Access to the Countryside and Bird Conservation
Priorities for Research
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Summary

This report identifies priorities for future research on bird conservation and access to the countryside in England. It repeats similar work carried out in 2001, and summarises the work completed since. A workshop bringing together researchers and policy makers was held and the workshop discussions used to form a foundation for the recommendations included in this report.

The focus in 2001 was very much on the impacts to birds likely to result from the implementation of the access provision in the Countryside and Rights of Way Act (2000). Research priorities in 2001 were the likely impacts to birds of access on foot to mountain, moor, heath and down ("open country") and to commons. The list of proposed works was therefore focused, and was centred on studies of particular bird species, reviews of existing work and on monitoring, both of birds and access levels.

The context within which we seek to identify further research is very different from that in 2001. Since then, various studies have been completed. A conference, on birds and disturbance was held at Peterborough in 2005[1] and the proceedings from this conference collate much of the work and provide an overview of work done to date. We now have more information on a wider variety of bird species, and a better understanding of how disturbance impacts a selection of different species. At the time of writing, a new agency is still in its infancy. Natural England brings access and nature conservation firmly under the same roof. One of Natural England's stated aims is to promote and increase access to the natural environment. The CRoW Act has provided a right of access to an extra 7% of England's land area, most of which is SSSI. Patterns of access to such areas are likely to take some time to develop as people discover where they can walk and which areas are open. There are likely to be new initiatives that increase access to natural habitats such as the Access to the English Coast Initiative. Proposed urban development adjacent to heathlands in southern England has resulted in concern about future levels of visitor pressure on heathlands and there has been intense scrutiny of existing research at public inquiry.

There has been a shift in how access is perceived. Access and nature conservation are no longer perceived to be in irreconcilable conflict, and the days of excluding people as a knee-jerk mechanism to protect important bird populations are past. In contrast, excluding people is considered as a last resort to be used when there are no other options. Enjoyment of open spaces is now recognised as crucial to people's well-being, health and understanding of the natural environment, and birds have a key role in attracting people to the countryside. There is, of course,

[1] The Proceedings have been published as a special edition of IBIS: March 2007 - Vol. 149 suppl. 1 Birds and Recreational Disturbance Page 1-124.
http://www.blackwell-synergy.com/toc/ibi/149/s1

still a need to ensure the protection of the very things people have come to see. Consequently access management has become targeted at asset management.

We therefore propose a suite of future research that focuses on the area where social and ornithological research meet. There is now exciting potential to combine social and ornithological approaches in applied studies.

The impacts of access to the coast are clearly important to understand, and we propose studies of people's behaviour when visiting the coast and modelling work to consider the impact of different coastal access scenarios, for both breeding and wintering birds. These projects should focus on the particular characteristics of coastal access, such as wide vistas, aggregated distributions of people and birds, and people typically following linear access routes.

We propose further studies which look at peoples' behaviour and access patterns within the countryside. There is a need for predictive modelling of visitor numbers across the countryside, allowing areas of high visitor pressure or particular problems to be identified. There should be a shift in emphasis for researchers from asking 'how?' to 'where?' In the majority of cases the need to manage access to limit disturbance is widely agreed. What is often unclear is where to target finite resources to most benefit birds and minimise unnecessary restrictions to public access. Particular activities (such as climbing, canoeing and coasteering[2]) also warrant individual studies.

Access management techniques are important. Further work is needed on the efficacy of access management to enhance our understanding of how car-park locations, car-park capacity, path surfacing, interpretation and wardening can influence where people choose to go. The effectiveness of providing alternative sites to draw people away from areas currently under high visitor pressure is yet to be tested.

Studies such as these are focused on human behaviour. However they must be conducted in a way that allows them to link directly with bird research to ensure that applied, practical recommendations can be made. There is still a need for research focused on particular bird species, their ecology and the impact of disturbance. Such studies should fit alongside existing work to provide us with baseline information about which species are vulnerable to disturbance and how it affects them. Below we highlight particular species for which information is lacking, and suggest twenty-one different examples of relatively discreet studies (most of which would make suitable masters theses or similar). The impact of dogs is of widespread concern, and we provide some ideas for further work addressing their impact on breeding success. Some generic ornithological work will also be needed to provide further context, in particular work on habituation

[2] Coasteering can be defined as the physical activity encompassing movement along the intertidal zone of a rocky coastline on foot or by swimming (including scrambling and diving), without the aid of boats or other craft.

(which would compare the impacts of on-going and sporadic disturbance) and studies enabling parallels to be made across species.

We provide our recommendations as a prioritised list of specific studies (summarised below), and suggest for each how the work might be achieved. The resulting list of proposed work is much broader than that produced in 2001 and contains studies that relate to different issues, such as urban planning and coastal access. While some of the work could be achieved as student projects or similar, other aspects require large, long-term research contracts. Given the variety of the work involved, the different means with which the work will be achieved and the range of people and organisations likely to be involved, it is essential that a strategic overview is maintained. We recommend a central steering group and a repeat of this report and workshop in five years time to help achieve this.

Summary of research recommendations

We summarise the recommendations given in the body of the report into three tables: ornithological work, access management studies and work on access patterns / behaviour. In each group we approximately rank studies according to their priority and give them a score of one (lowest) to three (highest) priority. The "three star" projects are highlighted in red and should represent the core of any research programme.

Ornithological work

Description	Means of achieving	Methods / notes	Priority
Individual-based population model extended to different site(s) / scenarios	Research contract	Scenarios and locations to be decided in close consultation between researchers and Natural England staff to ensure realistic and pertinent case study material	***
Density-dependent model for breeding ringed plover applied to different site(s) and scenarios	Research contract	Scenarios and locations to be decided in close consultation between researchers and Natural England staff to ensure realistic and pertinent case study material	***
Little Terns and disturbance	PhD	Applied PhD looking at management recommendations, population consequences and interactions between predation, beach management and disturbance. Study to be a flagship / case study of coastal access issues and bird disturbance	**
Cross-species study	Research contract	Addressing the potential to draw conclusions across species and to identify characteristics that allow species to be grouped in their response to / impacts of disturbance	**
Study of habituation	Research contract	Study of a single species, comparing the effects of disturbance at a range of sites with differing levels of access.	**
Thresholds at which disturbance effects occur	Research contract	Largely desk-based study collating studies of disturbance effects and identifying whether thresholds occur, how these vary between species and species' densities	**
Impact of dogs on bird breeding success	Research contract	Detailed monitoring of incubation and nest survival in relation to disturbance from dogs	**
Simple correlative studies of disturbance on single species	Student projects, small research contracts as opportunities arise	We suggest 21 different examples, more are possible. Each piece of work would make a discreet, small piece of work in itself.	*
Physiological effects of disturbance and their impacts at a population scale	Research contract	Experimental manipulation of disturbance, use of heart rate monitors and possibly blood sampling, long term monitoring to relate breeding success to physiological effects.	*

Research on access management techniques at sites important for birds

Description	Means of achieving	Methods / notes	Priority
Test of the effectiveness of access management techniques	Research contract or PhD	Experimental manipulation of access management measures across a suite of reserves (e.g. NNRs or RSPB reserves). Possibly enhanced / refined and further tested through use of virtual reality	***
Effectiveness of alternative sites	Large, long term research project / or a PhD	Monitoring of visitors on a range of sites over a number of years, combined with interviews and possibly experimental manipulation.	***
Size and design of alternative sites	Research contract or as part of recommendation 17	Questionnaires and possibly other methods to look at features of sites that attract people.	***
Review of management of tern colonies	Research contract / student project	Review of the extent to which wardening, fencing, etc. reduce disturbance at tern colonies. Distance people are kept away from the birds.	**
Documentation of individual access management measures on different sites	Conservationevidence.com write-ups, student projects	Before and after visitor monitoring to show effectiveness of access management measures (path surfacing, car-park closures, new paths, sign posts etc). Ad hoc as opportunities rise	*
Effectiveness of hides / screening in reducing disturbance	Research contract / student project	Review of different designs used to reduce disturbance. Written as a best practice guide.	*

Research on behaviour of people (and dogs)

Description	Means of achieving	Methods / notes	Priority
Visitor access patterns at coastal sites	Research contract	Questionnaires, counts and observational work across a sample of coastal sites	***
Development of predictive model of access levels to coastal sites	Research contract	Model would allow estimates to be made of visitor numbers to sites without actual data and could then be used to guide management	***
Review of access monitoring within the UK	Desk-based review or small conference / workshop	Contact with various organisations and people to assess how visitor monitoring is conducted and potential to coordinate with bird data	***
The relationship between types of housing, dog ownership and access	Research contract	Questionnaires focusing on comparisons between people living in different types of houses, including flats and properties with gardens	**
Predictive models of access on Thames Basin and Dorset heaths used to explore impacts on species besides nightjar	Research contract	Existing work on nightjar extended to other species such as woodlark, Dartford warbler, tree pipit and stonechat	**
Predictive models used in the uplands in conjunction with BBS data to assess impact of CRoW	Research contract	Entec model or similar could potentially be used, but careful design needed	**
Workshop on predictive models of access	Workshop / small conference with proceedings	Proceedings would document different methods and their potential future use	**
Application of standard model for heathlands to other heathland SPAs	Research contract	Direct comparison of different SPAs, levels of visitor pressure and impacts on bird populations	**
Dog behaviour	Research contract / thesis	GPS collars or observational work to determine how far dogs stray from their owners	**
Work on the impact of climate change on access levels	Research contract	Existing data sets for a sample of sites (e.g. national on site monitoring data) used to determine influence of variations in weather on access levels	*
Study of climbers	Research contract	Questionnaires, counts and observational work across a sample of coastal and inland sites	*
Study of non-motorised boating	Research contract / thesis	Focused study of particular user group conducted in such a way that the results are useful for site managers and ecologists.	*
Study of windsurfing & paragliding in coastal waters	Research contract / thesis	Focused study of particular user group conducted in such a way that the results are useful for site managers and ecologists.	*

Study of coasteering	Research contract / thesis	Focused study of particular user group conducted in such a way that the results are useful for site managers and ecologists.	*
Visitor access patterns in the East Devon Heaths	Research contract / thesis	Questionnaire work and counts (following Clarke *et al.*, 2006)	*
Visitor access patterns in the Brecks / Thetford Forest	Research contract / thesis	Questionnaire work and counts (following Clarke *et al.*, 2006)	*
Visitor access patterns in the Wealden Heaths	Research contract / thesis	Questionnaire work and counts (following Clarke *et al.*, 2006)	*
Visitor access patterns in Ashdown Forest	Research contract / thesis	Questionnaire work and counts (following Clarke *et al.*, 2006)	*

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Contents

1 Introduction

Access to the countryside and the implications for conservation have long been a contentious issue. Public access has even been an "anathema" for some conservationists (Adams, 1996). However, access to the countryside has health benefits (e.g. Bird, 2004; English Nature, 2002; Morris, 2003; Pretty *et al.*, 2005), can provide inspiration (e.g. Hammond, 1998; Saunders, 2005; Snyder, 1990; Tansley, 1945) and is important in generating understanding and awareness of countryside issues and conservation (e.g. Miller & Hobbs, 2002; Robinson, 2006; Thompson, 2005). Yet there are also circumstances where recreational access can adversely impact on wildlife, and disturbance to birds is an area of particular concern to many.

A workshop was held in January 2001 to identify priorities for future research concerning birds and access to the countryside. This was at a time when there was particular concern about the implementation of the access provisions within the Countryside and Rights of Way (CRoW) Act (2000) and the possible impacts on bird conservation. The workshop drew together experts and the output from the event was a report (Liley, 2001) which outlined fifteen key approaches / actions that were needed to fill gaps in our knowledge and inform the implementation of the CRoW Act.

Several years on from that original workshop there is a very different context. The right of access to open country has been granted, and in some parts of the country has been in place for a number of years. There is also a growing evidence base comprising work on recreational access, bird disturbance and access management. Disturbance to birds in the UK was in fact the subject of a conference in late 2005 (Drewitt, 2007), which served to highlight the extent to which our understanding, and general awareness, of access issues and bird conservation has developed.

In order to identify future research priorities it is necessary to recognise the policy / conservation issues that are on the near horizon. We recognise the following as potentially important issues (and provide more detail about these in Appendix 1):

- With the formation of Natural England there is a single government body charged with a broad remit that include both access and nature conservation.
- Patterns of recreational access may still change as a result of increasing awareness of the right of access granted by the CRoW Act (2000)
- The government is committed to improving access to the coast
- There is a lobby group seeking a right of access to waterways for non-motorised craft
- Dog owners represent a large group of people with particular access patterns, and in some areas they have formed lobby groups opposing access restrictions such as the need to keep dogs on leads
- Urban development, especially adjacent to heathlands in southern England, has resulted in high human populations adjacent to sites of nature conservation importance. Concern over levels of existing levels of access and the impacts of future development has resulted in intense scrutiny of existing research on access and bird disturbance at public inquiry.

In the light of the current context, Natural England commissioned Footprint Ecology to organise a second workshop, intended to bring the original participants together to review the work done since the last meeting and, as a group, to identify priorities for future research. This report is based on this second workshop, held on 25th October 2006. The workshop met with the following aims:

- To provide an overview of the work conducted since the report in 2001, focusing on the benefits of the work done to date and its usefulness in informing policy, management and future research.
- To identify where recommendations made in 2001 have not been implemented and identify why
- To identify future research priorities concerning recreational access and bird conservation

The workshop provides the foundation for this report. We highlight particular issues raised in the workshop and also state where there were different opinions expressed. The interpretation and collation of the various discussions within the workshop is our own. In some cases (such as the species matrix) we present information developed outside the workshop.

2. The 2001 report and workshop: a review of the work completed 2001 - 2006

In Appendix 2 we summarise all the work done towards the specific recommendations made in the 2001 report. Here, rather than list particular pieces of work, we aim to address the extent to which the research conducted to date has been useful in informing access management and the implementation of the access provision within the CRoW Act. We seek to identify whether there are any key recommendations that have not been met and highlight why such gaps may have occurred.

In retrospect, much of the research recommended in the 2001 seminar was not used by Countryside Agency and English Nature officers in assessing the potential impacts of a new right of open access. This is not because they felt that disturbance wasn't a possibility but both because much of the research had only recently been commissioned, and because the risk of additional disturbance on most sites was low. Many sites already had de facto public access or held few concentrations of important birds. Such situations required an understanding of visitor behaviour to predict new access patterns rather than a detailed understanding of the ecological effects of disturbance on bird species. The exception to this is for species such as stone curlew, nightjar and woodlark where an understanding of the behaviour of these birds in relation to disturbance has directly influenced local visitor management.

The research was carried out concurrently with the implementation of CRoW. Restrictions to access under CRoW have only been granted where access management was deemed inadequate to protect nationally or internationally important bird populations (some 44 locations). Restrictions have primarily been granted where stone curlew or black grouse occur, but also for two tern colonies. There are a few limited few lowland heathland sites with nightjar present where the need to keep dogs on leads has been extended by a month during the breeding season. These restrictions are mainly based on research of disturbance effects, although for black grouse the restrictions are in place despite the lack of any evidence that disturbance may have an impact (Richardson & Baines, 2004).

There were wider benefits of the research that were perhaps not appreciated in 2001. The research conducted has provided reassurance to conservationists that the need to protect important bird populations was being taken seriously alongside the implementation of CRoW, a case of "easing the wheels". The exercise of gathering academic researchers and conservationists together and identifying research priorities has engendered confidence that that issues of concern are being taken seriously. The prioritised list of actions, funding provision and a steering group to oversee the work have provided clear evidence that this is the case. This has helped to remove some of the uncertainty among certain groups about the implementation of CRoW. In addition, the close working relationship established between English Nature and Countryside Agency staff was unique and may have made the progression to the new agency easier.

In the 2006 workshop, participants were asked where the principal gaps in our understanding still remain. There were specific recommendations made in 2001 that have not been

implemented, and in addition gaps in our understanding that were not anticipated in 2001 and are clear only with the benefit of hindsight.

The specific recommendations from 2001 not actioned are listed in Appendix 1. The original recommendations included detailed, intensive population level studies and more general, less expensive studies using a trade-off approach or simply looking for correlates with disturbance measures (for example bird numbers with people counts on different sites). Such a combination of studies should form a hierarchy, as illustrated in Figure 1. This hierarchy has not been achieved to date; there is a lack of the broad base of correlative and more simple studies. There is also a need to be able to draw parallels between species and habitats, and at present we do not have the understanding to do this: are disturbance effects for a given species similar where people follow linear routes or where access is more diffuse? Are the impacts of disturbance similar for a given species in different habitats? There is also still perhaps a need for further work at the very top of the pyramid, as to date we have a population level understanding for just three species (two breeding and one wintering). The key gaps can be summarised as follows:

- No review of correlative studies
- A lack of basic studies, using simple correlative and behavioural studies to identify circumstances and species where disturbance has an impact.
- No experimental studies excluding access
- Few studies showing the impact of disturbance on population size.
- Some key species gaps, which include curlew, redshank and ring ouzel.

As might be expected, some of the gaps identified are ones that were beyond the scope of the original report in 2001, for example there are clearly gaps in our knowledge of disturbance effects for habitats such as linear waterways, open water, woodlands, and to some extent coastal habitats, all of which were outside the remit of the original workshop. There was also recognition in the 2006 workshop that studies have, to date, been very much species focused, meaning that there are opportunities to broaden the repertoire and range of approaches. More applied studies may be particularly appropriate, and examples specifically mentioned in the workshop included the efficacy of access management techniques and the efficacy of restrictions (currently in place for stone curlew and black grouse).

A variety of different reasons were given for the lack of research in certain areas. Some of the research, such as the detailed population studies and experimental manipulation studies, is expensive, and securing funding for such work is clearly an issue. There were also some practical limitations for example the difficulty in securing sites where experimental manipulation of access could be achieved. Particular species pose particular problems. Small sample sizes make research challenging, for example in the case of breeding curlew. Ring ouzels were mentioned as a species for which determining a suitable approach for detailed study of disturbance effects had proved difficult.

Studies of people in the countryside are clearly outside the ‘comfort zone’ of many ecologists, and often such studies require techniques, approaches and experience that many ecologists do not have. While social techniques are receiving increasing attention in ecological journals (e.g. White et al., 2005), the incorporation of studies of human behaviour clearly may necessitate a multi-disciplinary team of researchers. It is not always easy for such teams and approaches to develop.

There is essentially only a relatively small group of researchers who are active in the field of human disturbance and birds. The capacity for many different studies to happen simultaneously is therefore limited and the particular research interests of each group will also to some extent restrict the actual work done. It was suggested that some areas of potential research of applied nature are not always academically challenging or of theoretical interest. Flushing distances are an example.

3. Methods for studying disturbance

Methods for study were focussed on specifically by one group within the workshop. They were tasked with identifying approaches that have worked to date and suggesting key approaches and techniques for the future, approaches that would allow our understanding to develop. After the workshop a number of people made further suggestions and these are included within this section.

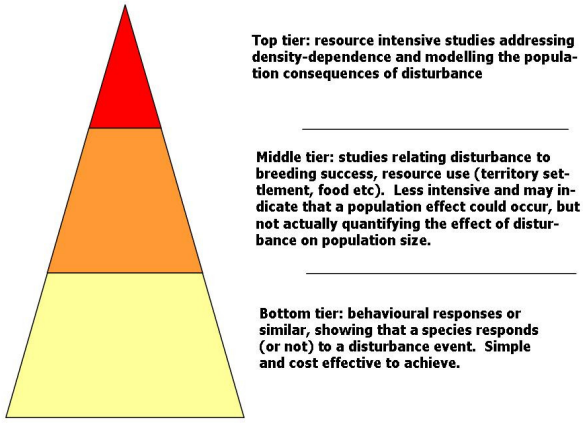

Figure 1: Three tiers levels of disturbance research

The group within the workshop referred to the pyramidal structure shown in Figure 1. It was suggested that the range of approaches could be approximately grouped into three tiers, each representing a more detailed, larger-scale understanding. These tiers are: 1) behavioural or physiological responses - essentially how an individual bird responds to disturbance; 2) exclusion from resources, where the approach is essentially correlative and determines the extent to which settlement, food or other resources are not used as a result of disturbance; and 3) population consequences, where an understanding of density-dependent population regulation is used to examine how disturbance actually operates as a 'macro' level.

Behavioural and Physiological Responses

Behavioural responses to disturbance are relatively easy to measure and record. It was therefore felt that there was scope for more studies of flush distances and the time taken for birds to return when disturbed. However, such studies provide little information at a population level and in isolation, have little practical relevance in conservation terms. The benefit of such studies would be in a wide variety being conducted, in different situations and for a range of species. The comparison and linking of such studies would provide the broad base to the pyramid (Figure 1) and would answer questions about the importance of weather, extent to which habituation occurs (and for which species), and whether there are measures we can use to group species (for example whether body mass provides an index for behavioural response to disturbance).

Behavioural responses for breeding and wintering birds will obviously be different, and studies could be grouped along these lines. For breeding species, the distance at which individuals leave their nest, the time it takes them to return and how this varies between sites, individuals and species is of interest. For wintering birds, it is the distance at which individuals fly or stop feeding, and how this relates to landscape features, varies between species, sites and weather

conditions. There was recognition in the workshop that the individual studies were perhaps not as academically interesting and that there was perhaps scope for much of such work to be done by masters students or similar.

Physiological studies are potentially harder to conduct, as heart rate, stress levels etc are harder to measure. There are however a range of techniques available such as the use of heart rate monitors, blood sampling, fat scores, assessment of body shape and plumage scoring, all of which can indicate individual condition and health to varying accuracy. Little is currently known about the variation between individuals in physiological responses, and how this may influence behaviour, let alone population size.

Exclusion from resources

Correlative studies using measures of disturbance to look at abundance in suitable habitat and breeding success provide the middle tier, and, particularly when such studies show that suitable habitat is not settled, or there is an impact on breeding success, such work can indicate a likely impact on population size. Such studies are particularly useful at a local scale and could be useful for site managers and those responsible for managing access at a local level.

In order to look at the extent to which there is some trade-off between resource use and disturbance, measures of disturbance are required. For example to look at settlement patterns in relation to visitor numbers, a measure of visitor numbers in different areas is required, An understanding of access patterns is therefore necessary for these studies (much more than with the behavioural studies). Mapping people, questionnaire studies and the use of surrogate measures of access are therefore needed for such studies, and will be a component to any of the work commissioned.

Population consequences

Few studies have shown the consequences of disturbance at a population level (but see the work on oystercatchers (Stillman *et al.*, 2001; Stillman *et al.*, 2007; West *et al.*, 2002), woodlarks (Mallord, 2005; Mallord *et al.*, 2007a; Mallord *et al.*, in press,) and ringed plovers (Liley & Sutherland, 2007). Such studies provide the top tier of the pyramid, and the cost and time involved in achieving this level of understanding means it will be possible for relatively few species. The oystercatcher studies relate behaviour to survival and explore population effects of wintering birds, the ringed plover and woodlark studies both use territorial models to look at population consequences for a breeding species. There is scope for both approaches to be more widely applied.

Looking more widely

The three tiers discussed above provide a useful pyramidal structure for considering future research, with a broad base of studies across many species conducted at a simple level and more detailed studies focusing on a smaller selection. However, the pyramid only represents studies which look at directly at the effects of disturbance to particular bird species and essentially the approaches are all very similar to those originally highlighted in 2001. There are methods outside these tiers which were raised both during and outside the workshop.

Studies of visitor access patterns, preferences and variation are clearly important. While such studies are to some extent outside the remit of the workshop, there is also clearly a need to dovetail such studies with ornithological studies and for such studies to identify / test successful access management measures. Social scientists use statistical techniques that are likely to be unfamiliar to ecologists: for example conjoint analysis which provides a means of testing human preferences for different combinations of attributes. There is the exciting potential to use such techniques to quantify path use, or visitor levels to particular sites and then relate these back to bird distributions or breeding success. Such studies would advance our understanding of access and human behaviour in the countryside as well as disturbance effects, and therefore they would have particular relevance for access management.

Virtual reality is being increasingly used by social scientists and environmental scientists to explore people's reactions to complex situations. This technology allows researchers to create computer generated, three dimensional representations of new environments. Key decision makers, stakeholders and, most importantly, the public can then explore virtual worlds, and such technology clearly provides the potential to test access management techniques in a controlled environment. The virtual reality approach allows experimental manipulation of the appearance of alternative access locations, paths, signs and other features in a cost effective and carefully controlled fashion.

Ornithologists regularly use data loggers which record nest temperatures or similar (indicating when the adult is incubating) and nest cameras to record behaviour at the nest. Technology has improved greatly in recent years and such techniques are not prohibitively expensive. Access monitoring can also be similarly high-tech, with treadle counters, gate-counters and infra-red beams widely used to automatically record people. Such techniques provide long-term, comparative data (Gardiner, 2000) and can be satellite linked, reducing the need for large amounts of fieldwork, to achieve simple counts of visitor numbers (Curbishley & Wilson, 2006). Such approaches could be combined with nest cameras, nest data loggers and similar to record disturbance levels at nests or areas of importance to birds.

Visitor pressure and access patterns can be predicted across large areas of countryside (for examples see Entec Ltd., 2002; Jones *et al.*, 2003; Liley *et al.*, 2006a; Liley *et al.*, 2006b). There is clearly more potential in testing and developing these GIS approaches, in combination with remote counters and actual count data, to allow accurate mapping of the spatial distribution of visitor levels in relation to path networks, desire lines, view points, housing, access points etc.

One of the problems with many correlative analyses is the difficulty associated with confounding variables, as access levels will vary with the amount of urban development surrounding sites, distance to roads, distance from the site edges and in different habitats. It is then difficult to determine any underlying mechanism or cause of any correlations found. Teasing apart these kinds of associations requires large data sets from a range of sites and circumstances, and also requires careful analysis and presentation. Such problems were not discussed at the workshop.

4. Species

It was recognised within the workshop that it was difficult to prioritise species for further work, as there were various criteria that could be applied and it was not straight forward to apply these across the wide range of potential species which might warrant study within the UK. Potential criteria discussed included:

- Amount of previous work done on the species and disturbance effects
- Current level of knowledge on the species' ecology / breeding biology
- Feasiblity of study (suitable study population(s), ease of finding nests, densities, etc)
- Conservation status
- Potential to draw parallels with other species
- Habitat

It was recognised that detailed studies of all species would be unfeasible. However, it would be possible to use a few detailed case studies as flagship studies for particular habitats, species groups or scenarios. These studies would address population scale impacts and be well documented. They would represent the top tier of the pyramid in Figure 1.

For this approach to be successful it is necessary to know how easy it is to draw parallels between species and habitats, something which may be potentially valuable at Public Inquiry or under comparable scrutiny. One suggestion from the workshop was that a species matrix could be developed and circulated, with key information about each species summarised, and the matrix used to identify species for future research and to make suggestions as to where parallels could be drawn among groups. It is essential that such a matrix is transparent and the methods used to highlight species for further work is widely endorsed. A simple matrix is provided in Appendix 3. We only include species of conservation concern (i.e. those listed as amber or red in Gregory (2002)) and for each species we have identified whether there are any existing studies of disturbance (ranking studies from 1 – 3, with 1 indicating behavioural studies or similar, 2 indicating studies have explored resource use, or correlations with disturbance levels and a score of 3 indicating population level studies). We also highlight those species associated with CRoW habitats, coastal habitats and those which are ground-nesting (for full details see Appendix 2).

Table 1 shows the number of studies of disturbance for species of conservation concern. It includes 136 species (105 amber listed species and 31 red listed species). There are studies addressing disturbance for 38 of these species (i.e. 28%). For 18 species (13%) these studies are only behavioural, giving flushing distances or similar. There are correlative studies or studies exploring resource use in relation to disturbance for 17 species (12%), and population level studies of disturbance for just three species (2%). There are disturbance studies for a slightly higher proportion of amber-listed species than red-listed ones (Table 1).

Table 1: Numbers of studies of disturbance for species of conservation concern (taken from Appendix 2)

	Number of species listed	Number of species for which there are simple behavioural studies of disturbance	Number of species for which there are resource use or correlative studies	Number of species for which there are population level studies	Total number of species for which there are disturbance studies
Red listed	31	1	4	1	6
Amber listed	105	17	11	2	30
Total	136	18	15	3	36

From the list in Appendix 3 we can also determine that:

- There are 71 species associated with CRoW habitats and there are disturbance studies for 21 (29%) of these.
- There are 68 species associated with coastal habitats and there are disturbance studies for 29 (43%) of these.
- There are studies addressing disturbance for 17 species that breed in the UK and are ground-nesting. Most of these 17 studies (13, i.e. 76%) are on species with nidifugous young.

Using Appendix 3 we can look across species groups to determine the proportion of species within broad groups for which disturbance has been studied. These results are summarised in Table 2. As might be expected, waders and waterfowl have been much better studied than gulls & terns and passerines.

Table 2: Numbers of studies of disturbance for different species groups (and of conservation concern) extracted from Appendix 2. Waterfowl includes divers, grebes, ducks, geese and swans.

	Number of species in Appendix 2	Number of for which there are simple behavioural studies of disturbance	Number of for which there are resource use or correlative studies	Number of for which there are population level studies	Total number of species for which there are disturbance studies
Waders	16	6	4	2	12
Waterfowl	28	10	5	0	15
Gulls & terns	8	0	1	0	1
Passerines	42	0	2	1	3

Of the waders, the species for which disturbance studies are lacking are predictably those that are particularly hard to study, such as Snipe or Woodcock. Curlew were specifically mentioned in the workshop as warranting further study during the breeding season, though any study is likely to be hampered by the difficulty in finding a large enough sample of nests, particularly in the lowlands. With this group it may be more beneficial for further work to focus on the species

for which detailed, comprehensive studies are possible. Ringed Plover and Oystercatcher may provide suitable 'flagship' species with which to explore the potential impacts of coastal access provision and it may be possible to extend existing models at a UK scale.

Gulls and terns are a clear gap. The one study we refer to (that by Hunt, 1972) is somewhat dated and was conducted in America. Little Tern is perhaps one species that stands out as warranting further study, as the species is one associated with coasts and that will often nest outside of nature reserves or other locations where access management is simple.

Passerines have also been disproportionately little-studied. Apart from the detailed studies for two heathland species (woodlark and Dartford warbler), there are very few specific studies of disturbance and passerines, although there are relevant studies which have looked very broadly at bird densities on sites with different levels of access (Van der Zande, 1984). Passerines associated with the key habitats (see Appendix 2) and that nest low to the ground perhaps warrant further attention: Ring Ouzel, Stonechat and Redstart perhaps stand out. Ring Ouzel was mentioned specifically within the workshop.

The matrix itself warrants further development. For simplicity, only birds of conservation concern have been included. Studies of other species may of course also be useful and may allow parallels to be drawn across species.

5. Recommendations for further work

The following key recommendations are taken from the workshop discussions, our review of previous work and our understanding of likely future issues. We group the recommendations according to various sub-headings, and for each sub-heading we provide some background followed by a list of specific projects. Each project is given a priority scoring of 1 star (relatively low priority) to 3 stars (relatively high priority). The individual projects are also listed at the front of the report (pages 6-9), where they are grouped by overall type and ranked in order of priority.

Our recommendations cover a wide range of topics, issues and sites. We recommend that a strategic overview be maintained through a steering group or consortium.

A key issue for many of the recommendations is that they are unlikely to have a high academic profile nor are they pioneering pieces of research. Taking into account the relatively small number of people working in the fields of access research and bird disturbance, it may be difficult to commission the work and care will be needed to ensure that the outputs have applied conservation relevance. We have recommended two topics which would make suitable workshops or small conferences, and these may help to generate interest and cross-fertilisation of ideas. Many of the research priorities could also make suitable projects for masters students or similar. For convenience we collate these as a separate list in Appendix 4, allowing them to be widely circulated.

5,1 Patterns of access in the countryside

5.1.1 Baseline data for key habitats on access patterns

In order to understand where particular problems might arise and to provide baseline information for those responsible for access management there is a need for studies quantifying access patterns at a site or regional level. These should be conducted in a way that allows comparison between sites, will inform access management and will allow ecological data (for example bird distributions) to be related to the access patterns. If such work is strategically co-ordinated, it will be possible to use the data to develop means of predicting visitor levels in areas with where no visitor data are available.

The studies should focus on showing:

- how far people travel to reach sites:
- how far they walk (ideally expressing the extent people move from car-parks etc rather than total route length); and
- the extent to which visitor numbers vary temporally through the year.

Ideally counts of different user groups (dog walkers, joggers etc.) should be compared. The issue of diffuse access, as opposed to people following specific routes, was raised within the workshop as warranting particular attention, identifying which people stray off paths, where they do so and why.

We consider such studies to be a priority for coastal sites. Access along coastlines is typically linear and the reasons for people's visits, their behaviour and the length of their visits may be different from other habitats and will vary between sites. Questionnaires, visitor counts and observational work across a range of sites would allow basic information, such as how far people move from car-parks, how tide and weather influence visitor numbers and behaviour and what features may particularly attract people. It may be possible to incorporate existing data sets (for example the data used in ringed plover and oystercatcher studies). The aim of the work should be to provide baseline information to inform access management measures and for use in studies of coastal birds and disturbance.

Vistor access studies on inland sites are less of a priority. The national on-site visitor monitoring programme, commissioned by Natural England, is taking place on thirty-two sites across England and is repeated annually. This will provide data on a sample of sites, and there has already been work on lowland heathland in Dorset and the Thames Basin (Clarke *et al.*, 2006; Liley *et al.*, 2006c; MORI, 2004). The remaining gaps are sites where there are particular issues with access management or where development issues in the future may change visitor pressure. In this context we consider other heathland SPAs, such as the Brecks, Ashdown Forest, Wealden Heaths and East Devon Heaths to warrant detailed visitor surveys.

	Description	Means of achieving	Description / notes	Priority
1	Visitor access patterns at coastal sites	Research contract	Questionnaires, counts and observational work across a sample of coastal sites	***
2	Visitor access patterns in the Brecks	Research contract / thesis	Questionnaire work and counts (following Clarke *et al.*, 2006)	*
3	Visitor access patterns in the Wealden Heaths	Research contract / thesis	Questionnaire work and counts (following Clarke *et al.*, 2006)	*
4	Visitor access patterns in the East Devon Heaths	Research contract / thesis	Questionnaire work and counts (following Clarke *et al.*, 2006)	*
5	Visitor access patterns in Ashdown Forest	Research contract / thesis	Questionnaire work and counts (following Clarke *et al.*, 2006)	*

5.1.2 Studies focusing on particular user groups

Certain types of visitor / recreational activities are often of particular concern to those responsible for managing access. There is potential for studies focusing on some of these groups and looking at how such groups decide where to visit, how long they spend at different locations, how information (such as key sites for each activity) is shared between individuals, what motivates the users and which clubs / societies act as bodies for each activity. This information should be presented in such a way that it is relevant to both site managers and ecologists. It is hoped that this work would enable site managers and others to develop an understanding of the activity, the types of users, the potential conflicts and how to engage with those undertaking the activity.

Some of this information is collated by Anderson *et al* (2006) and dog walkers have been the subject of a particular study (Edwards & Knight, 2006), hence this is a relatively low priority for future work. The dogs study provides a useful template for studies of particular groups, and activities that are perhaps of particular interest are climbing (both coastal and inland), coasteering, windsurfing, paragliding in coastal waters and non-motorised boating (canoes etc.).

There is still a lack of information on the extent to which dogs stray from their owners, how far they typically roam and the variation between different individual dogs / breeds of dog. These data would need to be collected through observation or through the use of GPS collars or similar. The information would be useful for site managers and could also be used in the development of predictive models (see 5.1.5). Given the level of concern about dogs, we rank this as medium priority.

	Description	Means of achieving	Methods / notes	Priority
6	Study of climbers	Research contract	Questionnaires, counts and observational work across a sample of coastal and inland sites	*
7	Study of coasteering	Research contract / thesis	Focused study of particular user group conducted in such a way that the results are useful for site managers and ecologists.	*
8	Study of windsurfing & paragliding in coastal waters	Research contract / thesis	Focused study of particular user group conducted in such a way that the results are useful for site managers and ecologists.	*
9	Study of non-motorised boating	Research contract / thesis	Focused study of particular user group conducted in such a way that the results are useful for site managers and ecologists.	*
10	Dog behaviour	Research contract / thesis	GPS collars or observational work to determine how far dogs stray from their owners	**

5.1.3 Review of access monitoring techniques

Many different organisations (e.g. Natural England, County Councils, Forestry Commission, the National Trust, RSPB) collect visitor data, and while various networks (such as the Countryside Recreation Network) serve to link those with interests in access, there has been no attempt to bring together or coordinate visitor monitoring. It would be useful to explore how visitor data is collected and used by different organisations to inform conservation and access management. A review of the different methods used to collect visitor data, and the potential to then relate the visitor data to bird data would be useful and help ensure future access monitoring and bird monitoring can be combined and used together. This could be achieved through a desk-based review or alternatively through a conference or day workshop. The latter would have the added benefit of linking those involved in access monitoring, social scientists / market researchers working in the field of recreational access and ornithologists working on disturbance to birds.

	Description	Means of achieving	Methods / notes	Priority
11	Review of access monitoring within the UK	Desk-based review or small conference / workshop	Contact with various organisations and people to assess how visitor monitoring is conducted and potential to coordinate with bird data	***

5.1.4 Effectiveness of access management techniques

Site managers and those responsible for managing access have a repertoire of potential techniques for modifying or influencing people's behaviour in the countryside. These may range from reducing car-parking capacity to more subtle measures such as the placement of benches, surfacing of paths or allowing vegetation to grow up in particular areas. Signs, interpretation, wardening and publicity in the media are other means which can be used to influence people's choices. There is very little available evidence of the efficacy of these different measures, and the crucial gap in our understanding is how these may relate to bird conservation on a site level. We recommend experimental work to test people's behaviour within sites, through manipulating sites and recording changes in visitor behaviour (e.g. through CCTV). Nature reserves would provide the ideal locations for such work, and the reserves used in the study could then be used as best practice examples of access management. We see the lack of evidence for the efficacy of access management as a clear gap and therefore consider this to be a high priority.

Further testing and manipulation of access management measures could be conducted using virtual reality studios, which could provide a means of testing some of the results from the experimental manipulations described above. This would allow further refinement of exactly why particular measures are effective and the range of circumstances in which they might work. The output from this study and the above could in electronic format, e.g. a DVD, showing examples of best practice access management.

Site managers across the country implement a range of access management measures and when making changes there is an ideal opportunity for these to be documented as individual case studies. The conservation evidence website (conservationevidence.com) provides an ideal forum for these to be documented and their effectiveness described. Currently the site contains no case studies regarding access management. We therefore recommend that any future opportunities to document before and after changes in access levels on sites should be taken – these opportunities will be ad hoc and could also make suitable subjects for student projects or similar.

Reviews of particular issues (e.g. management of tern colonies, use of hides / screens) are recommended to provide detailed guidance for site managers. The management of tern colonies could be linked to recommendation 22 (section 5.2.1). The reviews would be conducted by visiting sites, talking to site managers and collating information on the current range of techniques used and their effectiveness. Such reviews should be produced in a way that gives clear best practice guidance. Due to the potential changes in coastal access we assign relatively high priority to a review of access management of tern colonies.

	Description	Means of achieving	Methods / notes	Priority
12	Test of the effectiveness of access management techniques	Research contract or PhD	Experimental manipulation of access management measures across a suite of reserves (e.g. NNRs or RSPB reserves). Possibly enhanced / refined and further tested through use of virtual reality	***
13	Documentation of individual access management measures on different sites	Conservationevidence.com write-ups, student projects	Before and after visitor monitoring to show effectiveness of access management measures (path surfacing, car-park closures, new paths, sign posts etc). Ad hoc as opportunities rise	*
14	Review of management of tern colonies	Research contract / student project (see also 5.2.1)	Review of the extent to which wardening, fencing, etc reduce disturbance at tern colonies. Distance people are kept away from the birds.	**
15	Effectiveness of hides / screening in reducing disturbance	Research contract / student project	Review of different designs used to reduce disturbance. Written as a best practice guide.	*

5.1.5 Predictive models of access patterns

Predictive models which describe the spatial variation in visitor numbers across the countryside provide a powerful means of exploring the potential effects of access management, housing provision, provision of alternative sites etc. and also a means to explore the impact of such measures on bird distributions and breeding success (i.e. correlative studies in the middle of the pyramid, see Figure 1, p19). They are useful where actual visitor data are lacking. To date, few such models exist and few have been published (but see Entec Ltd., 2002; Jones *et al.*, 2003; Liley *et al.*, 2006b). Different methods have been used and therefore a workshop or small conference would provide a useful forum for collating existing approaches and highlighting future potential. Such an event could be held in conjunction with recommendation 3.

There is clear scope to refine existing models and to apply these more widely. For example existing models of access patterns across heathlands could be applied to other heathland SPAs to allow comparison of visitor pressure and access levels on different SPAs. In the uplands predictive models could be used in conjunction with the Breeding Bird Survey monitoring (see Noble *et al.*, 2006) which will assess the impact of CRoW access to the uplands. In this case it might be difficult to dovetail the resolution of the BBS (1km squares) with spatial variation in visitor pressure (which can vary considerably over a single km), but there would still be merits in using the predictions to categorise squares according to their level of access. In all cases such models should be developed in such a way that they can be related directly to ornithological data and provide the potential to identify areas where particular issues may occur.

We recommend that a predictive model is developed for coastal sites. This would predict visitor numbers along linear stretches of coast, taking into account habitat, car-park locations, facilities etc. We place a high priority on the need for such a model as it could then be used to determine where access management measures (such as beach exclosures or car-park closures) could be effective. There would also be the potential to combine the model with coastal bird data (such as national surveys of ringed plover and the studies of breeding ringed plover in Norfolk) to

show where disturbance is having an impact and to explore changes in the national population size that might be expected under different access scenarios.

Existing models on heathland sites (Liley *et al.*, 2006a) could be used to apply correlative studies for a wider suite of species (for example woodlark, Dartford warbler, tree pipit and stonechat). Where visitor models already exist (the Thames Basin and Dorset Heaths), this could be done at relatively low cost. Detailed studies of disturbance already exist for woodlark and Dartford warbler, so such work is only likely to be important where it adds additional information, such as in conjunction with access management plans for particular sites.

	Description	Means of achieving	Methods / notes	Priority
16	Workshop on predictive models of access	Workshop / small conference with proceedings	Proceedings would document different methods and their potential future use	**
17	Application of standard model for heathlands to other heathland SPAs	Research contract	Direct comparison of different SPAs, levels of visitor pressure and impacts on bird populations	**
18	Predictive models used in the uplands in conjunction with BBS data to assess impact of CRoW	Research contract	Entec model or similar could potentially be used, but careful design needed	**
19	Development of predictive model of access levels to coastal sites	Research contract	Model would allow estimates to be made of visitor numbers to sites without actual data and could then be used to guide management	***
20	Predictive models of access on Thames Basin and Dorset heaths used to explore impacts on species besides nightjar	Research contract	Existing work on nightjar extended to other species such as woodlark, Dartford warbler, tree pipit and stonechat	**

5.1.6 Impact of climate change on access

Climate change may well have consequences for access patterns, as people are more likely to visit the countryside during warm periods of sunshine and likely to be deterred by rainfall. Changes in access at particular times of year (such as spring when birds are settling on territories) may have particular relevance to bird populations. Long-term changes in access patterns may mean that existing monitoring and predictive models are not applicable too far into the future. It would be useful to understand any likely changes and have advance warning if they may have conservation implications.

Due to the relatively long-term timescale involved, we assign this relatively low priority. The work would best be achieved by reviews of access data (i.e. people counts at different locations on different dates) in relation to weather and relating this to future scenarios of climate change.

	Description	Means of achieving	Methods / notes	Priority
21	Work on the impact of climate change on access levels	Research contract	Existing data sets for a sample of sites (e.g. national on site monitoring data) used to determine influence of variations in weather on access levels	*

5.2 Particular bird species

5.2.1. Little Tern

There is a clear gap in studies of disturbance effects on gulls and terns within the UK and given the future prominence of coastal access, detailed work is warranted. In addition, most of the UK species within this group are red or amber listed (black-headed gull, common gull, herring gull, arctic tern, little tern and roseate tern are all birds of conservation concern due to declines in breeding range and or numbers). Of these species, little tern stands out as most warranting further study.

Breeding success varies markedly between years, and predation rates are often high. Disturbance effects may therefore be difficult to determine unless the work is conducted over a number of years, and we therefore suggest this work would make a suitable PhD. Disturbance effects are more likely to occur at the more transient colonies as large, more permanent colonies tend to be wardened and fenced. As little terns are a species for which disturbance and predation may interact a PhD could also address this interaction. The efficacy of protection measures such as fencing, wardening etc. could also be tested (see 5.1.4).

We would recommend that a PhD should be linked to the predictive modelling of visitor pressure on coastal areas (see recommendation 19), allowing the results of the PhD to be applied to a wide suite of sites. For example, if the work showed that areas with high visitor pressure were less likely to be settled by breeding pairs, then it would be possible to identify areas from the modelling work where a reduction in visitor levels would potentially result in an increase in the area of available breeding habitat.

We consider this to be an important piece of work, but have allocated it 2 stars due to the fact that similar work has taken place in Portugal and it may be possible to draw parallels from this work (Medeirosa *et al.*, 2007).

	Description	Means of achieving	Methods / notes	Priority
22	Little Terns and disturbance	PhD	Applied PhD looking at management recommendations, population consequences and interactions between predation, beach management and disturbance	**

5.2.2. Density-dependent models of shorebirds

Coastal access is clearly a key issue, and we therefore recommend further work on disturbance for coastal species. There is already an extensive body of knowledge on shorebirds and disturbance, and we suggest that further work on already well-studied species (oystercatcher and ringed plover) would provide detailed case study material. Research needs to address the particular conditions of coastal access, such as clear visibility (i.e. people are often on the skyline), locally high concentrations of people, and the vulnerability of species to particularly exposed weather conditions (Clark *et al.*, 1993; Le V. dit Durell *et al.*, 2006).

The best approach to addressing these issues, and the impact of disturbance at particular sites, is to extend the individual-based models, developed by CEH staff in Dorset. To date these models have been applied to shorebirds in the Exe estuary, Poole harbour and Southampton Water in the UK, Baie de Somme, France, Bahia de Cadiz, Spain, Brent Geese in western Europe and Black Scoter in the Irish Sea (see Stillman *et al.*, 2007 for a review). The work on disturbance to oystercatchers on the Exe Estuary in Devon (West *et al.*, 2002) was confined to mussel beds, the main feeding areas. The upshore feeding area and the meadow were left undisturbed and simulations were run with either 10 or 50% of the total area of mussels disturbed. The model was run for each of these two conditions and with two types of disturbance, 'major' (a person walking across the mussel bed) and 'minor' (people near to the mussel beds). The simulations were also run with different temporal variations, such as disturbance for the whole winter or just part of the winter.

We recommend that this work is extended, perhaps using a different site, and using different disturbance parameters in the modeling. The model should test a range of scenarios of different levels of access and different spatial distributions of access. The exact scenarios tested would ideally reflect a range of realistic access scenarios at the site, and would therefore be carefully selected through close consultation with Natural England staff.

We recommend that a similar piece of work is conducted for a breeding species on the coast. It would be possible to extend the work on ringed plovers in north-west Norfolk (Liley, 1999; Liley & Sutherland, 2007) to address a larger scale (i.e. a longer stretch of coastline) and to address different scenarios of coastal access. As with the oystercatcher work it would be possible to apply the model to different sites, and to consider actual scenarios of planned or possible coastal access. As an alternative, it may be possible to build a similar model for breeding oystercatchers.

There may the possibility, with both these pieces of work, to use model predictions (see recommendation 5) to help build the scenarios.

	Description	Means of achieving	Methods / notes	Priority
23	Individual-based population model extended to different site(s) / scenarios	Research contract	Scenarios and locations to be decided in close consultation between researchers and Natural England staff to ensure realistic and pertinent case study material	***
24	Density-dependent model for breeding ringed plover applied to different site(s) and scenarios	Research contract	Scenarios and locations to be decided in close consultation between researchers and Natural England staff to ensure realistic and pertinent case study material	***

5.2.3 Single species studies

The species matrix (Appendix 3) highlights species for which there is a lack of studies of disturbance. There would be a benefit for many of these species to be the focus of a correlative study, or behavioural studies, filling in the base of the pyramid shown in Figure 1 (p19). Many of these would make suitable masters projects or similar. We suggest a list of possible studies

below (the list is not intented to be exhaustive), and while none of these would be a particularly high priority in itself, seen as a whole, this body of work would provide a good basis for identifying the kinds of situations, species and circumstances in which disturbance might be an issue for site managers.

Ring Ouzel was one species mentioned a number of times within the workshop and this species perhaps stands out as warranting further work. The species is declining in range (Wotton *et al.*, 2002) , with hunting and afforestation suggested as possible factors associated with the decline (Burfield, 2002; Burfield & Brooke, 2005). Nesting in relatively remote upland areas of the UK, the species is perhaps unlikely to coincide with areas of overall high visitor pressure, however, nests are located on crags and rocky outcrops which may specifically attract people, especially climbers.

Species

Arctic Tern: comparison of breeding success on a range of sites with different levels of access
Bar-Tailed Godwit: intake rates and choice of sites in relation to disturbance
Bewick's Swan: patterns of use of marshes during the winter according to disturbance, distance from roads etc.
Common Gull: breeding success at sites with different levels of disturbance
Curlew: breeding success in relation to disturbance (it may be difficult to achieve adequate sample sizes with this species)
Fulmar: breeding success in relation to disturbance
Grey Plover: intake rates and choice of sites in relation to disturbance
Hen Harrier: use of roost sites and effects of disturbance at roosts (it may be that no roosts occur in areas with any disturbance!)
Herring Gull: breeding success of roof-top pairs in urban areas and cliff-top pairs in areas subject to different levels of disturbance
Kestrel: choice of foraging areas in relation to disturbance levels
Little Tern: breeding success and settlement in relation to disturbance levels (see also recommendation 8)
Meadow Pipit: breeding success and settlement in relation to disturbance
Peregrine: effect of disturbance on breeding success (coastal nest sites could be assigned to different levels of disturbance, potentially in combination with recommendation 5)
Puffin: effect of disturbance on breeding success, nests at locations such as Skomer could be assigned to different disturbance levels due to their proximity to footpaths
Ring Ouzel: breeding success and settlement in relation to disturbance
Skylark: breeding success and settlement in relation to disturbance
Shag: breeding success at locations with varying levels of access
Stonechat: settlement and breeding success at sites with different levels of access (existing visitor pressure models for Dorset and the Thames Basin could be used as a measure of disturbance)
Tree Pipit: settlement and breeding success at sites with different levels of access (existing visitor pressure models for Dorset and the Thames Basin could be used as a measure of disturbance)
White-fronted goose: patterns of use of marshes during the winter according to disturbance, distance from roads etc.
Whooper swan: patterns of use of marshes during the winter according to disturbance, distance from roads etc.

Behavioural responses

Distances at which incubating birds leave the nest when approached by different group sizes, types of disturbance and at different locations.

Distances at which foraging birds react to disturbance, collected for different species, at different locations, in different weather conditions etc.

	Description	Means of achieving	Methods / notes	Priority
25	Simple single species behavioural or correlative studies	Student projects, small research contracts as opportunities arise	We suggest 21 different species, and a range of examples, more are possible. Each piece of work would make a discreet, small piece of work in itself.	*

5.3 Cross-species studies

5.3.1 Habituation

There are no formal studies of habituation (Nisbet, 2000), and a better understanding of the extent to which behavioural and physiological responses may depend on habituation would be useful. The study should compare the disturbance effects of constantly high access levels compared to sporadic access. We recommend that the study focuses on a relatively easy species to study which occurs across a suite of sites where there is a range of visitor levels. Data loggers (recording nest temperature and heart rate) would be used to look at incubation behaviour and could be combined with visitor data (collected through the use of trailmasters, observation or cameras) on different sites to explore how behaviour differs according to levels of access. The study would provide a case study which is anticipated to inform whether chronic and sporadic disturbance do have different impacts. This work would form a single season research contract, and could perhaps be combined with other recommendations (e.g. predictive modelling of coastal access, recommendation 19; the impacts of dogs 5.5 and the shorebird population models, recommendation 23). The work should be used to make general conclusions about how birds respond to different levels of access and address whether, for those responsible for managing access, there are benefits to maintaining relatively constant access patterns. The work would also provide a means of testing the usefulness of a correlative approach in other studies. As such we suggest this is a relatively important piece of work.

	Description	Means of achieving	Methods / notes	Priority
26	Study of habituation	Research contract	Study of a single species, comparing the effect of disturbance at a range of sites with differing levels of access.	**

5.3.2 Parallels across species

We have recommended a suite of correlative studies, and a limited number of more detailed studies. In order to enable parallels to be drawn across species we recommend some work looking at how the impact of disturbance varies between species. The work should focus on which characteristics of species (such as body size, diet, habitat, behaviour) may allow species to be grouped in terms of disturbance effects. The study would probably require a combination of reviewing existing studies and potentially some fieldwork. There is some cross-over with recommendation 12 and we suggest that the two pieces of work could be conducted simultaneously or even combined.

We assign this work a moderate priority, as it would be most beneficial for this work to follow on from the studies in recommendation 9.

	Description	Means of achieving	Methods / notes	Priority
27	Cross-species study	Research contract	To address the potential to draw conclusions across species and to identify characteristics that allow species to be grouped in their response to / impacts of disturbance	**

5.3.4. Thresholds

Avoidance of areas of high disturbance is one of the principal mechanisms by which disturbance has been shown to impact population size (Liley & Sutherland, 2007; Mallord *et al.*, 2007b). Where areas of suitable habitat are not utilised due to disturbance, it is clearly useful to understand the level of disturbance at which the avoidance may occur. Studies are necessary to test whether such thresholds are consistent across variations in bird density. With this knowledge it should then be possible to use predictive models (recommendation 5) to identify potential areas of unused habitat and to guide decisions on access management and strategic planning. We therefore recommend a research contract to look at existing correlative studies, perhaps combined with some additional analysis, in order to allow general conclusions to be made about the level of access at which a decline in bird density / breeding success might occur, whether this level and the shape of the decline is the same for all species, and the extent to which the shape varies with population size / density. This is essentially recommendation 3 from the 2001 report and would also link with recommendation 10 (study of habituation) in this report.

Given the strong weight often placed by planners on particular thresholds (for example see Burley, 2007) we assign this a relatively high priority.

	Description	Means of achieving	Methods / notes	Priority
28	Thresholds at which disturbance effects occur	Research contract	Largely desk based study collating studies of disturbance effects and identifying whether thresholds occur, how these vary between species and species'densities	**

5.3.5. Physiological impacts of disturbance and their relevance at a population scale

Various studies have shown disturbance to have physiological effects such as changes in heart rate or the production of hormones associated with stress (e.g. Heath & Dufty, 1998; Jones *et al.*, 1994; Nimon *et al.*, 1996; Nimon *et al.*, 1995; Regel & Putz, 1997; Tempel & Gutierrez, 2003; Walker *et al.*, 2005; Walker *et al.*, 2006; Weimerskirch *et al.*, 2002). Most of these studies have involved seabirds, especially penguins, and it is also very difficult to place them in a population context. We therefore have a very limited understanding of whether physiological impacts of disturbance have population consequences. Such work would be complex and difficult to

undertake, and would be comparatively expensive, (experimental manipulation of disturbance may be necessary). We therefore recommend that it is conducted for a single species only and in a study which will have relevance to other species and circumstances. The work could be linked to the study of habituation (recommendation 10). We assign this relatively low priority due to the potential costs and difficulties.

	Description	Means of achieving	Methods / notes	Priority
29	Physiological effects of disturbance and their impacts at a population scale	Research contract	Experimental manipulation of disturbance, use of heart rate monitors and possibly blood sampling, long term monitoring to relate breeding success to physiological effects.	*

5.4 Urban development & planning issues

5.4.1 The relationship between visitor levels and housing

The current evidence base used to underpin strategic planning of housing development would benefit from further studies relating housing to access. The research should focus on areas important for bird conservation (such as lowland heathland SPAs) and explore the links between housing, greenspace and visitor levels. In particular the work should address the extent to which the number of people visiting the countryside is related to the amount of countryside available to visit. Where there is only a small amount of land available, is it likely to receive a higher density of visitors? Are people living in areas with lots of visitable countryside around them more likely to own a dog? These questions are best addressed by conducting work across a range of study areas or sites with different degrees of countryside around them. One possible approach is to contact households at random and ask questions about dog ownership, visits to the countryside and local sites visited. These local sites would then be mapped together with the interviewee's home address. GIS-based analysis would then identify the range of sites and greenspace in the vicinity of each interviewee and how that determines their use of their local countryside. It may be possible to undertake this work in connection with the England day visits survey.

This action may well be achieved through the predictive modelling recommended above (recommendation 7) and we assign it as a moderate priority.

	Description	Means of achieving	Methods / notes	Priority
30	The relationship between housing, available greenspace and visitor numbers	Research contract	Questionnaires and visitor counts conducted across a range of sites or directly with a random selection of houseolds.	**

5.4.2 Types of housing and access

High density housing is often in the form of flats or building with few or no gardens. We know little about whether people in such dwellings are less or more likely to visit the countryside and

why they might visit. We recommend work to investigate the likelihood of dog ownership for people living in flats and properties with / without gardens and comparative studies looking at people's access patterns in different types of housing. Such work would involve questionnaires, access diaries or similar and would best be conducted as a research contract. As this recommendation is likely to benefit local planning authorities, it may be possible for local authorities to include a questionnaire in their direct mailings. This work could also be conducted with recommendation 14 as the approach would be similar.

	Description	Means of achieving	Methods / notes	Priority
31	The relationship between types of housing, dog ownership and access	Research contract	Questionnaires focusing on comparisons between people living in different types of houses, including flats and properties with gardens	**

5.4.3 Effectiveness of alternative sites in attracting people

The role of alternative natural greenspace sites in attracting people away from areas of conservation importance warrants further study. The promotion of alternative sites as a means of reducing visitor numbers on key sites has been widely promoted, for example it is one of the principle approaches suggested in Natural England's Delivery Plan for the Thames Basin Heaths. There is currently no evidence that new sites can be created and attract people away from other sites, especially when existing access patterns have perhaps become established over a considerable time period.

We recommended that access monitoring is established on a series of newly created sites in a standard fashion, for example through the use of gate counters or beam counters, and that identical monitoring is conducted on nearby sites where it is hoped that the visitor pressure is reduced. Interviews would also be necessary with visitors to the sites. There is a need to test the extent to which management on existing sites (wardening, introduction of livestock, reduction in parking capacity etc.) can help encourage people to switch to visiting other sites. We suggest that a major study over a number of years is established, in an area such as the Thames Basin Heaths or across the country. The work would make a suitable PhD. Some of the site management measures (wardening, livestock, parking control etc.) could be experimentally manipulated. There has been much high profile debate on the relative effectiveness of access management techniques and alternative site provision with respect to urban development in southern England, and we therefore allocate this as a high priority.

	Description	Means of achieving	Methods / notes	Priority
32	**Effectiveness of alternative sites**	Large, long term research project / or a PhD	Monitoring of visitors on a range of sites over a number of years, combined with interviews and possibly experimental manipulation.	***

5.4.4 Size and design of alternative sites

In order for alternative sites to function effectively, they must be of a design and form that attracts people that would otherwise visit areas important for nature conservation. Some guidance is available (Liley *et al.*, 2006d) but there is scope for more detailed analysis. Landscaping, site size, vegetation, provision of paths etc. may all influence people's choice of

site and could all be tested experimentally. This could be conducted in parallel with the above study, perhaps as the same PhD.

Choices could also be tested through the use of virtual reality or through questionnaires and conjoint analysis. This could be achieved as a discrete research contract. It would also be worthwhile exploring people's choices of where to visit in different parts of the country, comparing areas where there is considerable choice to areas where such choice is limited. This may help
explain why some sites appear to attract particularly high numbers of people. The work would have widespread relevance for access managers as it would identify the general features of sites that work to attract or detract visitors. It should therefore be conducted to make sure it is relevant to a wide audience. Given the general nature and applicability of this work we assign it a high priority.

	Description	Means of achieving	Methods / notes	Priority
33	**Size and design of alternative sites**	Research contract or as part of recommendation 17	Questionnaires and possibly other methods to look at features of sites that attract people.	***

5.5 Impacts of Dogs

Dogs are a key concern for many site managers, and within the UK there has been work focusing on dog walkers behaviour (Barnard, 2003; Edwards & Knight, 2006; Liley & Underhill-Day, 2006) and a review of the impacts of dogs (Taylor *et al.*, 2005). The review highlights the relative lack of studies which show the impacts of dogs. While there are examples that show dogs taking both adult birds and chicks (e.g. Pienkowski, 1984), of dogs flushing birds off the nest (e.g. Langston *et al.*, 2007) or of incubating birds reacting differently to people without dogs compared to those with dogs (Lord *et al.*, 2001), there is certainly scope for further work to quantify the impacts of dogs.

We therefore recommend a detailed study of a single species that looks directly at impacts of dogs and is able to suggest the extent to which this may influence population size. It is not straightforward to suggest how this might be achieved in a cost-effective manner and in a way that the results are widely applicable and relevant to policy makers and site managers. One possibility could be work on a ground-nesting species that is easy to monitor and occurs at sites used by dog walkers. Ringed plover, oystercatcher and possibly lapwing could be suitable. The work could then look at incubation and chick survival for different nests in relation to the number of dogs recorded in the vicinity of the nest. Data loggers or cameras could be used to compare the time spent off the nest as a result of different disturbance events (i.e. dogs off leads, different breeds of dog etc.). Observational work would be necessary to quantify how the birds respond to the dogs.

In order to place this observational work in a population context (at least to suggest whether the presence of dogs can affect the population size) it would then be necessary to identify whether survival or breeding success is affected. We recommend that the study looks at nest

temperatures and the amount of time adults would need to be kept of the nest before embryonic development of the eggs might be impaired.

We assign this moderate importance, as while there is a clear need for the work it will be difficult to ensure the work is applied and widely relevant, and given these risks other studies should be given higher priority.

	Description	Means of achieving	Methods / notes	Priority
34	**Impact of dogs on bird breeding success**	Research contract	Detailed monitoring of incubation and nest survival in relation to disturbance from dogs	**

5.6 Monitoring and Other Issues

Monitoring of access levels in the countryside and of bird numbers is clearly essential baseline information and the results of the monitoring highly pertinent to the work in this report. Both access levels (national on-site visitor monitoring and the England day visits survey) and bird abundance (through BBS, CES and other monitoring schemes) are already monitored at a national level, and we have therefore not included a specific section on monitoring (however see recommendation 5).

Within the workshop, mention was made of a variety of factors that potentially relate to disturbance, or are associated with access, such as fire, noise pollution and light pollution. While these issues may have impacts on birds, and there is potentially a need to understand how such factors relate to disturbance and bird conservation, we consider them beyond the scope of this report.

Appendix 1: Current policy context and current / future issues where new research may be required

The following issues may be relevant and drive research priorities. We summarise them in the text of the report and provide further detail here.

Natural England

Natural England was established by the Natural Environment and Rural Communities Act 2006. The agency has been formed by bringing together English Nature, the landscape, access and recreation elements of the Countryside Agency and the environmental land management functions of the Rural Development Service. Its purpose is to ensure that the natural environment is conserved, enhanced and managed for the benefit of present and future generations, thereby contributing to sustainable development.

Natural England has four strategic aims, one of which is entitled "enjoyment of the natural environment" (see Natural England, 2006). The agency believes that access to the natural environment provides people with a range of benefits, including health and wellbeing. Increasing levels of physical activity is seen as a national priority for improving people's health and the agency promotes the natural environment as providing a range of opportunities: "The challenge for Natural England is to build on this interest and translate it into greater levels of support, resources and action for the natural environment".[3]

Access to the natural environment is therefore at the core of Natural England's current strategic direction and access and nature conservation both now come under the remit of the same government agency.

Access land under the Countryside and Rights of Way Act 2000 (CRoW)

The CRoW Act received Royal Assent on 30 November 2000 and the implementation of access to open country has been a major policy change within UK conservation. In England the public now have 'open access' to approximately 940,000 ha, some 7% of the country. The Act has been implemented effectively and smoothly (DEFRA, 2006) and none of the fears originally expressed in Parliament have been founded.

Patterns of access on CRoW land are still unlikely to have formed and it will take a number of years for people to become aware of where they can go and to start using these locations. Patterns of access and awareness of access rights are therefore likely to be in a state of flux and may slowly change over time. This is within a context of a general decline in the number of visits to the countryside and some changes in the reasons why people visit, as highlighted in the English Leisure Visits Survey (Natural England *et al.*, 2006).

[3] http://www.naturalengland.org.uk/pdf/about/Natural_England_Strategic_Direction.pdf

Access to the English coast.

The Labour Rural Manifesto and Defra's Five Year Strategy commits the Government to giving early priority to taking action to improve access to the coast. When the CRoW Act 2000 was passed coastal land was omitted and it was recognised at the time that coastal access was different and needed to be looked at separately.

Defra see coastal access as "contributing to the vision of a coastal environment where rights to walk along the length of the English coast lie within a wildlife and landscape corridor that offers enjoyment, understanding of the natural environment and a high quality experience; and which is managed sustainably in the context of a changing coastline"[4]. Coastal access is likely to be a key focus for access provision throughout the five year period covered by this report.

Waterways

Waterways were not included within the access provision of the CRoW Act (2000) and most inland waterways have no public access. Where a river does not have a public right of navigation (major rivers and canals only) it is trespass to wade within the water or to pass by in any kind of water-borne craft without consent. The British Canoe Union (BCU) is the governing body for the sport and recreation of canoeing in the United Kingdom and it runs a Rivers Access Campaign[5] which seeks to extend the right to roam to include a right of access to waterways for non-motorised craft. Various pilot studies have tested the efficacy of different approaches, such as voluntary agreements, for allowing access (see Environment Agency, 2006) and it seems likely that access to waterways will remain on the political agenda in the near future.

Dogs

While there appears that there may have been a decline in dog ownership within the UK, there are still 6.8 million pet dogs and 20% of households have a pet dog (Mintel International Group Ltd., 2006). A very large proportion of visitors to the countryside are dog walkers (Clarke *et al.*, 2006; Edwards & Knight, 2006; Taylor *et al.*, 2005) and within the UK, compared to other countries, there is typically a less restrictive approach to allowing dogs on sites of nature conservation importance (Taylor *et al.*, 2005). Dog walkers as a group have a distinct access pattern, often visiting sites daily.

Dog owners are therefore a particularly important subset of visitors to the countryside, and good dog ownership and responsible owner campaigns have been widely promoted[6] in recent times. Dog owners' perceptions of responsible behaviour and definitions of "close control" vary (Liley & Underhill-Day, 2006), and dog-owners have, in some regions, formed a powerful lobby group[7]. Dogs are important in bringing people into the countryside, and bring immense joy to their owners. There is clearly a need to promote responsible dog ownership while not alienating a large group of visitors to the UK countryside. This balance remains a challenge for nature conservation practitioners.

[4] http://www.defra.gov.uk/wildlife-countryside/issues/accesscoast.htm
[5] http://www.riversaccess.org/pages/pv.asp?p=rac2&v=0&fsize=0
[6] See for example http://www.the-kennel-club.org.uk/crufts/respondogown.htm and http://www.gooddogcampaign.co.uk/gdc/links.htm
[7] For example see: http://www.newforestdog.org.uk/index.htm

Urban development.

There are a particular suite of issues concerning urban development, nature conservation and access, especially with respect to European protected heathland sites in southern England. Among the broad suite of urban impacts (see Underhill-Day, 2005) to lowland heathlands, a number are due to increased access resulting from the new housing. In areas such as the Thames Basin Heaths or the Dorset Heaths, where large human populations occur alongside the heaths, access levels can be very high (Liley *et al.*, 2006a; Liley *et al.*, 2006b). The heaths often provide the only large areas of green space and are widely used for various recreational activities, especially dog walking.

A growing body of work has shown disturbance effects to the Annex 1 bird species associated with lowland heathland (Langston *et al.*, 2005; Liley & Clarke, 2002, , 2003; Liley *et al.*, 2006a; Mallord, 2005; Mallord *et al.*, in press, ; Murison, 2002; Murison *et al.*, in press,), much of which has been conducted since the workshop in 2001. This research, some of which was commissioned to investigate the impacts of CRoW on these sites is now subject to intense scrutiny at public inquiry and regional hearings. The research has played a major role in informing the debate about development adjacent to heathland. The issues are however complex – the links between the spatial distribution of housing, patterns of recreational access and disturbance impacts are not straightforward. Further research will continue to inform this debate and it is likely to be a high profile issue for conservationists in southern England into the near future.

Appendix 2: Detail of work done towards original recommendations made in 2001

We list the recommendations made in 2001 and identify work done towards those recommendations. We focus on work commissioned by the UK government agencies, however other work is included where relevant (i.e. addressing a particular recommendation and focusing on species occurring within the UK).

1. Undertake a literature review of the behavioural responses of breeding birds to human disturbance

The rationale for this recommendation was that the information would provide some potential to group species according to their behavioural responses. Such a grouping may help identify species for which results from more detailed studies of other species might be broadly applicable.

No such study has been undertaken. The literature review by Woodfield & Langston (2004) only includes papers where there is a potential for a demographic effect. There are a large number of recent papers focusing on behavioural responses to disturbance (e.g. Blumstein, 2003; Blumstein *et al.*, 2003; Fernandez-Juricic *et al.*, 2001; Fernandez-Juricic *et al.*, 2002; Fernandez-Juricic *et al.*, 2003; Fernandez-Juricic & Schroeder, 2003; Fernandez-Juricic *et al.*, 2004; Fernandez-Juricic *et al.*, 2005; Thomas *et al.*, 2003). The review by Blumstein *et al* (2005) provides comparisons of behavioural responses between species and does address this recommendation to some degree. Beale & Monaghan (2004), while not addressing breeding species, have very neatly demonstrated that behavioural responses to disturbance are dependent on the condition of the individuals and behavioural responses are therefore likely to be of little conservation relevance (see also Gill *et al.*, 2001b).

2. Undertake a review of the mechanisms by which disturbance affects birds and the demographic effects of each mechanism

The literature review by Woodfield & Langston (2004) focuses on studies where there is a potential for a demographic effect, but focuses on species and habitats rather than mechanisms, this recommendation is therefore met to some extent. A systematic review of disturbance effects is currently being conducted by Dave Showler (UEA / CEBC).

3. Conduct a review of correlative studies of disturbance

This recommendation was to collate all studies that correlate any aspect of bird biology with disturbance. Studies that correlate bird density with people density and those that correlate breeding success with people density were considered to be of particular interest. It was expected that some analysis would be required in order to allow general conclusions to be made on the level of access at which a decline in bird density / breeding success might occur and whether this level and the shape of the decline is the same for all species. This recommendation has not been done.

4. Apply a correlative approach to existing large data sets of selected species, in cases where it is possible to adequately quantify disturbance

A variety of new correlative analyses have been conducted, for example:

- Footpaths & breeding success (Langston *et al.*, 2007; Mallord, 2005; Murison, 2002; Pearce-Higgins & Yalden, 1997; Whitfield *et al.*, 2001)
- Housing density surrounding sites and bird density within sites (Liley & Clarke, 2002, , 2003; Mallord, 2005; Murison, 2002)
- Disturbance (amount of handling) and breeding success (Blackmer *et al.*, 2004)
- Numbers of people and breeding success (Beale & Monaghan, ; Mallord, 2005)
- Tracks and bird distribution (Summers et al., 2004)
- Visitor numbers and bird numbers (Liley *et al.*, 2006e)

There is on-going work (using the national survey data sets for woodlark, Dartford warbler and nightjar) on the Thames Basin Heaths SPA and Dorset Heaths SPA to look at the effect of housing, visitor pressure and habitat on the bird numbers and distribution.

5. Conduct a long-term study manipulating access levels across a suite of sites using a rigorous experimental design

This has not happened. The possibility was explored for an upland experiment, however, there were several acknowledged problems, notably providing adequate replication, switching treatments and realistic levels of experimental disturbance to cover the range of possible scenarios. The scale and hence cost of such an experiment were expected to be very high with limited expectation of being able to achieve the necessary level of study to provide conclusive results. Furthermore, the applicability of results from such an experiment, if feasible, would be likely to have been limited to the uplands.

6. Quantify the effect of disturbance in terms of resource use for a number of breeding bird species. This trade-off approach should be applied to a range of breeding species where the relationship between habitat and density can be identified quickly and cheaply

This has been done using habitat use for golden plovers, dunlin and woodlarks (Finney, 2004; Finney *et al.*, 2005; Mallord, 2005).

7. Extend existing behaviour-based individual energetic models (which include the energy and time costs of disturbance) to predict the effect of disturbance on mortality and body condition of birds in the non-breeding season

Various papers have been published and the team at CEH Dorset have continued to develop this approach (e.g. Le V. dit Durell *et al.*, 2006; Stillman & Goss-Custard, 2002; Stillman *et al.*, 2001; West *et al.*, 2002)

8. Test the population model developed for Ringed Plovers, by manipulating disturbance levels or applying it to alternative sites

This has not been done. The Ringed Plover model was published in 2007 (Liley & Sutherland, 2007). The application of the model to data from the Waxham / Winterton area has been considered (Perrow pers comm.) and there has been some work (Tratalos *et al.*, 2005) at UEA to look at Ringed Plover numbers and visitor pressure along the entire East Anglian coastline.

9. Apply the population model similar to that developed for Ringed Plovers to further suitable breeding species where many of the parameters are already known. Stone Curlew, Lapwing and Merlin are recommended

Modelling work has been conducted on Woodlarks (Liley *et al.*, 2006d; Mallord, 2005) and Stone Curlew (Taylor, in press).

10. Collect data on a wide suite of breeding species, possibly up to 20, with the long term aim of constructing density-dependent models in the future

To my knowledge there has been little done in this area specifically. Such models might be possible using data for a variety of species – the following are thought possible candidates: Divers, Golden Plovers, Black Grouse, Lapwing, Dartford Warbler. Some work has been done on Chough breeding success in relation to access levels in south-west Wales (Poole, 2003).

11. Establish monitoring of species across a suite of representative sites, reflecting different levels of access as well as including sites identified in 13 (below).

The BTO have completed a pilot study and are now undergoing the main project, using BBS data to monitor bird populations on squares with and without CRoW access. Limited monitoring was established prior to the implementation of CRoW (but see GCT & MA, 2004; 2005), but there may be some potential to use existing data sets retrospectively.

12. Develop a predictive model of access levels in the countryside

Predictive models have been developed and their potential application explored. Asken Ltd & Entec produced a model of visitor pressure for northern England, Footprint & CEH have produced a predictive model for the Thames Basin and Dorset Heaths SPA (further work in this area is currently in progress) and ALTERRA have been developing a modelling approach in the New Forest for the past 12 years. None of these studies have been published.

13. Identify key areas for monitoring by using the above model (12), together with maps of bird distribution and abundance, to determine areas where current and future access levels are likely to conflict with bird conservation. These areas will be the key areas for monitoring

The visitor pressure model produced by Asken Ltd and Entec has been widely used by Countryside Agency / English Nature staff in northern England to determine areas of potential conflict.

14. Establish the efficacy of access restrictions by monitoring access and people's behaviour in the countryside

Visitor monitoring on CRoW access land has been taking place this summer in a contract organised by the Countryside Agency and being undertaken by Asken Ltd and others. However, this work will look at use of access land and will not determine the efficacy of access restrictions or any other access management measures.

15. Establish of a review group to oversee the commission and completion of the proposed research.

A review group was established and the commissioning of work with input of funding and expertise from various people and organisations.

Summary Table of original recommendations and the extent to which these have been completed

	Action	Species suggested in 2001	Urgent	Core	Completed ?	Species actually studied	Comments
1	Review of behavioural responses				partly		Broad application and use in grouping species.
2	Review mechanisms of disturbance				partly		Potentially helpful in identifying parameters for modelling approaches.
3	Review of correlative studies				no		Helpful in identifying levels of access at which disturbance may have an effect.
4	Applying a correlative approach to existing large data sets	Black-throated Diver, Slavonian Grebe, Goldeneye, Guillemot, Nightjar (and others).			partly	Nightjar, Woodlark, Guillemt, Kittiwake, Capercaillie, Dotterel, Black Grouse, Leach's Petrel, Black-necked Grebe	Will enforce above review using data from key species.
5	Experimental manipulation of access	Depends on available sites.			no		Difficulty in finding suitable sites always a problem
6	Trade-off approach to be applied to breeding species	Black Grouse, Golden Plover, Hen Harrier, Dartford Warbler.			partly	Dartford warbler, Golden Plover, woodlark	Results useful in identifying degree of areas unsettled due to disturbance. Where an effect is found, data would be useful in a density-dependent model (no. 9).
7	Winter density-dependent model applied to a wider selection of species	Wildfowl, Hen Harrier, Merlin.		√	yes	Focus has been on shorebirds	The most suitable approach for looking at winter disturbance effects.
8	Ringed Plover model tested on alternative sites, or by manipulating disturbance levels	Ringed Plover.			no		Some practical problems.
9	Territorial framework applied to species where many of the parameters	Merlin, Stone Curlew, Lapwing.	√	√	yes	Stone Curlew, Woodlark	Immediate need for population consequences of disturbance calculated for more species.

	are already known						
10	Data collection on a suite of species with the long-term aim of constructing density-dependent models.	Little Tern, Ring Ouzel, Wheatear, Stonechat, Chough, Linnet.		√	?	Chough	Long time period is needed before density-dependent models will be available.
11	Monitoring established for a suite of species	Annex 1 species	√	√	Yes		Not established before the access changes
12	Predictive model of access levels in the countryside		√	√	Yes		Nothing published to date
13	Using the above model to determine areas where access levels are likely to conflict with bird conservation interests		√	√	yes	Has been used for upland areas particularly – e.g. Black Grouse	
14	Monitoring of access and people's behaviour in the countryside		√		partly		Access monitoring is in place, but nothing in place to look at the efficacy of access restrictions / access management measures.
15	Review group to oversee the commission and completion of the proposed research			√	yes		.

Appendix 3: Species matrix

Table 3 gives a list of species that breed in England, Scotland and Wales and could be considered as target species for future work. The species included in the table are those that fulfil all the following criteria:

- Species of national conservation concern as listed as red, amber or candidate red (Gregory *et al.*, 2002).
- Occur as regular breeding or wintering species within England and for which the breeding or wintering population is sufficient for the species to be studied

Species with unusual breeding or mating systems are highlighted with an asterisk, indicating species for which it might be difficult to draw conclusions applicable to other species. The table highlights species that occur on CRoW access land and coastal habitats, as these are particularly relevant for future research. Ground-nesting species (for those species that breed within the UK) are identified (we include species nesting in burrows as ground-nesting), and for ground-nesting species, those with nidiculous ("c") or nidiflugous ("f") young identified, as this may facilitate parallels to be drawn between species. Population sizes are taken from the BTO website, we also indicate whether species are only breed in England (b), winter in England (w) or are present all year-round (a). We indicate species where some work on disturbance has been conducted, ranking studies from 1 (behavioural studies or similar), 2 (studies have explored resource use, or correlations with disturbance levels) or 3 (population level studies). These studies have been found through the use of Web of Science, Google Scholar and the author's own knowledge / reference databases.

Table 3: Species matrix to highlight species for further work. For details see above.

Species	CRoW Access land	Coastal Habitats	Ground-nesting	Amber / Red	Breeding / wintering / all year	Breeding population (pairs or territories)	Wintering population	Existing studies on disturbance	Reference(s)
Arctic Tern		1	C	Amber	b	53000			
Avocet		1	F	Amber	a	743			
Barn Owl	1			Amber	a	4000			
Barnacle Goose		1		Amber	w		40000	2	(Percival, 1993; Percival *et al.*, 1997)
Bar-tailed Godwit		1		Amber	w		53000	1	(Tensen & van Zoest, 1993)
Bean Goose		1		Amber	w		450		
Bearded Tit	1			Amber	a	355			
Bewick's Swan		1		Amber	w		7200		
Bittern		1	C	Red	a	21			
Black Grouse	1		F	Red	a	6600		2	(Richardson & Baines, 2004)
Black Guillemot	1			Amber	b	30000			
Black-headed Gull		1	C	Amber	a	138000			
Black-necked Grebe		1	F	Amber	a	42		1	(Liley *et al.*, 2006e)
Black-tailed Godwit		1	F	Red	a	44		2	(Gill *et al.*, 2001a)
Black-throated Diver		1	F	Amber	a	172.5			
Brent Goose		1		Amber	w		120000	2	(Owens, 1977; Riddington, 1996; Stock, 1993; Stock & Hofeditz, 1997)
Bullfinch	1			Red	a	166000			
Chough	1	1		Amber	a	475		1	(Poole, 2003)
Cirl Bunting	1	1		Red	a	459.5			
Common Gull		1	C	Amber	a	49000			
Common Scoter		1		Red	a		35000	1	(Kaiser *et al.*, 2006)
Cormorant		1		Amber	a	9018		1	(Santoul *et al.*, 2004)
Corn Bunting	1			Red	a	10350			
Corncrake	1			Red	a	589			
Cuckoo				Amber	a	14800			

Species	CRoW Access land	Coastal Habitats	Ground-nesting	Amber / Red	Breeding / wintering / all year	Breeding population (pairs or territories)	Wintering population	Existing studies on disturbance	Reference(s)
Curlew	1	1	F	Amber	a	107000		1	(Fitzpatrick & Bouchez, 1998)
Dartford Warbler	1			Amber	a	1800		2	(Murison *et al.*, in press,)
Dunlin	1	1	F	Amber	a	26000		2	(Finney, 2004)
Dunnock				Amber	a	2163000			
Eider	1	1	F	Amber	a	174000		2	(Bolduc & Guillemette, 2003; Kay & Gilchrist, 1998; Keller, 1991)
Fieldfare				Amber	w		750000		
Firecrest				Amber	a	38.5			
Fulmar		1	C	Amber	a	506000			
Gadwall	1	1		Amber	a	790		1	(Pease *et al.*, 2005)
Gannet	1	1		Amber	a	227000			
Garganey				Amber	a	68.5			
Goldcrest				Amber	a	842000			
Golden Eagle	1			Amber	a	422			
Goldeneye	1	1		Amber	a	200		1	(Hume, 1976)
Grasshopper Warbler	1			Red	b	12300			
Great Northen Diver		1		Amber	a		3000		
Great Skua		1		Amber	a	9600			
Green Woodpecker	1			Amber	a	24200			
Grey Partridge	1		F	Red	a	72500			
Grey Plover		1		Amber	a		43000		
Grey Wagtail				Amber	a	42300			
Greylag Goose		1	F	Amber	a	15700			
Guillemot	1			Amber	b	952000		1	(Fernández-Juricic, 2002)
Hawfinch	1			Amber	a	4800			
Hen Harrier	1		C	Red	a	570			
Herring Gull	1	1	C	Amber	a	144000		2	(Hunt, 1972)
Honey Buzzard				Amber	b	51			
House Martin				Amber	b	404000			
House Sparrow				Red	a	2887500			

Species	CRoW Access land	Coastal Habitats	Ground-nesting	Amber / Red	Breeding / wintering / all year	Breeding population (pairs or territories)	Wintering population	Existing studies on disturbance	Reference(s)
Kestrel	1			Amber	a	36800			
Kingfisher	1			Amber	a	6400			
Kittiwake		1		Amber	a	380000		2	(Beale & Monaghan)
Knot		1		Amber	a		291000	1	(Smit & Visser, 1993)
Lapwing	1	1	F	Amber	a	156000		2	(Fletcher *et al.*, 2005)
Leach's Storm Petrel	1	1	C	Amber	b	51000		2	(Blackmer *et al.*, 2004)
Lesser Black-backed Gull	1	1	C	Amber	a	114000			
Lesser Redpoll				Amber	a	26900			
Lesser-s. Woodpecker				Red	a	2150			
Linnet	1			Red	a	556000			
Little Egret		1		Amber	a	72.5			
Little Tern	1		C	Amber	b	1900			
Long-tailed Duck		1		Amber	w		24000		
Manx Shearwater	1	1	C	Amber	b	301000			
Marsh Harrier		1		Amber	a	151			
Marsh Tit	1			Red	a	52800			
Meadow Pipit				Amber	a	1680000			
Mediterranean Gull		1		Amber	a	110			
Merlin	1		C	Amber	a	1300			
Mistle Thrush				Amber	a	222500			
Mute Swan		1		Amber	a	24750		1	(Tydeman, 1978)
Nightingale				Amber	b	6700			
Nightjar*	1		C	Red	a	4600		2	(Langston *et al.*, 2005; Liley & Clarke, 2003; Liley *et al.*, 2006a; Murison, 2002)
Osprey				Amber	b	127		2	(Poole, 1981)
Oystercatcher	1	1	F	Amber	a	113000		3	(Stillman & Goss-Custard, 2002; Stillman *et al.*, 2001; Verboven *et al.*, 2001; Verhulst *et al.*, 2001; West *et al.*, 2002)
Peregrine	1	1		Amber	a	1400			

Species	CRoW Access land	Coastal Habitats	Ground-nesting	Amber / Red	Breeding / wintering / all year	Breeding population (pairs or territories)	Wintering population	Existing studies on disturbance	Reference(s)
Pink-footed Goose		1		Amber	w		192000	2	(Gill, 1996)
Pintail		1		Amber	w		28000	1	(Pease *et al.*, 2005)
Pochard	1	1	F	Amber	a		44000	1	(Cryer *et al.*, 1987; Fox *et al.*, 1994)
Puffin	1	1		Amber	b	621000			
Purple Sandpiper				Amber	w		21000		
Quail	1			Red	b	227.5			
Razorbill	1	1		Amber	b	126000			
Red Grouse			F	Amber	a	155000			
Red Kite				Amber	a	431			
Red-necked Grebe		1		Amber	a		150		
Redshank	1	1	F	Amber	a	38800		1	(Fitzpatrick & Bouchez, 1998)
Redstart	1			Amber	a	101000			
Red-throated Diver	1	1	F	Amber	a	1217.5			
Redwing				Amber	a		750000		
Reed Bunting	1	1		Red	a	201500			
Ring Ouzel	1			Red	a	6853			
Ringed Plover	1	1	F	Amber	a	8540		3	(Liley, 1999; Underhill-Day & Liley, in press)
Roseate Tern		1	C	Red	b	56			
Sand Martin	1			Amber	b	138650			
Sandwich Tern	1	1	C	Amber	b	13000			
Scaup		1		Amber	a		11000		
Shag	1	1		Amber	a	29000			
Shelduck	1	1	F	Amber	a	8300			
Short-eared Owl	1		C	Amber	a	2300			
Shoveler	1	1	F	Amber	a	1300			
Skylark	1		C	Red	a	1785000			
Slavonian Grebe		1	F	Amber	a	45			
Snipe	1	1	F	Amber	a	59300			
Snow Bunting		1		Amber	a		11000		

Species	CRoW Access land	Coastal Habitats	Ground-nesting	Amber / Red	Breeding / wintering / all year	Breeding population (pairs or territories)	Wintering population	Existing studies on disturbance	Reference(s)
Song Thrush	1			Red	a	1144000			
Spotted Flycatcher	1			Red	b	63700			
Starling	1			Red	a	804000			
Stock Dove	1			Amber	a	309000			
Stone Curlew	1		F	Red	b	220.5		2	(Taylor, in press)
Stonechat	1			Amber	a	34350			
Storm Petrel		1	C	Amber	b	27000			
Swallow	1			Amber	b	726000			
Teal	1			Amber	a	2200		1	(Pease *et al.*, 2005)
Tree Pipit	1		C	Amber	b	74400			
Tree Sparrow				Red	a	68000			
Turnstone		1		Amber	a		64000	1	(Beale & Monaghan, 2004)
Turtle Dove	1			Red	b	44000			
Twite	1	1		Red	a	12000			
Velvet Scoter		1		Amber	w		3000	2	(Mikola *et al.*, 1994)
Water Rail	1			Amber	a	1100			
Whimbrel	1	1	F	Amber	b	530		1	(Kevin, 2001)
White fronted Goose		1		Amber	w		20000		
Whooper Swan		1		Amber	w		5600	1	(Rees *et al.*, 2005)
Wigeon		1		Amber	w		278000	2	(Cryer *et al.*, 1987; Madsen, 1998)
Willow Tit	1			Red	a	8500			
Willow Warbler				Amber	a	2125000			
Wood Warbler				Amber	a	9750			
Woodcock*	1		F	Amber	a	9550			
Woodlark	1		C	Red	a	1489		3	(Mallord, 2005; Mallord *et al.*, in press,)
Yellow Wagtail			C	Amber	b	19000			
Yellowhammer				Red	a	792000			

Appendix 4: List of studies suitable for Masters Theses or similar

The list below identifies discrete pieces of work which would make suitable subjects for Masters theses, or possibly even undergraduate dissertations. Our intention is that by collating these in a single location, in a form that is easy to circulate, these ideas for future research may be picked up by students or research departments seeking applied projects.

Visitor Behaviour / Access Management

Visitor access patterns in the Wealden Heaths: questionnaire work and visitor counts (following Clarke *et al.*, 2006)

Visitor access patterns in the East Devon Heaths questionnaire work and visitor counts (following Clarke *et al.*, 2006)

Visitor access patterns in Ashdown Forest questionnaire work and visitor counts (following Clarke *et al.*, 2006)

Study of coasteering: Focused study of particular user group conducted in such a way that the results are useful for site managers and ecologists.

Study of windersurfing & paragliding in coastal waters: Focused study of particular user group conducted in such a way that the results are useful for site managers and ecologists.

Study of non-motorised boating: Focused study of particular user group conducted in such a way that the results are useful for site managers and ecologists.

Dog behaviour: GPS collars or observational work to determine how far dogs stray from their owners

Documentation of individual access management measures on different sites

Before and after visitor monitoring to show effectiveness of access management measures (path surfacing, car-park closures, new paths, sign posts etc).

Review of management of tern colonies: addressing the extent to which wardening, fencing, etc reduce disturbance at tern colonies.

Effectiveness of hides / screening in reducing disturbance: a review of different designs used to reduce disturbance.

Ornithological Studies: single species studies

arctic tern: comparison of breeding success on a range of sites with different levels of access

bar-tailed godwit: intake rates and choice of sites in relation to disturbance

Bewick's swan: patterns of use of marshes during the winter according to disturbance, distance from roads etc.

common gull: breeding success at sites with different levels of disturbance

curlew: breeding success in relation to disturbance (it may be difficult to achieve adequate sample sizes with this species)

fulmar: breeding success in relation to disturbance

grey plover: intake rates and choice of sites in relation to disturbance

hen harrier: use of roost sites and effects of disturbance at roosts (it may be that no roosts occur in areas with any disturbance !)

herring gull: breeding success of roof-top pairs in urban areas and cliff-top pairs in areas subject to different levels of breeding success

kestrel: choice of foraging areas in relation to disturbance levels

little tern: breeding success and settlement in relation to disturbance levels (see also recommendation 8)
meadow pipit: breeding success and settlement in relation to disturbance
peregrine: effect of disturbance on breeding success (coastal nest sites could be assigned to different levels of disturbance, potentially in combination with recommendation 5)
puffin: effect of disturbance on breeding success, nests at locations such as skomer could be assigned to different disturbance levels due to their proximity to footpaths
ring ouzel: breeding success and settlement in relation to disturbance
skylark: breeding success and settlement in relation to disturbance
shag: breeding success at locations with varying levels of access
stonechat: settlement and breeding success at sites with different levels of access (existing visitor pressure models for Dorset and the Thames Basin could be used as a measure of disturbance)
tree pipit: : settlement and breeding success at sites with different levels of access (existing visitor pressure models for Dorset and the Thames Basin could be used as a measure of disturbance)
white-fronted goose: : patterns of use of marshes during the winter according to disturbance, distance from roads etc
whooper swan: : patterns of use of marshes during the winter according to disturbance, distance from roads etc

Ornithological work: behavioural responses
Distances at which incubating birds leave the nest when approached by different group sizes, types of disturbance and at different locations.
Distances at which foraging birds react to disturbance, collected for different species, at different locations, in different weather conditions etc.

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