*Microtus arvalis orcadensis*), which reaches highest abundance in moorland, rough pasture and unmanaged grassy features such as field edges and set-aside. Other important prey for this population includes Lagomorphs, Snipe (*Gallinago gallinago*) and Starlings (*Sturnus vulgaris*), which were abundant in both rough and improved pastures.

In Orkney, the juxtaposition of moorland and rough pasture is critical for Hen Harriers. The loss of 11% of rough pasture and doubling of grazing pressure over the period 1960-1998 may have been a key factor in reducing productivity and driving recent population decline (Gorman & Reynolds 1993; Amar & Redpath 2005). Foraging range from the nest site is dependent on a number of factors, but both sexes have been shown to forage up to 5 km from the nest although most activity may be within 2-3 km of the nest (Schipper 1977; Picozzi 1978; Mellon *et al.* 2005). Forestry habitats used by Hen Harriers during the breeding season become unsuitable with canopy closure (at 10-15 years old for first rotation and 6-9 years for second rotation), although larger open rides within mature forestry may still be used for both nesting and foraging (Scottish Raptor Study Group data; Mellon *et al.* 2005).

Outside the breeding season Hen Harriers occur in coastal and lowland habitats as well as moorlands, and make significant use of cropped habitats for foraging and in some cases for roosting. Roosts are communal and tend to be traditional, although the numbers of birds at each fluctuates widely within and between years, and may be located in a variety of different habitats including marshes, rough grassland, heaths, conifer plantations and, rarely, arable crops (Watson & Dickson 1972; Clarke & Watson 1990).

Diet outside the breeding season is very varied, and includes small passerines, including many farmland species like Sky Lark, small mammals, Lagomorphs, beetles and other birds (Watson & Dickson 1972; Marquiss 1980; Clarke & Palmer 1987; Clarke *et al*. 1988; Clarke *et al*. 1997). A study of two roosts in SW Scotland showed that foraging range was highly variable; at one roost most sightings of foraging birds were within 3 km, but at the other frequent sightings came from as far as 6 km. A wide variety of habitats was used for foraging and this is reflected in the wide variety of dietary items (Watson & Dickson 1972). There is some evidence that individual birds occupy their own home ranges during the winter (see Lack 1987).

Merlins (*Falco columbarius*) in Britain nest in rough pasture, moorland and both young and mature plantation forestry, principally in the uplands, and occasionally in dunes. As in other moorland birds of prey that use young forestry, this habitat becomes less suitable for Merlin once it has reached the thicket stage (12-15 years old), although in some areas Merlins continue to nest and forage in maturing forest. Clear-felled forestry is not used (Newton *et*

al. 1978 and 1986). The nest is typically placed on the ground in heather, but may occasionally be placed on a low rocky outcrop, and many are in old, unused crow (*Corvus* spp.) nests both on the ground and in trees.

Tree nesting birds select isolated or small groups of trees, or nest close to the forest edge (Newton *et al*. 1978; Williams 1981; Ellis & Okill 1990; Parr 1991; Parr 1994; Little & Davison 1992). In Northern Ireland, almost all Merlins nest in upland mature forestry, in trees close to the forest edge, and infrequently in isolated trees or hedges and on the ground (Northern Ireland Raptor Study Group, pers. comm.). A large proportion of nesting areas are unoccupied each year, but some are occupied in successive years over long periods and individuals are relatively area-faithful. Nest-site fidelity is only moderate; many females use alternative nest-sites in the same nesting area between years (Newton *et al*. 1978 and 1986; Bibby 1986; Ellis & Okill 1990; Parr 1991; Parr 1994; Rebecca & Cosnette 2003).

Merlins are short-lived raptors, and nesting area occupancy may rarely exceed four years for any individual and typically much shorter periods for females (Marsden *et al*. 2003). In addition to survival, land-use change and disturbance may be key factors in determining whether nesting areas remain occupied (Newton *et al*. 1978). Merlins prey almost exclusively on small passerines, predominantly those that nest in moorland areas or adjacent pastures, i.e. birds of open habitats, rarely taking small mammals and insects.

In Shetland, Wheatear (*Oenanthe oenanthe*) and Sky Lark each represented a third of total weight of prey taken, with Meadow Pipit and young Dunlin also being significant prey (Ellis & Okill 1990). In other studies, Meadow Pipits, Sky Larks, House Sparrows and Starlings are principal prey species, and a number of woodland birds also feature in the diet, but are relatively unimportant (Newton *et al*. 1978 and 1984; Watson 1979; Bibby 1987; Meek 1988).

Afforestation in the uplands is likely to have reduced suitable Merlin habitat over the longer term, given the species' reliance on prey of open countryside (Newton *et al*. 1978 and 1986; Rebecca & Cosnette 2003). Bibby (1986) suggests that good areas may remain unoccupied in a population with poor productivity, due to lack of recruitment, leading to localized extinctions even in the presence of good habitat. Low productivity has been demonstrated in various parts of the species British range and is linked to both increased predation pressure and decline in habitat quality of nesting areas through certain land-use changes, such as afforestation of moorland and adjacent farmland, and pasture improvement (Newton *et al*. 1986; Bibby 1986).

In winter, Merlins move to lowland and coastal areas and may occupy communal roosts (Dickson 1973 and 1988; Lack 1986). Birds forage over open habitats and probably avoid woodland, but very little information on the behaviour of the species in winter is available. A study in SW Scotland showed that favoured habitats were lowland farmland, including pasture and cropped habitats, and associated marginal habitats, such as rough pastures. Relatively little use of coastal habitats or upland habitats (rough pasture and moorland) was observed for birds roosting near the coast. Main prey species were Sky Larks, Starlings and Meadow Pipits, with other small passerines and small waders making up the remaining diet (Dickson 1988).

Short-eared owls (*Asio flammeus*) nest mainly in upland moorland habitats, including young forestry, and numbers fluctuate widely according to the abundance of small mammals, which

are the main prey. Nest-site fidelity is very low and the species appears to be opportunistic in settling to nest each season, responding to local prey abundance (Village 1987). The almost complete reliance on small mammals as prey means that Short-eared Owls forage mainly over rough grassland habitats where prey species are most abundant: grassy moorland, rough pastures and other grassy features such as field boundaries (Picozzi & Hewson 1970; Glue 1977; Lawton Roberts & Bowman 1986).

Conifer plantations over moorland support high densities of voles and remain suitable as nesting and foraging areas until the trees are around 12 years old (Shaw 1995). A study in Orkney showed that Orkney Voles, which were the most important prey, were absent from improved pasture, barley and turnip crops (Gorman & Reynolds 1993).

There is no information about home range use by Short-eared Owls. Like Hen Harriers, the majority of Short-eared Owls winter away from the uplands, principally along the coast, and roost communally. Again diet is highly varied, but little is known about the birds' behaviour during this time.

Marsh Harriers (*Circus aeruginosus*) breed primarily in marsh habitats – nesting typically in *Phragmites communis* reedbeds, and rarely in salt-marsh and cereals (Underhill-Day 1984). There is no information on nest-site choice, nest use or home range use. Marsh Harriers are polygynous, with more than a third of females mated to a polygynous male (Underhill-Day 1984). Prey includes a wide variety of birds and mammals; Underhill-Day (1984) states that practically all species of bird or mammal of suitable size occurring in a territory appear in the diet, the only exception being woodland birds as Marsh Harriers do not hunt in woodlands. In the UK, small passerines, especially Starlings, young pheasants and ducks, and small mammals and rabbits were the most numerous prey types recorded (Underhill-Day 1984).

In Germany, a similar wide variety of prey was taken, with small passerines and small mammals of particular importance, but also insects and fish appeared in the diet (Lange & Hoffman 2002). Birds foraged typically up to 2 km from the nest, focussing activity over marshy areas within wetlands, and occasionally dune systems and cropped habitats adjacent to reedbeds (Schipper 1977).

The small population of Montagu's Harrier (*Circus pygargus*) in the UK nests primarily in arable habitats (winter wheat, barley and oils seed rape), but has used a wide range of other habitats including rough and improved grasslands, reedbeds, marsh, dune, heathland and young conifer forest (Brown & Grice 2005).

The species builds its nest on the ground, selecting a new site each year, and is semi-colonial. Relocation of 'colonies' often takes place from one year to the next, often over considerable distances. Factors influencing settlement of pairs in nesting locations include prey abundance, vegetation height and previous success (Arroya *et al*. 2002). Diet is diverse and the species is a generalist; in the UK a wide range of small passerines and small mammals is taken, along with the young of a variety of birds and some insects (Clarke 1996).

In East Anglia, where birds are found in arable habitats, the main prey is Sky Lark and Meadow Pipits (Underhill-Day 1993). Foraging ranges are extensive, in some areas males hunt up to 12 km from the nest, but females range over shorter distances, focussing their hunting around the nest site (typically within 2 km of the nest). Birds hunt over many different open habitats, utilising linear features and transitional zones between different

vegetation types, but males tended to avoid reedbeds (Schipper 1977). One of the key threats to breeding birds in Europe is crop harvesting regimes – nests are frequently destroyed and young birds killed during harvesting (Arroyo *et al*. 2002; Mischler 2002). Diet is similar throughout Europe, but insects and reptiles feature in southern parts of the breeding range. In The Netherlands, specific set-aside prescriptions have been used to increase small mammal abundance for this and a number of other birds of prey (Mischler 2002). Montagu's Harriers are migratory, wintering in sub-Saharan Africa.

Clarke (2002) suggests that conditions in wintering grounds, especially those affecting the abundance of its primary prey – large Orthoptera - such as rainfall, habitat degradation and pesticide use, are critical in influencing the breeding population in the UK.

Birds of plantation forestry

In addition to a number of raptors, there are four species that make use of planted forestry: Capercaillie, Nightjar, Wood Lark and Scottish Crossbill.

The Capercaillie (*Tetrao urogallus*) was re-introduced into a wide range of forest habitats in Scotland from the early 1800s, including some of the remaining fragments of mature semi-natural Scots Pine (*Pinus sylvestris*) woodland that were once the species natural habitat.

Suitable forest is mature with at least 40% canopy cover and 500-800 trees per hectare, although areas of very dense canopy cover (over 70%) are avoided by males (Gjerde 1991a). Managed forests that are thinned to less than 500 trees per hectare were abandoned, as were those from which pine trees were removed (Gjerde 1991b). The denser cover afforded by spruce (*Picea* spp.) is favoured by males seeking roost sites and removal of mature spruce from mixed woodland made it less attractive to males (Gjerde 1991a & 1991b).

The distribution of the Capercaillie throughout its European range is closely linked to the presence of bilberry (*Vaccinium myrtilus*) (Storch 2001). Display areas (leks) are traditional and located in more open areas of mature forest, typically on raised areas or slopes with short vegetation. Mean distance between leks was 1.9 km and they occur at a density of one per 5 km^2 of forest (Summers *et al*. 1995; Storch 2001). Males maintain a home range while associated with a lek, excluding other males, and these ranges tend to be radially arranged around the lek. Males show high fidelity to both a lek and spring home range.

Home range size varies with age, more mature males occupy smaller ranges typically less than 30 ha, while younger birds may occupy from 70-130 ha ranges (Storch 2001). Females visit one or more leks; those visiting a single lek occupy a range of around 50 ha, but range size may be several times this size when females visit more than one lek. Nests are sited in deep heather close to the forest edge, typically within 25 m, and often at the base of tree; location is not related to lek location (Storch 2001; Proctor & Summers 2002). Females use the same nesting area in successive years and in some circumstances may be territorial (Storch 2001).

Diet varies through the year with fresh shoots, leaves and flowers of ground layer plants, especially those of bilberry, being predominant during late spring and summer, supplemented in late summer and autumn with berries of a variety of shrubs. Invertebrates are also taken.

From late autumn through to late spring diet comprises almost exclusively pine needles and shoots (Zwickel 1966; Storch 2001). Birds show a strong preference for pine needles when available, but will feed on the needles of a variety of conifers, although tend to avoid those of Norway Spruce (*Picea abies*). They will seek out stressed trees, which may have less resin and higher energy content in their needles (Storch 2001). Chicks rely on invertebrates for the first 3-4 weeks of life, especially Geometridae larvae in Scotland, adding vegetation to their diet as they mature (Moss 1985; Picozzi *et al*. 1999; Storch 2001).

The Nightjar (*Caprimulgus europeaus*) and Wood Lark (*Lullula arborea*) overlap considerably in their UK breeding distributions due to some overlap in habitat requirements. The Nightjar is a migratory species that is present in the UK only as a breeding bird, nesting in lowland heaths, conifer plantations, mixed woodland, coppiced woodland, bogs and, less frequently, other open habitats such as dunes and grasslands.

Plantation forestry is generally suitable only until canopy closure at 15-20 years of age, although small clearings within mature forestry may be used. Large forests are favoured, with birds missing from apparently suitable small and fragmented forests. The nest is on the ground, typically associated with scattered trees or at the edge of woodland. Adults are generally faithful to a nesting area between years if it remains suitable (Berry 1979) and females may occasionally use the same nest scrapes from one year to the next. When double-brooded, successive nests may be 50-250 m apart (Alexander & Cresswell 1990).

Nightjars are nocturnal, feeding on a variety of night-flying insects and gleaning other invertebrates from vegetation. During the day, birds roost singly in open habitats or woodland, either on the ground or perched in vegetation up to 10 m above the ground, and return to the same roost daily unless disturbed; males typically roost 50–100 m from the nest (Lack 1932; Berry 1979; Cresswell & Alexander 1992). Birds will forage over a variety of habitats, including forestry and woodlands, gardens, wetlands and open heath, showing a preference for deciduous and mixed woodland. Arable and improved grassland is avoided, but farmland was an important part of foraging habitat.

Foraging habitat quality may influence nest site selection as birds typically range only short distances from the nest site to feed: in Breckland within 1 km of the nest and in Dorset an average distance of 3 km from the nest (Berry 1979; Alexander & Cresswell 1990). Home-range size is typically 5–6 ha (Berry 1979). However, in a radio-telemetry study in Dorset, birds foraged as much as 7 km from nest areas in deciduous woodland, gardens and wetland areas – few fed in the heaths and conifer forests in which they nested (Alexander & Cresswell 1990). The majority of the British population is now associated with conifer plantations, where the availability of open forest structure, either as clear-felled areas or young restock is crucial.

The Wood Lark occurs primarily in lowland heath and young conifer plantations, but small numbers nest in rough grasslands (especially downlands), woodland clearings and other open habitats such as set-aside, arable, horticultural habitats and dunes (Sitters *et al*. 1996; Wotton & Gillings 2000). Most territories lack shrub or tree canopy, but when present this was typically very sparse (Sitters *et al*. 1996). Eighty five percent of territories in 1997 were in habitats growing on sandy, especially acidic, soils, but in Devon up to 20% were on clays (Wotton & Gillings 2000).

Diet comprises largely invertebrates during the breeding period, but at other times also includes seeds taken from a wide range of open habitats. Woodlarks use clear-felled areas and young conifer plantations, but the latter begin to become unsuitable as early as 5-8 years after planting, probably as a result of increased ground cover rather than tree maturation (Bowden 1990; Bowden & Hoblyn 1990). Grazing regimes in heath and grasslands appear to be critical for Woodlarks, as short-swards (<5 cm) and bare ground are favoured foraging areas, and re-instatement of grazing in some areas, *e.g.* Breckland, has been beneficial (Bowden 1990; Sitters *et al*. 1996).

Territories in conifer plantations are relatively large at around 3 ha, but birds forage close to the nest when feeding young, with most movements of less than 400 m (Bowden 1990). Woodlarks are partial migrants, some leaving breeding areas during winter, but probably not moving far (Sitters 1986; Wernham *et al*. 2002). Those birds wintering in Britain tend to occur in small flocks, and may include continental migrants, but movements have not been studied. Little is known of habitat use in winter, but flocks have been recorded in set-aside and stubbles (Wotton & Gillings 2000).

The evaluation of habitat use by Scottish Crossbills (*Loxia scotica*) is problematic due to the difficulties in identifying them in the field from both Common Crossbills (*Loxia curvirostra*) and Parrot Crossbills (*Loxia pytyopsittacus*).

All three species breed in Scottish conifer forests, but recent evidence suggests that the occurrence of Parrot Crossbills is influenced strongly by irruptions from Continental Europe and the species remains a rare breeding bird in the UK. Examination of museum specimens supports historical evidence that the majority of 'large-billed' crossbills occurring in Scotland were Scottish Crossbills. However, recent surveys based on call analysis suggest a wider distribution for Scottish Crossbills than previously described in the *New Atlas* (Gibbons *et al*. 1993). Although the core distribution remains forested areas of Deeside, lower Strathspey, Great Glen, and Easter Ross, records were widespread throughout Nairn, and Moray and Banff (NW Grampian), and there were scattered records in recently forested areas of Sutherland and Caithness. Scottish Crossbills may be more generalist in their use of conifer forests than is traditionally thought, utilising mixed conifer plantations as well as natural and semi-natural Scots Pine (*Pinus sylvestris*) woodland. However, they show preference for Scots Pine woodland, even though they feed in a variety of conifer species (Summers *et al*. 2002).

The movements of all species of crossbills are thought to be similarly complex and determined by food availability (cone crops). The Scottish Crossbill appears to be no exception, moving to take advantage of differing patterns of cone maturation (Nethersole-Thompson 1975; Gibbons *et al*. 1993), but nothing is known about movements of individual birds and, hence, the characteristics of a functional unit system for the species. Mature plantation forestry, especially containing Scots Pine, is clearly important to the Scottish Crossbill population.

Other species reviewed

SPAs have been designated or may be considered in future for a number of passerines that have a functional reliance on cropped habitats; Chough, Dartford Warbler, Twite, and Ring Ouzel.

The Chough (*Pyrrhocorax pyrrhocorax*) was once far more abundant and widespread in Britain than it is now, occurring from southern England to northern Scotland. The population began to decline in the late 18th century, and widespread changes in farming practice may have been the primary cause, although shooting may have made a significant localised contribution (Owen 1988).

Choughs are territorial and highly site-faithful during the breeding period and are central-place foragers, typically remaining within 1 km of the nest at coastal sites and within 3 km at inland sites (Bullock *et al*. 1983; Roberts 1985; Johnstone *et al*. 2002). Short-sward (<4 cm) rough pastures and maritime turf are favoured foraging habitats, and both rocky and bare ground are also used by birds (Warnes 1982; Bullock *et al*. 1983; Roberts 1983; Johnstone *et al*. 2002). Birds that breed inland showed a preference for sheep-grazed rough pasture, but also made use of improved grassland.

In Scotland, cattle-grazed pastures are an important habitat, with the diet composed largely of dung beetles (*Aphodius* spp.). Soil, ground and dung living invertebrates form the mainstay of the birds' diet, especially Tipulid larvae, adults and larvae of beetles (Coleoptera; including dung beetles *Aphodius* spp.), spiders (Arachnidae), ants (Formicidae), and earwigs (*Forficula auricularia*) (Warnes 1982; Roberts 1988; Warnes & Stroud 1988). Changes in management of rough grassland leading to longer swards and loss of rough grassland to other crop types are both responsible for localised reductions in Chough numbers and remain the most significant threat (Bullock *et al*. 1983; Johnstone *et al*. 2002).

Non-breeding birds during the breeding period utilised a wide range of habitats over an extensive area, preferring grasslands, and in winter making greater use of heath, although spatial information is not specified (Bignal *et al*. 1988). In winter, birds typically form large communal roosts and loose foraging flocks, changing roost locations to take advantage of food availability (Monaghan 1988). Paired birds may also continue to use the nest area to roost and feed in, and may be accompanied by their young of the year (Bignal *et al*. 1988). Short-sward rough pastures remain a primary foraging habitat in winter. Choughs at the coast feed predominantly in grazed maritime and dune grasslands, also feeding amongst the tide line on invertebrates associated with washed up seaweeds.

Improved grasslands are used rarely, but birds feed on spilled grain within cereal stubbles and forage in root crop fields (Bullock *et al*. 1983; Warnes & Stroud 1988). In some areas, reliance on dung invertebrates may increase outside of the breeding period (Roberts 1983; Johnstone *et al*. 2002). Limited information suggests that flocks do not travel far from the roost site to foraging areas; in two separate studies maximum distances were 5 km and 8 km (Warnes 1982). An overview of the Chough's functional unit system is given by Bignal *et al*. (1988), highlighting that low-intensity pastoralism is the key habitat management factor for the species.

The Dartford Warbler (*Sylvia undata*) is resident and relatively sedentary, occurring in lowland heaths that have stands of gorse (*Ulex europea*) and mature heather in which to nest. Pairs tend to be site-faithful and hold territories all year round, but in years of high population density some adults may undertake partial migration and have been recorded in Ireland, the Channel Islands and NW France. Diet is almost entirely invertebrates, including spiders, beetles, bugs and Lepidoptera larvae. Open, extensive heaths with frequent patches of gorse shrub are favoured, while fragmented heath and that close to woodland avoided (Bibby

1978). The species does not make extensive use of cropped habitats in the UK, although winter habitat use and diet is unknown away from breeding areas.

Ring Ouzels (*Turdus torquatus*) nest on rocky outcrops in upland moorlands, foraging in moorland and semi-improved pastures. Open, grassy habitats were preferred foraging areas, and grazed areas with short-swards were the most favoured. However, bracken patches were also used for foraging, although woodland was avoided. Birds would forage as far as 860 m from the nest, but the majority remained within 450 m, and mean range size was around 5 ha. Diet was predominantly earthworms, but Tipulids and ground living invertebrates were also important (Burfield 2002).

Although a moorland nesting species, the Twite (*Carduelis flavirostris*) feeds in adjacent flower-rich meadows, rough pastures and other weedy habitat features. Fields used for foraging may be up to 3.5 km from the nest, and after fledging birds move into suitable feeding areas, which are typically relative close to nesting areas (average 2.4 km, up to 8.2 km from nests). There is no further information on factors influencing field selection. A wide variety of seeds is taken and birds exploit differing seed sources as they become available. After meadows are cut in summer, weedy features, such as road-side banks, become more important foraging areas.

In the Western Isles of Scotland, machair habitats are important where they occur, with birds feeding on fallow areas and in patches of vegetables up to 2 km from the nest during breeding. In these areas, bird forage in grasslands and meadows once the young have fledged (RSPB, unpublished).

Twite move away from their moorland nesting haunts in winter to the lowlands and coasts. The majority of English birds are found wintering along coasts, foraging almost exclusively in saltmarsh. Birds that breed elsewhere in Britain also make use of cropped habitats, especially foraging amongst stubbles of a variety of crops and in weedy turnip fields (Clark & Sellers 1997, 1998 & 1999; Hancock & Wilson 2003; Brown & Grice 2005).

Appendix 3

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