Appendices – Biodiversity (Mr Guy Stone)

(Inquiries Procedure (England & Wales) Rules 2004)

January 2022

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158454-ARC-ZZ-ZZZ-REP-ENV-000008 - Technical Note – Biodiversity Net Gain Assessment updated TWAO boundary

CAMBRIDGE SOUTH INFRASTRUCTURE ENHANCEMENTS

Technical Note – Biodiversity Net Gain Assessment updated TWAO boundary

Document Ref: 158454-ARC-ZZ-ZZZ-REP-ENV-000008 - Technical Note – Biodiversity Net Gain Assessment updated TWAO boundary.

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Biodiversity

1.1 Introduction

Arcadis Consulting (UK) Limited ('Arcadis') was commissioned by Network Rail Infrastructure Limited ('the Client') to carry out a Biodiversity Net Gain (BNG) assessment for the Cambridge South Infrastructure Enhancements Project (the proposed Development).

1.2 Purpose of report

The purpose of this technical note is to demonstrate the steps taken by Arcadis and Network Rail to achieve maximum possible biodiversity net gain on the site.

1.3 Site description

The site is situated within the County of Cambridgeshire, within the administrative boundaries of Cambridge City Council, Trumpington Ward and South Cambridgeshire District Council. The proposed Development comprises the construction of a new railway station with four island passenger platforms, a two-storey station building with space for ticket vending machines, automatic ticket barriers, station forecourt, main footbridge and stairs. There would be step-free access with two lifts on each platform covered by canopies. In addition, there would be taxi and passenger drop-off facilities, cycle parking, pedestrian and cycle paths into the station. The station is proposed to be built out in phases, whilst maintaining a live operational railway. The proposed Development would also incorporate some improvements to Shepreth Branch Junction and a new connection between existing lines at Hills Road. Space for 1,000 cycles arranged on both sides of the railway is proposed and includes a variety of "Sheffield stands", two-tier racks and parking for non-standard cycles. The precise location of the cycle stands would be finalised during detailed design of the station.

1.4 Methodology

The full details of the assessment can be found within the Cambridge South Infrastructure Enhancements Environmental Statement Volume 3: Technical Appendix 8.10 – Biodiversity Net Gain Assessment (document number: 158454-ARC-00-ZZ-STA-EEN-000022)

All versions of the metric were calculated using the Defra Biodiversity Metric 2.0 (Ref 1).

Extended Phase 1 habitat surveys were undertaken during May 2019 and updated in October 2020 and July 2021 to determine the extent and types of habitats present on-site. The Phase 1 habitat types were then converted into the habitat types used in the UK Habitat (UKHab) Classification System. The Phase 1 survey data also informed the condition assessments, which were supported by the habitat condition assessment sheet provided for UKHab habitat types within the Technical Supplement. This data was then used to calculate the number of biodiversity units provided by each habitat currently within the site boundary by using the Defra Biodiversity Metric 2.0. The resulting value represents the baseline condition of the site in terms of biodiversity units.

The site was reassessed for the post-development conditions using the same method; however, the post-development habitats were informed by the Development as shown in the Indicative Landscape Plan (158454-LMS-ZZ-ZZZ-DRG-LEP-000001 to LMS-ZZ-ZZZ-DRG-LEP-000015). Additional risk factors for difficulty of creating or restoring a habitat and temporal risk are predefined within the Metric tool.

1.5 Previous Metric Submissions

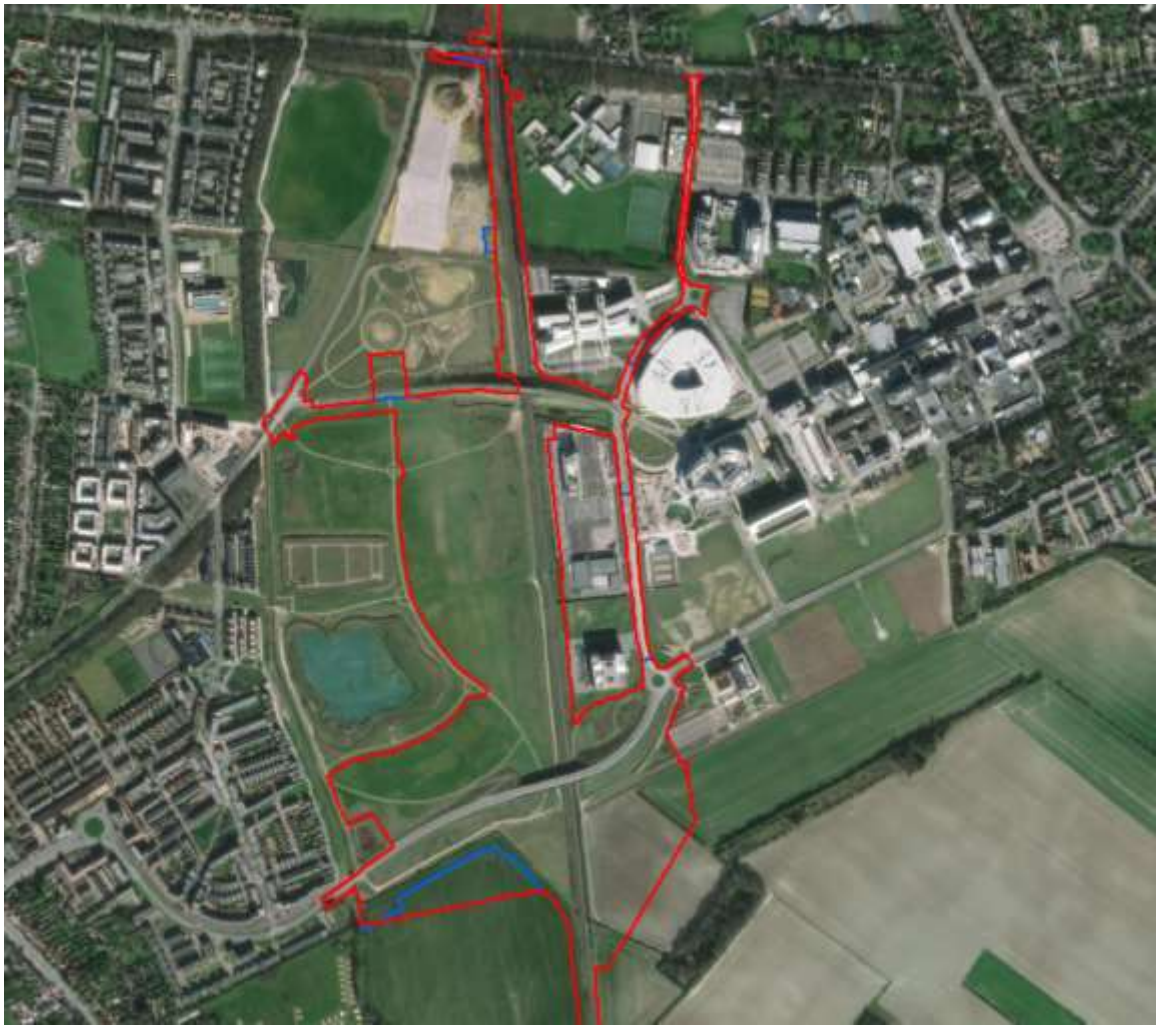
Several versions of the metric calculation have been previously provided to Network Rail. These are presented in the initial version of the Biodiversity Net Gain Assessment Technical Note 'Technical Note - Biodiversity Net Gain Assessment' (Issued April 2021).

These included iterations of the design which involved large areas of Hobson's Park being used for spoil storage and sorting, as well as versions which excluded spoil storage from this location.

1.5.1 Version 5 - Metric with Exchange land

The most recent previous submission of the calculation (Version 5), presented in Image 1 below, assumed spoil would be stored off-site, and so this area retained as undisturbed habitat. It also considered a change in the site boundary to compensate for the loss of land from Hobson's Park for the new station. The new proposed area comprised neutral grassland, woodland planting and a pond.

Image 1. Change to Site Boundary (Blue - previous site boundary, Red - current site boundary)



This version resulted in a percentage decrease in habitat units on-site post-development, with a finial habitat loss of -5.24%.

Image 2 BNG results for version 5

On-site post-intervention (Including habitat retention, creation, enhancement & succession)	Habitat units	231.48
	Hedgerow units	5.36
	River units	6.69
Off-site baseline	Habitat units	0.00
	Hedgerow units	0.00
	River units	0.00
Off-site post-intervention (Including habitat retention, creation, enhancement & succession)	Habitat units	0.00
	Hedgerow units	0.00
	River units	0.00
Total net unit change (including all on-site & off-site habitat retention/creation)	Habitat units	-12.80
	Hedgerow units	0.53
	River units	0.61
Total net % change (including all on-site & off-site habitat creation + retained habitats)	Habitat units	-5.24%
	Hedgerow units	10.91%
	River units	10.11%

1.6 Current Metric Submissions

The metric was recalculated following an update to the Phase 1 habitat survey for the baseline, and a change to the design for the proposals. Post-development habitats were calculated in two different scenarios. Version 6 included the spoil being stored on-site within Hobson's Park. Version 7 included this spoil being stored off-site beyond the site boundary and therefore excluded from the calculations.

For both calculations, the baseline habitats were updated from Version 5, based on the results of the updated Phase 1 habitat survey, and the red line boundary as established for Version 5.

1.6.1 Version 6 – spoil retained on-site

Updated Phase 1 habitat survey results were used to determine the baseline biodiversity units on-site. Landscape design plans were used to determine the post-development habitats.

This version of the metric assumed that the spoil would be stored on-site within Hobson's Park, an area of neutral grassland and woodland planting. 3.77 ha of this habitat would be reinstated following construction; however, the use of this area results in a large decrease in post-development on-site habitat units (-15.93%).

Hedgerow units on-site increased by 19.58%, largely due to the creation of several new biodiverse hedgerows. River units also increased by 10.11% as in Version 5, this is due to the proposed enhancement of a section of the river, described in more detail in Technical Note - Biodiversity Net Gain Assessment (April 2021).

Image 3 BNG result for version 6

On-site baseline	Habitat units	246.26
	Hedgerow units	11.07
	River units	6.07
On-site post-intervention (Including habitat retention, creation, enhancement & succession)	Habitat units	207.02
	Hedgerow units	13.24
	River units	6.69
Off-site baseline	Habitat units	0.00
	Hedgerow units	0.00
	River units	0.00
Off-site post-intervention (Including habitat retention, creation, enhancement & succession)	Habitat units	0.00
	Hedgerow units	0.00
	River units	0.00
Total net unit change (including all on-site & off-site habitat retention/creation)	Habitat units	-39.24
	Hedgerow units	2.17
	River units	0.61
Total net % change (including all on-site & off-site habitat creation + retained habitats)	Habitat units	-15.93%
	Hedgerow units	19.58%
	River units	10.11%

1.6.2 Version 7 – spoil moved off-site

This version of the Metric was consistent with Version 6, except that it accounted for the storage of the spoil off-site. This resulted in the retention of 3.77 ha of neutral grassland within Hobson's Park. The percentage decrease in habitat units on-site post-development would be 7.57%, with a loss of 18.64 habitat units.

Image 4 BNG result for version 7

On-site baseline	Habitat units	246.26
	Hedgerow units	11.07
	River units	6.07
On-site post-intervention (Including habitat retention, creation, enhancement & succession)	Habitat units	227.62
	Hedgerow units	13.24
	River units	6.69
Off-site baseline	Habitat units	0.00
	Hedgerow units	0.00
	River units	0.00
Off-site post-intervention (Including habitat retention, creation, enhancement & succession)	Habitat units	0.00
	Hedgerow units	0.00
	River units	0.00
Total net unit change (including all on-site & off-site habitat retention/creation)	Habitat units	-18.64
	Hedgerow units	2.17
	River units	0.61
Total net % change (including all on-site & off-site habitat creation + retained habitats)	Habitat units	-7.57%
	Hedgerow units	19.58%
	River units	10.11%

1.7 Conclusion

Although, a net loss for area-based habitats has been calculated, the proposed Development has committed to achieving 10% net gain. The calculations will be reviewed again at detailed design stage and the assessment will be refined further. In order to secure 10%, a combination of the following options will be explored:

- The purchasing of additional land to provide space to build new habitat;
- Purchasing biodiversity units from 3rd party organisations; or
- Working with 3rd parties such as local authorities, trusts, etc. to deliver biodiversity units on their land.

References

Reference	Title
Ref 1	The Biodiversity Metric 2.0 (JP029) 2019. Available at http://publications.naturalengland.org.uk/publication/5850908674228224 Accessed 19.1.21

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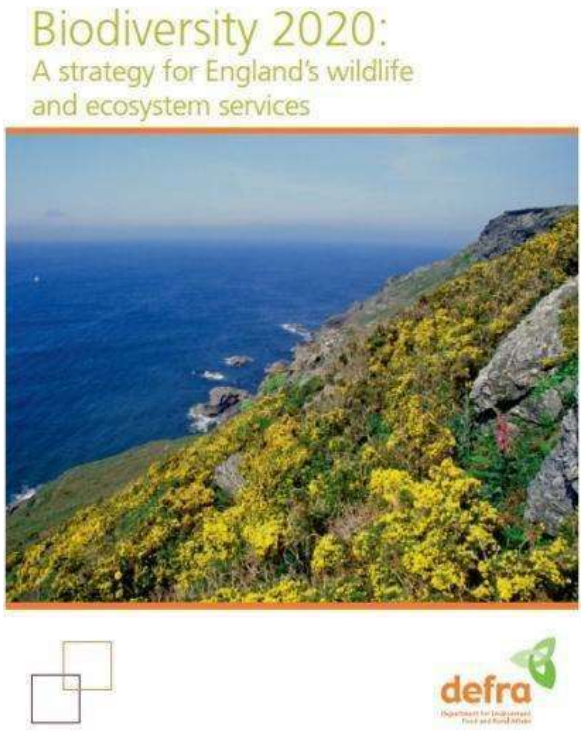
Appendix B

Natural England's The Mosaic Approach: Managing Habitats for Species (2013)

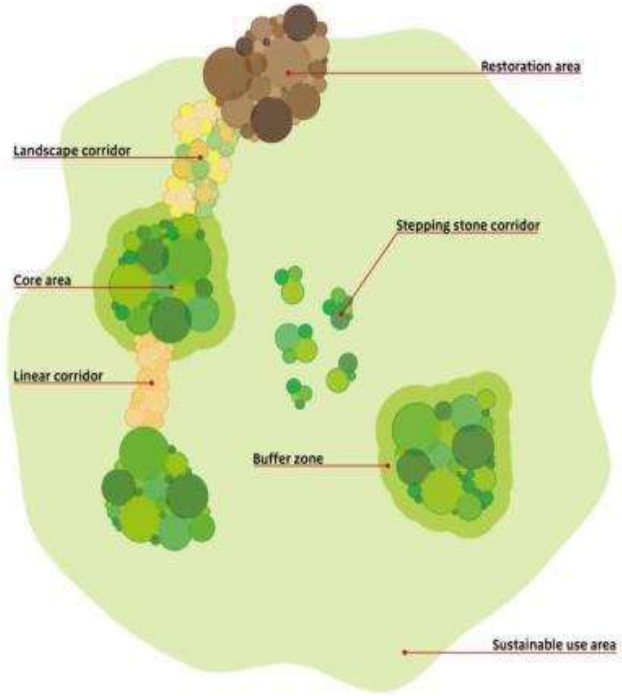

The
Mosaic
Approach
Integrating the requirements of species into habitat management

Why is a new approach needed?



A core element of *Biodiversity 2020* is a shift in emphasis towards a more integrated and large-scale approach to the conservation of biodiversity.

This will primarily involve the establishment of a resilient ecological network within the landscape, as recommended in *Making space for Nature*.



Amongst other things, this will require an effort to improve the quality of priority habitats. This will include increasing their structural diversity so that they support a wider range of species ...

... and are more resilient to climate and other environmental change.

A species-specific approach has been successful in improving the fortunes of a small number of species, such as the large blue butterfly and the cirl bunting.

However, it is not feasible to take this approach with every declining species.

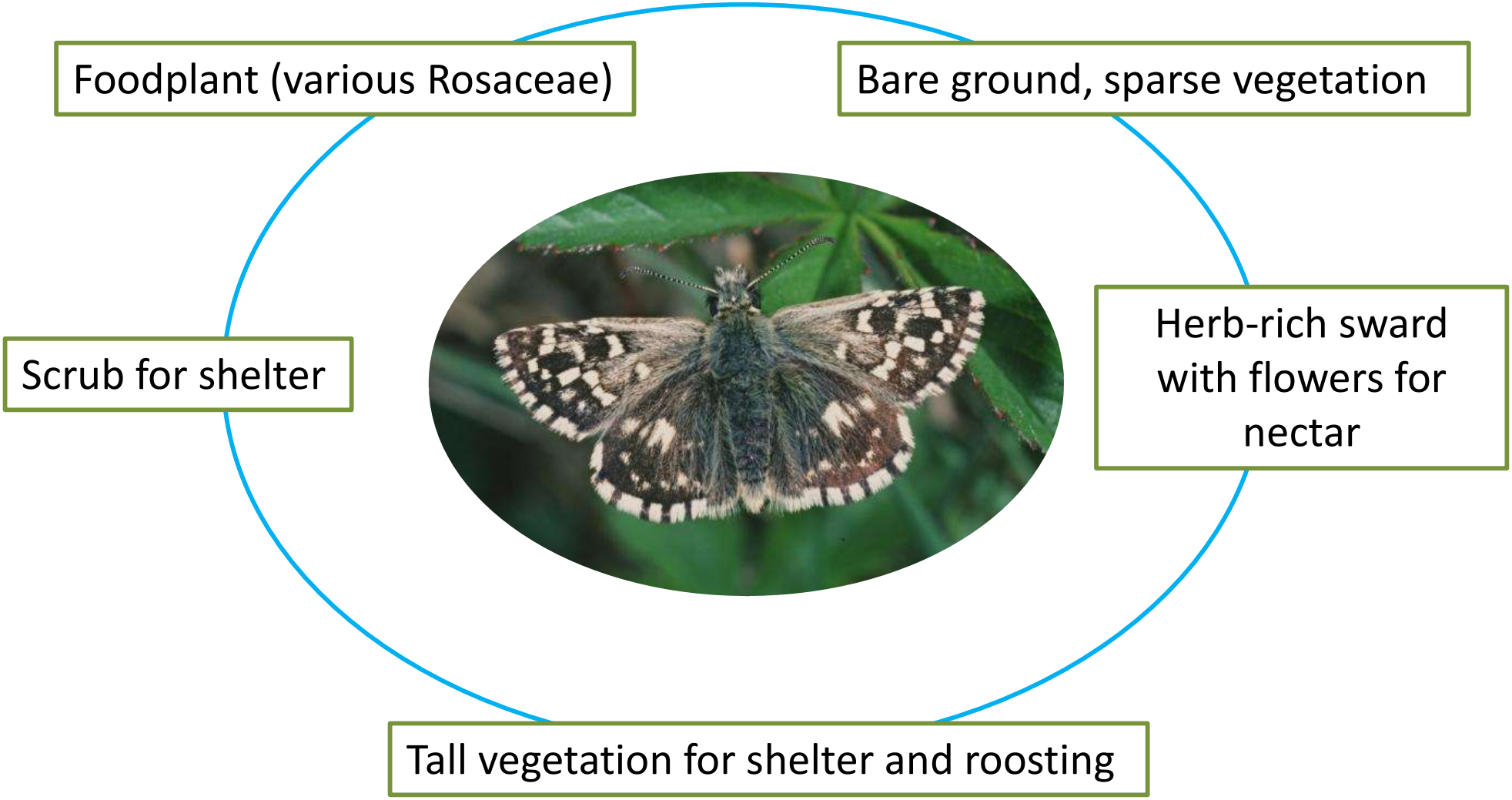
So what is the Mosaic Approach?

It is simply a way of looking at habitats, and their management, that focuses on the requirements of species.

And, as you will see, habitat mosaics play an important part in this.

The Mosaic Approach does not replace the species-specific approach, it complements it.

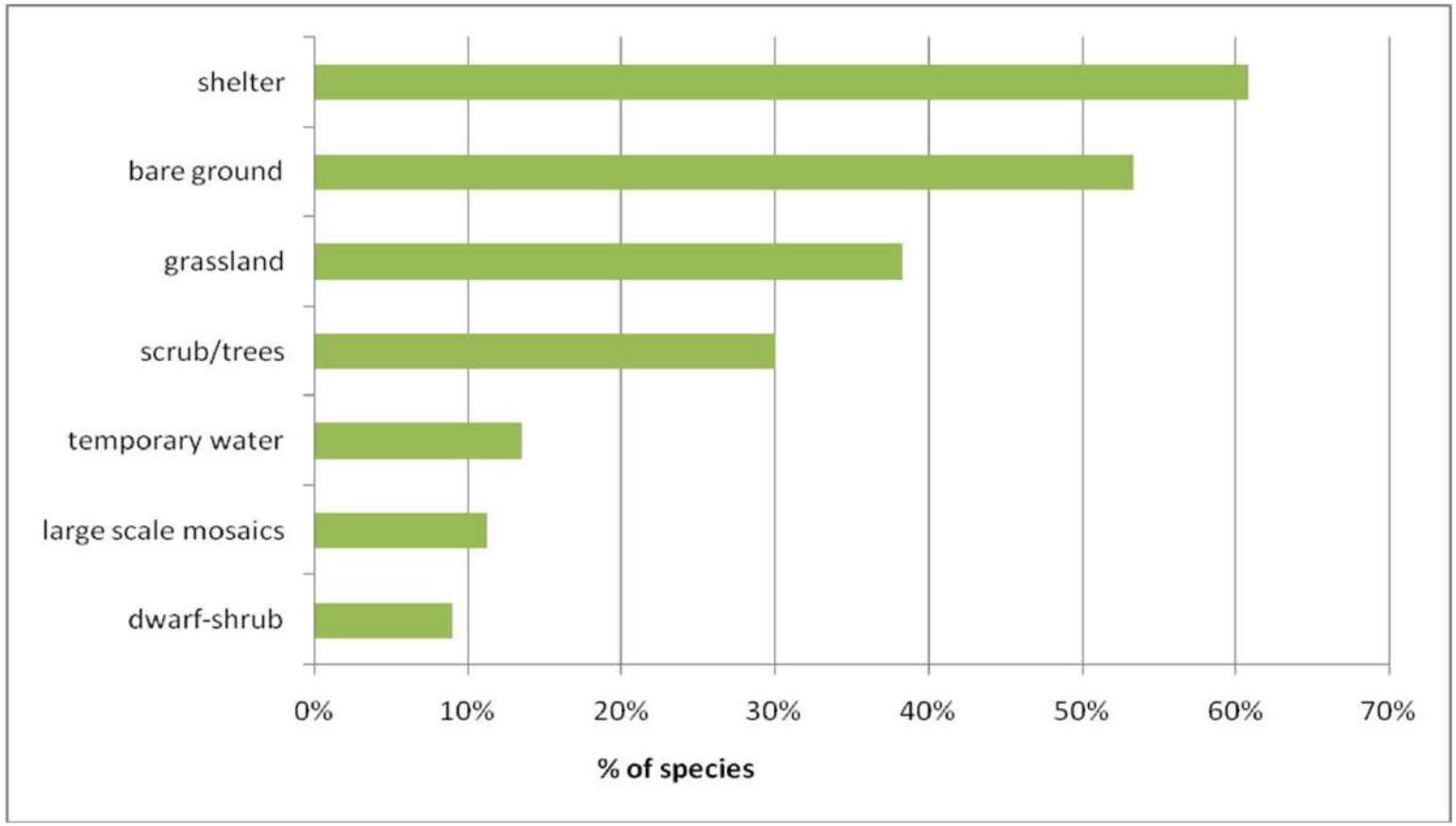
Every species has a particular set of requirements:



An analysis of the requirements of a suite of priority species showed that the conservation needs of almost **three quarters** of them can be met by carefully managing their habitats to create the conditions that they require.

Managing for species: Integrating the needs of England's priority species into habitat management

For priority species that are found on heathland, these are the most frequently required elements of the habitat.



The Mosaic Approach therefore focuses on these **key elements**.

Each of the priority habitats has its own set of key elements and these are described in separate habitat guides.

Here we concentrate on the more important ones. They are key elements across a range of habitats.

We also explain the **factors** that determine the key elements.

These are:

ECOLOGICAL PROCESSES
SCALE
TOPOGRAPHY
SOIL/AIR/WATER QUALITY
TIME

ECOLOGICAL PROCESSES

These are the processes that influence change in a habitat, and here we are concerned with just two; **disturbance** and **succession**.

For any habitat there is usually some form of occasional disturbance that affects it and often defines it.

For example, water flow in a river scours away banks and re-deposits sediment. Other examples include fire, windblow, grazing or browsing by animals, and any management by people.

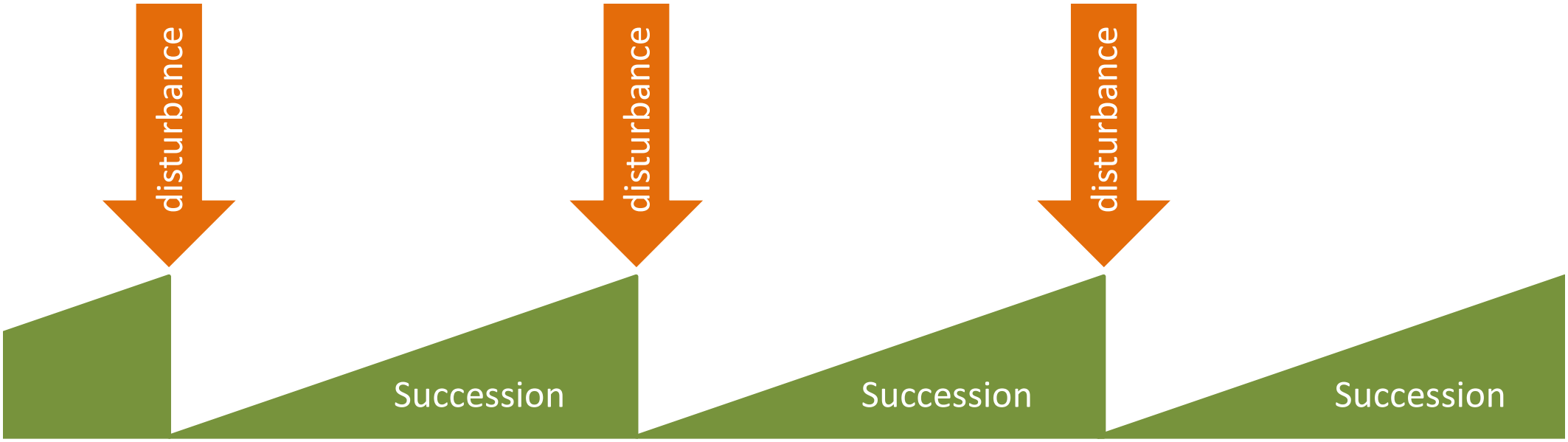




Of course, disturbance also has the potential to be damaging to biodiversity. Overgrazing, excessive water-course management, and fire on blanket bogs are examples. Some forms of disturbance therefore need be controlled, whereas others, such as inundation by the sea on a saltmarsh, do not.

Being clear about what form the disturbance takes, how extensive it is, and whether or not its effects are beneficial, is critical to getting the right outcome on a site.

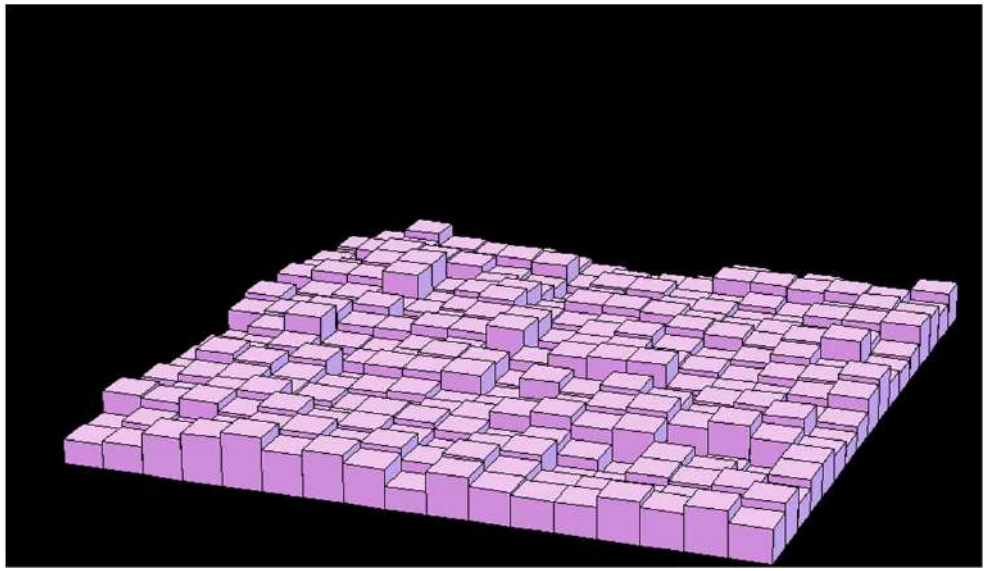
Disturbance events are followed by stable periods during which succession occurs. This continues until the next disturbance event.



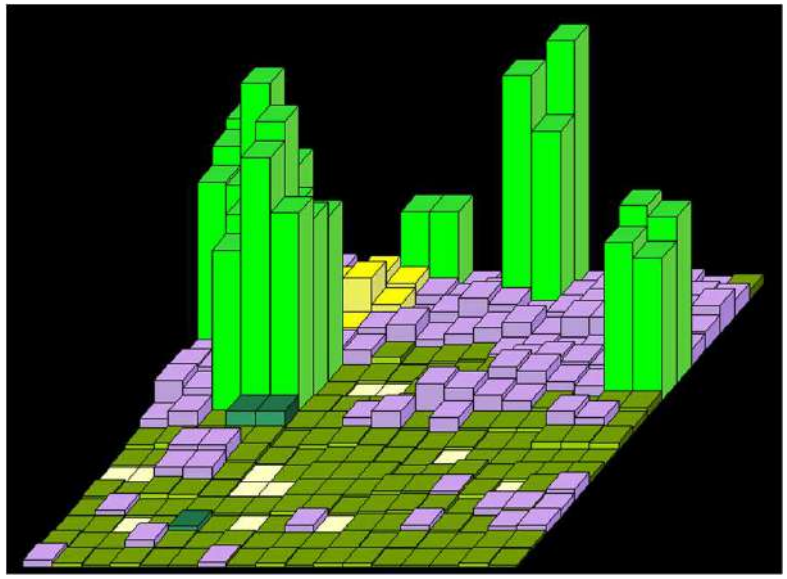
This alternation of occasional disturbance and succession leads to an intimate mix of structures in the habitat, or **structural variation**.

Structural variation

Few species, if any, require an extensive landscape that is homogenous in terms of vegetation composition and structure.



Homogenous



Structural variation

A landscape containing a varied plant structure, ranging from tall trees through layers of scrub to herbs and grasses, will provide a wider range of micro-environments, which in turn can be utilised by a greater diversity of species.

In general, more structural variation will benefit more species, although the exact nature of the structure will vary from habitat to habitat.

For example, in grasslands, species benefit when tussocks, tangled herb growth, plentiful flowers and areas of scrub are found ...

... and in woodland, species benefit from glades, dead and decaying wood, and the presence of trees of different species and ages.

Structural variation occurs at different SCALES in the landscape. Some species require a minimum size of habitat. This is particularly true for mammals and birds, which tend to require a range of different habitats in a **large-scale mosaic**.

Other species will require some form of small-scale mosaic, within which the key elements are:

- **Bare ground and early-succession habitats**
- **Shelter**
- **Ecotones**.

Large-scale mosaic

Landscapes that have a number of different habitats in close proximity tend to support more species than do more uniform landscapes.

Many highly mobile terrestrial species such as birds, mammals and amphibians require a large-scale mosaic of priority and non-priority habitats.

They require some types of habitat to breed, nest or roost in, and others in which to feed and forage.

Some species require physical links between habitats, so connecting corridors and networks will be of benefit. For others, the closer that sites are together the better it is for dispersal. This applies also to many species living in a small-scale mosaic.

Bare ground and early-succession habitats

Bare ground is very important for many species, but it is often overlooked.

Bare, loosely friable, freely draining soil (e.g. sand and chalk), where repeated disturbance removes vegetation, is critical for numerous species.

Many invertebrates, bryophytes and flowering plants require it for all or part of their life cycle.

Bare ground also includes pebbles, exposed rock, and usually has a scatter of early-colonising plants, many of which provide critical resources such as nectar and pollen.

A lot of apparently bare ground is not actually bare at all but contains carpets of lichens and mosses, which are also a beneficial feature.

The proximity of disturbed areas of bare ground to taller vegetation is also important, as small, sheltered bays can provide a habitat for many heat-loving species.

In wetlands bare ground includes mud, leaf and twig litter in drawdown zones, exposed riverine sand and shingle, and in saltmarshes, open silty areas.

Shelter

Either with or without bare ground, shelter is a requirement of many species. In sheltered conditions a habitat is exposed to sunlight but sheltered from the wind.

Shelter is often provided by scrub as an element of structural variation.

However, it is also influenced by TOPOGRAPHY. For example, many species are associated with soft rock cliffs due to the shelter that they provide, rather than because of any other specific habitat requirement.

Ecotones

An ecotone is the transition between two or more patches of habitat, such as woodland and grassland.

Ecotones appear as either a gradual blending of the two communities across a broad area, or as a more immediate transition, with a much sharper boundary line between habitat types. The latter, which is less beneficial, is often encouraged by management practices that treat the two habitats separately.

However, the broader the ecotone the greater the variety of micro-environments it will contain, which in turn will accommodate a greater diversity of species.

Ecotones can be found across the landscape from high moorland to coastal grazing marsh, in both terrestrial and freshwater habitats, and at different SCALES.

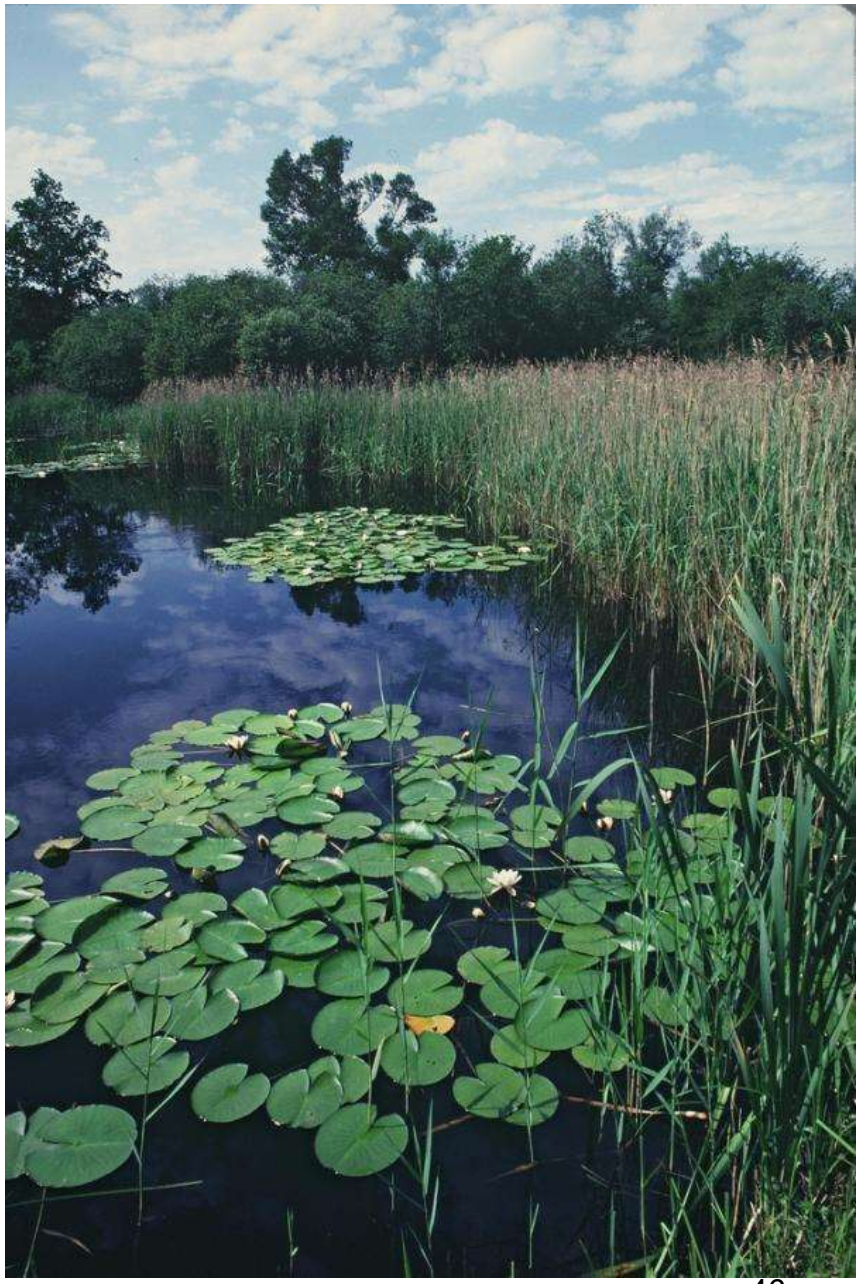
In addition to bare ground, shelter and ecotones, other habitat elements that are examples of structural variation include **scrub and scattered trees**, a range of grassland **sward types**, and **glades and rides in woodland**.

WATER/SOIL/AIR QUALITY

The underlying quality of the soil, air or water strongly affects habitat quality in both terrestrial and aquatic environments.

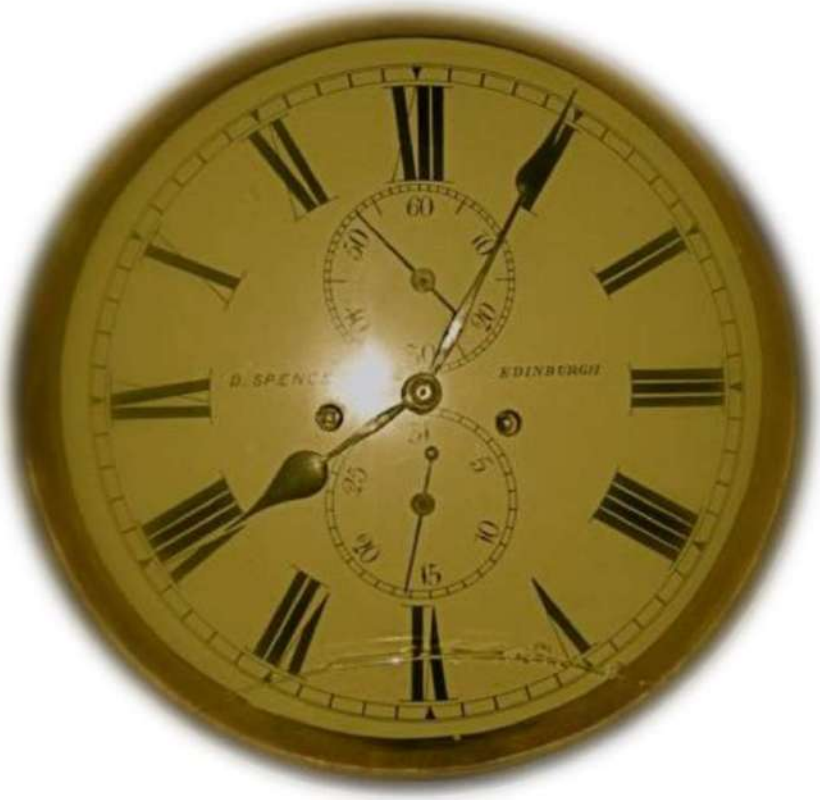
In both instances, enhanced nutrient inputs, such as from agricultural fertiliser, ammonia and nitrous oxides, will generally have a detrimental effect on biodiversity.

The availability of water and the naturalness of the hydrological regime are also important for the sustainability of many habitats.



Examples of associated habitat elements include the **high water quality** required by many freshwater species, the **low nutrient levels** that contribute to sward structure in grassland, and the **clean air** demanded by many lichens.

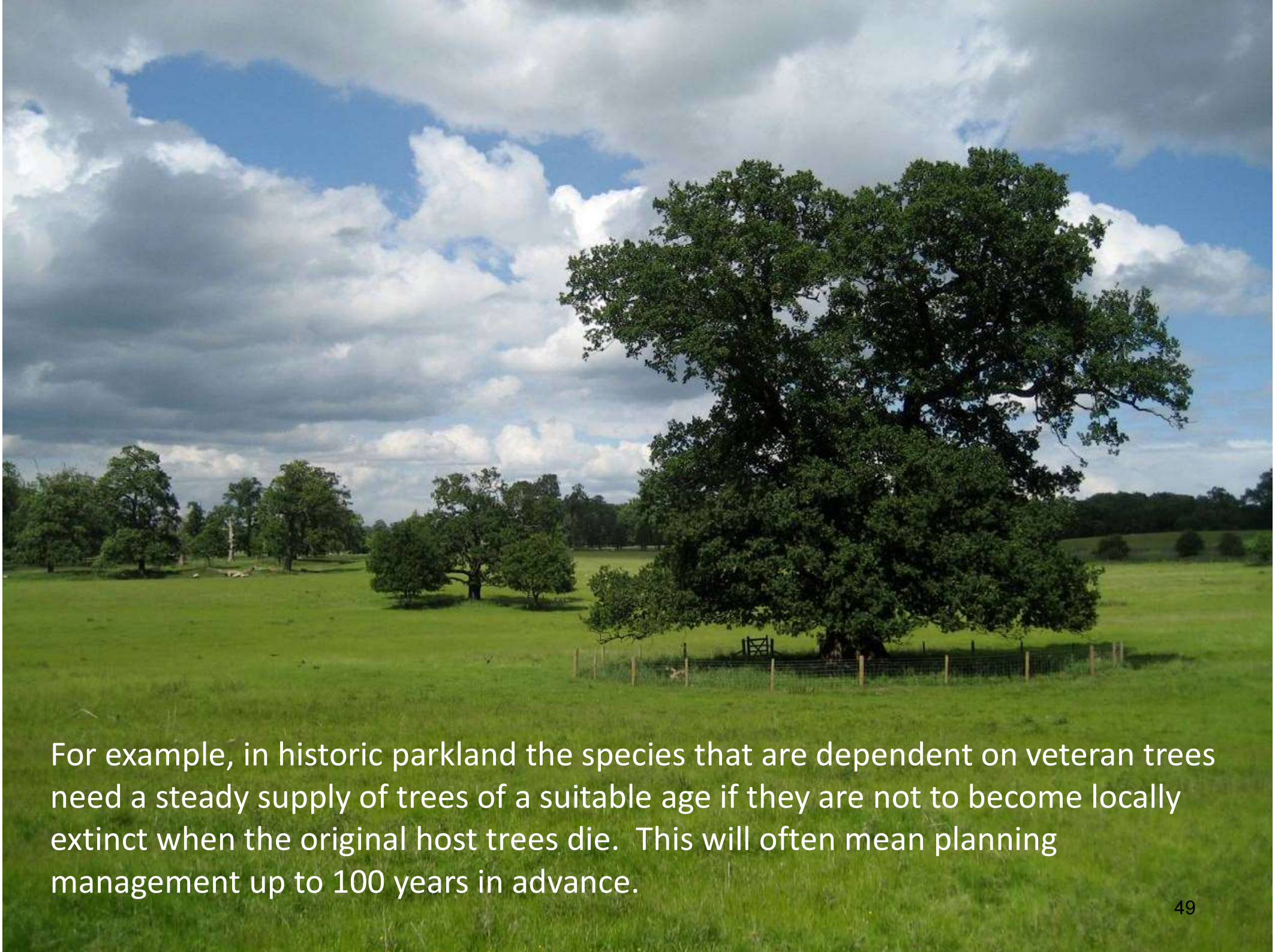
TIME



It takes time for a habitat to develop a range of elements. Some may emerge quickly while others may take decades or even hundreds of years.

It is important to remember this when considering the future management of a habitat.

Over time the mix of habitats in a landscape can and will change. However, habitats that have been present for a long time can be extremely important, especially to species that are not very mobile. Some elements of such habitats therefore need to be maintained in the long term.



For example, in historic parkland the species that are dependent on veteran trees need a steady supply of trees of a suitable age if they are not to become locally extinct when the original host trees die. This will often mean planning management up to 100 years in advance.

Important points to remember

In summary, the ECOLOGICAL PROCESSES of disturbance and succession lead to structural variation that can be found in **large-scale mosaics** and in small-scale mosaics, within which the key elements are **bare ground**, **shelter** and **ecotones**. These are the most important, but each priority habitat will have its own key elements.

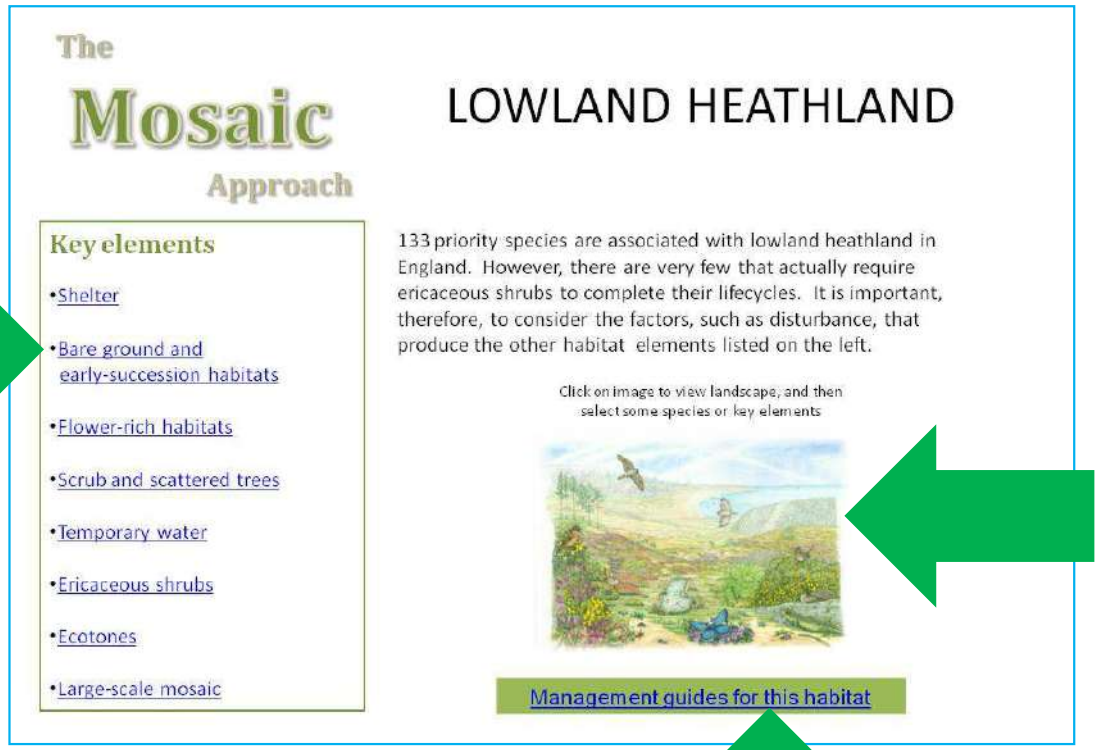
Don't forget that WATER/SOIL/AIR QUALITY, TOPOGRAPHY, SCALE, and TIME are all factors that influence the elements of a habitat.

Where next?

There is a series of guides, which each illustrate the Mosaic Approach in a different habitat.

How to use the habitat guides

The guides are interactive. You can enter them as shown on the example below, or simply scroll through the entire guide.



Go to the key elements of the habitat.

View an idealised landscape of the habitat, and then click on some of the species and/or elements shown in it.

Go to the management guides for the habitat.

Practical application of the Mosaic Approach

The habitat guides are not intended to be comprehensive guides to the management of the habitat. They simply illustrate the key elements that will benefit many priority species. However, each guide does contain links to existing management guidance.

Although key elements can be created in a variety of ways, often it may be sufficient to be more tolerant of those elements, such as bare ground and scrub, that are already present on a site. Similarly, it may often be better not to be too prescriptive, but instead allow mosaics to develop naturally through the interplay of ecological processes and the other factors.

Where does this leave a species-specific approach?

The Mosaic Approach can cater for around three quarters of priority species. However, although the remaining species will use elements within a mosaic, they all have more specific ecological requirements and/or limiting factors. This means that a more tailored approach to the management of their habitat is necessary.

A species-specific approach should therefore continue alongside the Mosaic Approach. The two approaches will complement each other.

Finally, remember that the Mosaic Approach is about integrating the requirements of species into habitat management. It is not intended to cover every aspect of habitat management, but it should be an important part of it.

Links

Biodiversity 2020

Making space for Nature (after opening this document you may need to exit the slideshow before being able to view it)

Acknowledgements

The landscape paintings in the habitat guides are by Lizzie Harper.

The photographs in this introduction are from the Natural England collection or have been provided by:

Isabel Alonso
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Chris Gibson
Robert Goodison
Roger Key
Tony Robinson
Peter Roworth
Nigel Russell
Jon Webb

Appendix C

English Nature Research Report 649. Dogs, access and nature conservation

ENGLISH NATURE

Report Number
649

Dogs, access and nature conservation

English Nature Research Reports

working today
for nature tomorrow

3 Dogs and birds

3.1 Key points

3.1.1 Effects on breeding birds

- **The research suggests fewer pairs of breeding birds settle in areas with high disturbance levels where dogs are present in the disturbance zone.**
- **All the breeding birds affected are ground nesting.**
- **There were significant increases in breeding success of a beach environment when dogs (but not other recreational activity) were managed showing that dogs can have a significant effect.**
- **Lekking bird species could be significantly affected by dogs and human visitors but no relevant research has been found for British species.**
- **Dogs, especially those off a lead, stimulate a greater behavioural response than walkers, and for some species, also than joggers. Only Eurasian dotterel shows no effects.**
- **The increased levels of opportunistic predation associated with corvids in particular would appear to be the greatest risk resulting from disturbance.**
- **Dogs consistently flushed ground-nesting birds off their nests earlier and for longer than recreational disturbance. Eggs are more readily taken from waders and nightjar, but woodlarks suffered greater predation of chicks than eggs.**
- **Most diurnal predators are aerial and nocturnal ones are terrestrial. Dogs are mostly daytime visitors. Thus the reaction to an intruding dog exposes the bird to aerial predators.**
- **Some non wading bird species have not been shown to be sensitive to disturbance by dogs; these include the American blackbird (a shrub-nesting species), a lark and a sparrow species (both ground nesting) in forest and meadows respectively in the United States. However, European blackbirds were affected by disturbance in Spain, and dog walking was part of the activities. However, in none of these studies was breeding success studied.**
- **Marsh harriers affected by disturbance by walkers and dogs produced less fit young, although there were no detectable behavioural responses. This effect needs to be researched for other species.**
- **More species need to be investigated, especially ground nesting ones like skylark.**
- **It is possible that the disturbance effect will increase in proportion to the number of visitors plus their dogs, and proximity to the bird or its nest. This has been found for walkers for two coastal nesting birds, but not tested directly for dog activity.**

3.1.2 Wintering birds

- **Dogs can have a greater effect on wintering birds, than walkers or, for some species, joggers.**
- **Different species seem to be more tolerant of approach than others, with distances at which a disturbance reaction occurs differing widely.**
- **For one species this response distance is half that of the birds in the breeding season.**

- **The research has focused on waders, and some wildfowl. None addresses any effects or impacts of dogs for other birds. Since ground nesting birds have been found to be most vulnerable, these might be expected to be equally susceptible in winter.**
- **There is no clear impact identified at the population level but there are a number of suggestions that birds have vacated sites when disturbance became too great. Generally these do not separate out dogs as a factor, although they are present on many sites.**
- **Since the reaction to dogs by wading birds has shown more flushing, longer absences from the nest, and greater reductions in feeding time, then it follows that if birds have abandoned sites, this could be attributed more to dogs than other activities if both are present, and in significant numbers.**
- **A reaction to dogs has an energy cost, which is particularly important in winter if resource acquisition is limited, or if winter conditions are particularly severe. Compensatory feeding is found in some species, for example, at night.**
- **Whether dogs impact on species or not will depend on the habitat involved (because of their effect on patterns of human behaviour), the numbers of dogs, frequency of disturbance, the sensitivity of the species and bird condition.**

3.2 Introduction

There has been very little experimental research into the effects of dogs compared with other forms of disturbance on wildlife in general or birds in particular. Only two studies have been found that use dogs as the experimental treatment and compare this with other disturbance activities (Miller and others 2001, Lord and others 2001), but there are others that have measured the levels of use on sites where dogs, or walkers with dogs, have been counted, and the impacts have been described and evaluated. Some of these also differentiate between whether dogs are on or off a lead.

The range of research on dogs and disturbance is limited.

Most of these studies relate to the effects of dogs, compared with other user groups, on birds, both on breeding and wintering species, and the work is concentrated in, but not exclusive to, North America.

One aspect that these studies do not cover is the potential for a disturbance effect or impact on birds to be related not just to an individual dog and walker and their distance from the species or its nest, but to a variation in numbers. Beale and Monaghan (2004) for example, although not mentioning dogs, tested the hypothesis that human disturbance effects would be increased with increasing numbers of visitors, and decrease with distance from a nest.

It is important to consider disturbance levels and proximity to birds as interrelated variables.

They found this to be true for breeding colonies of kittiwakes[2] and guillemots having taken other factors affecting breeding success into consideration. Both suffered decreased breeding success with higher numbers of visitors that also came closest to the nests. Importantly, this study did not show any behavioural responses that were recorded in relation to the levels of disturbance.

This combination of numbers and distance needs to be separated out from issues related to sites that are regularly or infrequently disturbed, which sometimes show the opposite effect. For example, grey herons at a fish farm reacted more strongly to infrequent severe disturbances than to where disturbance was less severe but more regular (Draulans and van Vessem 1985).

[2] Scientific names of species mentioned in the text are provided in Appendix 1

There is the potential for dogs to affect birds in a number of ways. Effects in the breeding season need to be separated from those in the non-breeding period. It is also important to identify when in the breeding season any effects are recorded. These could relate to:

- the territory, nest site selection, or nest building period;
- egg laying/incubation period;
- the nestling phase; and
- when fledglings are present.

Breeding birds could be affected at all or any of these stages in the breeding cycle, but impacts could differ between them since, for example, it has been shown that the further the birds are into the breeding season, the less likely they are to desert their eggs or young (Myrberget 1983).

The further birds are into the breeding season, the less likely they are to desert their eggs or young.

In addition, different bird species could be differentially susceptible to effects of dogs. It is well known for example, that the breeding Eurasian curlew is one of the most sensitive species to disturbance, flying up at distances of up to a kilometre from the intruder (van der Zande and others 1984). On the other hand birds such as grouse and dotterel sit tight on eggs until the last moment. What is not clear, however, is whether this difference in behaviour results in different degrees of impacts of disturbance based on the theoretical exposition outlined above, whether a dog is present or not.

However, the research available does not cover all species equally, nor all the stages in the reproduction cycle identified above. Inferences will need to be made from one to another as a result.

Birds could be affected at any stage of the breeding cycle.

The concern for non-breeding birds, especially those that migrate, relate to the energetic cost of disturbance (Woodfield and Langston 2004). Increased flight or alarming, reduced foraging time, or movements to other sites caused by disturbance by people with or without dogs could all incur an energetic cost. In some cases, such losses could be compensated by alternative strategies such as feeding at night time, or moving to undisturbed sites, provided the feeding resource was sufficiently rich. There could also be an issue of increased predation, as described here for many breeding birds.

If the birds could not replace the extra energy used reacting to disturbance, then their chances of survival may be reduced, or sites traditionally used by the birds could be abandoned (Woodfield and Langston 2004).

Energetic costs of disturbance are the key concern for wintering birds.

Another difficulty with the literature is the measurement of disturbance. This differs between studies and makes comparisons between studies, and inferences from them to others and to practical site management issues difficult as well. Furthermore, it is important to distinguish the significance of the effects recorded.

In many studies general disturbance is identified as having an effect on the birds in question. Only in a very few is the significance of this modelled or assessed at the population level either for the site in question, or for a region of the country.

Disturbance is measured variably making it is difficult to compare across studies. Effects at population level have been studied in very few species.

However, Sime (1999) states that despite this, "*even at the individual scale, impacts should not be summarily dismissed as insignificant, particularly in the light of the limited information available at*

present". One reason given by Sime for this is that the visitor often places great value on the individual rather than the population, whereas the manager may be more concerned about the longer term population of a species. Both levels of analysis, she submits, are warranted. This is also important when the nature conservation value of individual sites is considered. Sites of Special Scientific Interest (SSSIs) or other nature conservation sites are selected for their specific habitats and species, and if they lose any, or their populations are significantly reduced through disturbance, then the value of sites would also be reduced. This would be contrary to the nature conservation objectives, to government commitments in terms of attaining Biodiversity Action Plan targets, and in achieving favourable condition for SSSIs.

Moreover, as many visitors also wish to see the habitats and species of nature conservation value as part of their recreational experience, the reduction of any at the site level would also affect the value of this.

Even if disturbance does not affect species at the population level, numbers on designated sites are important for conservation and for people to enjoy.

With this background in mind, the following account separates out the effects found in the literature as far as possible between breeding and non-breeding birds.

3.3 Breeding birds

3.3.1 Waders

Golden plover

There are a number of studies where dogs have been highlighted as having a greater effect on breeding birds than walkers without dogs. Yalden and Yalden (1990) studied disturbance effects on breeding golden plover on the Snake Pass moors astride the Pennine Way in the Peak District, Derbyshire. They found that the birds flushed more readily in the pre-incubation period, and when people were within 200m of them. However, this flush distance was consistently greater when a dog was with the walker, as shown in **Table 3.1** below (adapted from Yalden and Yalden 1990).

Table 3.1: Flushing distance of golden plover by dogs or walkers

Dogs present or not	Golden plover flushed 0-9.9m	Golden plover flushes >10m	Total events
Dogs present	37%	63%	27
Dogs not present	68%	32%	69
$\chi 2 = 7.77$, p = 0.006:	Fisher's Exact *p* =	0.01	

Once incubating, golden plovers remained on the nest 96% of the time in which they were disturbed (as detected using temperature probes in the nests), but would have incubated for 98% of the time if undisturbed.

During this phase, they were flushed more readily from the nest by dogs (8 out of 13 disturbances for 6 nests) than by people without dogs, and took longer to resume incubation if people or dogs were present, compared with returning to incubate after, for example, feeding.

Flushing distance when birds re-settle is greater when a visitor has a dog, than for an unaccompanied walker.

Very young chicks are very vulnerable to death through a number of causes, according to Yalden and Yalden (1990), but older ones are more robust. However, the authors recorded three older chicks as having probably been killed (but not eaten) by dogs.

Yalden and Yalden (1990) conclude that golden plover are most sensitive in the pre-incubation period resulting in avoidance of highly disturbed areas.

Dogs flush incubating birds more than walkers without dogs, and dogs can kill well grown chicks.

This was also found for dunlin by Finney and others (2004) in the same area when they compared the number of dunlin nests before and after the Pennine Way that traversed the study area had been surfaced, and its trampling width reduced from up to 100m to a flagged path.

Breeding pairs increased by 50% after the resurfacing works, and the reduction of the width of the band of disturbance. This disturbance would have been by people and dogs.

Golden plover and dunlin avoid heavily disturbed areas.

Yalden and Yalden (1990) found for golden plover that sitting birds are generally less sensitive or reactive to disturbance. There was also very little evidence in this study of nest predation. However, golden plover's greater sensitivity to dogs than people is a cause of concern. The study area is well-used by visitors (the Pennine Way passes through it), and disturbance occurs throughout the day from 09.30 to 18.30, with about 300 dogs, (60% off leads), using the area during the breeding season. The low hatching success in 1988 (when half the eggs in active nests failed to hatch) could be attributed to these levels of disturbance.

Yalden and Yalden (1990) calculate that the energy cost for the adults of the alarming response to disturbance post hatching might make chick guarding some 15% more expensive than where there is no disturbance (walkers with or without dogs).

In addition, birds breeding close to disturbance moved their broods to quieter areas, but then interacted strongly with the resident pairs there, which would have used up more energy. There are also likely to be costs to the chicks that are in cover rather than feeding during such disturbance, but these could not be calculated.

There were energetic costs of being disturbed, and of moving young away from disturbed areas.

Pearce-Higgins (*in litt*.), using data presented in Pearce-Higgins and Yalden (2003), has updated Yalden and Yalden's studies on the Snake Pass after the Pennine Way had been restored to a flagged path. Of the 22 chicks radio-tagged from 12 broods, two appeared to have been killed by dogs, suffering bruising and bite marks but not being consumed. From these data, a very tentative estimate of the daily survival rate of dog predation has been calculated by dividing the number of chick-days survived, by the number of chick-days observed (excluding instances when chicks died from other causes). The resulting survival rate of 0.9930 suggests that there is a 23% probability of a chick that would otherwise survive to fledging being killed by a dog.

This calculation is based on only a small sample of the dog predation at Snake Summit, which has high use by dog walkers. Although owners are meant to keep their dogs on the lead, 58% do not and 14% were running wild during the breeding season in the study years of 1994-6 (Pearce-Higgins and Yalden 1997). Were dog predation eliminated, the proportion of chicks surviving to fledging of 20.8% at Snake Summit (Pearce-Higgins and Yalden 2003) could increase to 26.7%. This change would increase the modelled population growth rate of 1.02 (Pearce-Higgins and Yalden 2003) to 1.07. This gives a rough indication of the maximum magnitude of any change in breeding success and population trend that may occur as a result of opening up a currently unused site to large numbers of dog walkers.

The loss of potentially 1 in 4 or 1 in 5 chicks to dogs, on top of 'natural' predation levels is very high, but needs more quantitative work to confirm the scale.

Without disturbance golden plover population growth rate would be 1.07, instead of 1.02.

Other plovers

The enhanced effect of dogs compared with humans with no dogs is also noted by Hoopes (1993) (quoted in Sime 1999). In a study of piping plover in the USA in their beach breeding habitat, adults and chicks responded to disturbances for 8% and 15% of their time respectively, but dogs within 50m stopped them feeding for 52% of the time compare with only 31% for humans. Staine and Burger (1994) found a similar decline of 36% of time devoted to feeding and 27% decline in peck rate as a result of human disturbance on piping plover on east coast American beaches, but did not distinguish between the effects of dogs and people.

Hoopes (1993) also found that the response distance was greater for dogs (46m) compared with humans (23m). Hoopes documented a 33% mortality for chicks, but neither the percentage of chicks fledged nor the mean number of chicks per pair were significantly correlated with disturbance rates. Nevertheless, management was recommended that restricted dogs (and off-road vehicles), and provided refuge areas for chicks.

Disturbance of piping plover was greater by dogs than humans, with greater disturbance distances, and resulting in reduced feeding.

Pienkowski (1984) also found that dogs contributed to clutch losses for ringed plovers at Lindisfarne and St Cyrus NNR. A dog was considered to have taken an adult bird, and dogs were deemed to be responsible for the loss of five clutches, and possibly another three (about 5%) out of a total of 172 clutches over two years on three areas. Crows were the major predator, taking 34% of clutches. Pienkowski suggests that the disturbance effect of humans potentially gives a considerable advantage to diurnal predators such as crows or gulls, and that scent trails by humans or dogs to birds or nests can assist nocturnal predators such as foxes, stoats or weasels. Dogs are not singled out, or separated from counts of human disturbance, but Pienkowski found that survival of ringed plovers at Lindisfarne to hatching was highly correlated with the levels of human disturbance (see **Table 3.2** below).

Table 3.2: Nest survival of ringed plover on Lindisfarne in relation to disturbance

Site	Nest survival % 1976	Nest survival % 1977	Distance from car park	Number of human visitors/day
Old Law	43	58	3-4.5km	c.5
Ross Back Sands	21	33	1-2.5	<50
Snook	1.4	2	0-0.7	>100

Adapted from Pienkowski 1984

Pienkowski considered that unintentional disturbance of visitors plus their dogs was more serious than direct loss of eggs. Incubating birds normally left their nest when humans or dogs approached, and the more often this happened, the more opportunities crows had to predate the eggs. Carrion crows were seen using vantage points to watch for movements of disturbed birds. Ringed plovers normally crouch under cover and rely on camouflage when faced with an aerial predator, but are flushed by ground disturbance caused by humans and dogs. Additionally, ground predators are usually nocturnal on Lindisfarne. This means that the crows are provided with an advantage they would not find in undisturbed colonies.

Corvids and gulls are the main opportunistic predators and some can learn to associate recreational activity with feeding opportunities.

An equivalent interaction between visitors and predation has been recorded for black oystercatchers and egg predation by gulls in South Africa, and for dunlin and gulls in Scotland (Summers and Cooper 1977, and Hobson 1972, quoted in Pienkowski 1984), for great crested grebe in the Wadden Sea in Germany by Schulz and Stock (1993) and for great crested grebe in Switzerland (Keller 1989).

A number of other studies have also questioned whether crows or other similar types of diurnal predators are increasing the predation levels. Pearce-Higgins and Yalden (2003) tested this by examining golden plover productivity on a managed grouse moor where crow control is conducted as part of normal moorland management. They found that there was a low level of nest predation by crows and other predators at the Snake Summit in the Peak District, despite its regular use by large numbers of visitors (Pearce-Higgins and Yalden 1997), although survival was compromised by exposure in poor weather and starvation rather than predation. However, those nests that were predated were still largely taken by crows (seven out of eight where eggs were lost).

Predation resulting from disturbance is less where predators are controlled.

A more recent study by Liley (1999) is one of the few that has attempted to model the impact of disturbance on a population, in this case, of ringed plover breeding on the Norfolk coast. Liley counted the number and type of activities along nine kilometres of a beach divided into 120m-long sections from February to August 1996. He found significantly more people, dogs and specified activities (for example sunbathing, picnicking etc.) associated with access points, and thus could describe the beach where the ringed plover colony was nesting as busy, moderately busy or quieter.

Nesting ringed plover avoided sections of the beach where the mean number of walkers (the main user of the beaches in the breeding season) at each counted exceeded 20, and dog presence was more than about two. However, by ringing birds, Liley (1999) found that older birds avoided the more heavily used sections more than younger birds, which he interpreted as a possible learned response. Conversely older birds might be more successful at holding the most suitable (undisturbed) sites, although Liley did not suggest this. Territories were also smaller where there was less disturbance, but territorial behaviour was not affected.

Of all nests, 8.5% were lost to human activity (whilst 33% were lost overall), but dogs were only mentioned as eating one chick. Nest loss was highest on the sections of greatest disturbance from walkers and dogs. Compared with nest loss, chick hatching, survival and chick growth were not affected by visitor use, or by dogs. Disturbance by dogs and people resulted in the parents invoking broken wing displays, whilst aerial predators were mobbed in the air.

Liley (1999) predicted from his model that if the direct loss of nests from human activity were removed, population size would increase by 8%, whilst if all human-related disturbance were removed, the population could increase by 85%, demonstrating that disturbance is constraining the ringed plover numbers. However, the role of dogs in this model was not separated from other disturbance activities.

Disturbance, of which dogs were part, had a major impact on a ringed plover breeding population in one study.

Lafferty (2001a) reports that the western snowy plover in America has been lost from 52 of its former 80 western US coastal nesting sites, and quotes a number of studies suggesting that this is largely due to disturbance by a wide variety of activities including dog walking. He was studying wintering snowy plovers, but noted that they were only half as sensitive to disturbance as breeding ones at Vandenberg Air Force base, where they were disturbed more readily and at double the distance (80m compared with the average of 40m for wintering birds).

Western snowy plovers have vacated a number of breeding sites possibly due to disturbance. Breeding birds shown to be twice as sensitive as wintering ones.

He also notes that breeding snowy plovers deserted a particular beach when it was opened to the public, but continued to winter there for 30 years before abandoning it permanently, coincident with increasing levels of disturbance. Dogs are not mentioned specifically here, but Lafferty studied their effects in more detail on wintering snowy plovers (see below).

The hooded plover has been the subject of disturbance studies in Victoria, Australia by Dowling and Weston (1999). An estimated 2.5 million visitors use the Mornington Peninsula National Park and its 28km of coastline. Dowling and Weston (1999) instigated five different management strategies – no dogs from 09.00 to 17.00 during the breeding season, no dogs at any time, a programme of controlling and educating visitors, no dogs or people, and dogs permitted at all times. Over 7 years, territories and breeding success were checked for 171 nests. 60.2% failed to produce chicks, with 51.2% of nests trampled on beaches where human activity was concentrated. The trial management was found to result in significant differences.

Monitoring the 128 chicks that were found showed that only 27.3% fledged, with the failure believed to be related to the presence of dogs on a site. When dog management was put in place, the chick hatching and pre-fledging survival rates were significantly higher (see **Table 3.3** below). These were the main stages of failure for the hooded plovers where dogs were not managed.

Managing dogs had a very significant effect on breeding success of hooded plover in Australia on a beach habitat.

Table 3.3: Survival Rates under different management regimes

Management	Numbers of clutches monitored	% successful clutches	Mean numbers, fledglings/clutch
No dogs 9.00 to 17.00	82	12.2	0.2
No dogs	5	40.0	0.6
Plover watch (asking people not to use the area)	13	30.8	0.3
No dogs or people	22	36.4	0.7
No restrictions	49	0.0	0.0
Total	**171**	**35**	**0.2**

Source – adapted from Dowling and Weston 1999

Dotterels

Lord and others (2001) studied the impact of human disturbance on nesting northern New Zealand dotterel, which is an endangered shorebird in the country. This study used walking, running (to mimic joggers) or leading a dog as experimental treatments from 200m away to 5m from a nest, and then measured flush distance, length of time parents were off the nest, and distraction display intensity. Efforts were made to minimise the effect of the experiment since the birds are rare, for example, by not applying treatments in wet or windy conditions, and allowing a 2-hour gap between approaches of the test treatment. Nests were tested during early or late incubation. These treatments were tested on beaches in North Island New Zealand with low (0-3 visitors/hour), and high (7-20 visitors/hour) use. Leading a dog proved to cause the greatest disruption of breeding (even though it was muzzled and on a lead):

- the birds were flushed at significantly longer flush distances (mean 93.7m,) when approached by the dog + walker, than the walker or runner (mean distance 64m, $\chi 2 = 7.6$, $p < 0.006$);
- incubation was disrupted for longer (mean 4.8 mins) by dogs + walker, than by the walker or runner (mean 3.4 mins, $\chi 2 = 14.6$, $p < 0.001$);
- incubation was disrupted for longer periods with the dog on beaches that had low visitor numbers.

The study did not measure breeding success but alluded to other studies such as that of Pienkowski (1984), which had suggested increased thermal stress and predation rates resulting from the disturbance found.

New Zealand dotterel more sensitive to dog + walker than walker alone or runner.

It is possible that dogs are seen by waders as predators more than humans, as dogs can catch and kill them. Dogs can find nests through their keen sense of smell, even though the dotterel eggs are very well camouflaged. Lord and others (2001) suggest that free roaming dogs could behave in a much more exploratory manner than a muzzled and leashed one, and therefore engender a much more pronounced response from the birds. As flocks of New Zealand dotterel did not react more strongly to larger groups of people, it is suggested that it is the presence of the dog that has increased the disturbance effect.

Waders may react to dogs as a more threatening potential predator than humans.

Lord and others (2001) did note that birds nesting on busier beaches seem to habituate to disturbance more than those on low use beaches.

This result is not shared by Lafferty (2001a) who found an increased sensitivity with repeated disturbance of snowy plover in California. There could be a difference between breeding birds and migrating species that has not yet been tested.

Evidence for habituation by birds to disturbance is mixed. Some species do exhibit habituation to high levels of disturbance whilst others show an increased sensitivity to disturbance when at high levels.

Watson (1988) studied Eurasian dotterels, in relation to disturbance, on the Cairngorm Plateau. He counted people plus dogs in sectors of the Cairn Gorm as well as dotterel spring densities and breeding success.

Dotterel densities were not correlated with people or dog density, nor with year (the surveys covered the period 1971-80 when visitor use was increasing). Numbers of people varied between 0.1 and 6.8/km^2/count. The number with dogs is not separated in the figures given. Watson attributes the lack of relationship to the fact that dotterel remain on the nest and do not react to disturbance until the last moment when approached (exhibiting a comparable behaviour as grouse). However, Watson did note that crows, which had rarely been seen in the arctic-alpine zone before the 1950s, had increased significantly after 1953 when the first ski facilities were provided. The crows followed the visitors, feeding on picnic scraps, and had been seen to rob a number of nests.

Whitfield and others (in press, quoted in Woodfield and Langston 2004) have corroborated Watson's earlier work on dotterel and found no relationship between nest location, hatching success or post fledging survival and footpath proximity or numbers of people and dogs. They did suspect a dog of taking one clutch, but blamed mammals and birds for the main cause of nest failure, followed by desertion due to snow.

Not all ground nesting waders are equally affected by disturbance. For example, there are no observed effects of disturbance on Eurasian dotterels.

Anecdotal comments

The only other comments found about breeding waders and the impact of dogs are summarised below in **Table 3.4**. These anecdotal reports cannot attribute the lack of dogs specifically to the increases in bird numbers witnessed, but the patterns found are in line with the research findings presented above.

Table 3.4: Anecdotal comments on breeding wader numbers and disturbance with or without dogs

Species	Comment	Source
Breeding waders	3 pairs successful on Dawlish Warren NNR after banned dogs in more remote parts of sand spit. None had bred before	P Chambers pers. comm.
Curlew, dunlin, golden plover	Increased numbers 2001, foot and mouth, Snake Summit, Peak District, birds settling on territories while moor closed. Highest counts of dunlin and curlew since 1972	Questionnaire survey, PAA 2003
Lapwing	Howden Moors, Peak District, declined in 2002, higher 2001 no access	As above
Lapwing	Returned to breed in Ashdown Forest, Sussex, due probably to reduced dog use inside grazed fenced areas, the grazing itself and increased food supply related to grazing.	Marrable 2003

3.3.2 Non-waders

There are few papers where non-wader bird species have been subjected to experimental disturbance involving dogs. However, the effects of dogs are mentioned regularly in the literature, as summarised in **Table 3.5** below.

Table 3.5: Summary of the effects of dog disturbance on other breeding birds

Species	Location	Comment	Source
Blackbird	Spain urban parks	Flushed more by pedestrians and magpies than by dogs, activity levels (eg feeding) of blackbirds decreased, density decreased with higher levels of human use.	Fernández-Juricic and Tellería 2000
Capercaillie	Scotland	Area of woodland avoided by capercaillies ranged from 1 ha per 46 m of track to 1 ha per 82 m of track. Dogs part of visitor use measured.	Summers and others 2004
Dartford Warbler	Dorset	Possible negative relationship of breeding density with proximity of urban areas	Van den Berg and others 2001
Eider duck	Scotland	People and dogs caused most disturbance, dogs believed to be responsible for the difference between this and people only. Predator encounters increased x 5.	Keller 1991
Marsh harrier	Spain	Reduced physical condition of fledglings, caused by disturbance, including dogs	Fernández and Azkona 1993

Species	Location	Comment	Source
Nightjar	Dorset heaths Cannock Chase	Anecdotal evidence dogs take nightjar chicks, will flush adults and approach eggs and chicks, but not necessarily harm them. Nest on Cannock where dogs and people cannot reach them easily amongst the brash of clear-fell compartments.	Liley and Clarke 2003 F. Gribble, West Midlands Bird Club, pers comm.
Nightjar	Dorset heaths	Birds nesting close to paths flush more readily with dogs, dogs eat chicks occasionally.	Murison 2003
Nightjar	4 Dorset heaths	Strong negative relationship between successful breeding and location of paths, Nest cameras on 12 nests, 1 robbed by crow, 1 disturbed by dog. 12.2% chance of being flushed. Most failures are during incubation.	Woodfield and Langston 2004
Red Grouse	Peak District	No difference between grouse productivity on access and non-access moors.	Picozzi 1971
Red Grouse	North of England	A dog off a lead, running around, can disturb 7 times more grouse than a dog under control.	Hudson 1982
Sharp-tailed grouse	Manitoba	Experimentally disturbed, various factors, including unleashed dogs. Males intolerant of humans and dogs, left lek, but returned in 5 minutes after disturbance ceased. Females more sensitive, did not attend lek during any of disturbances tested.	Baydack 1986, quoted by Sime 1999
Stone Curlew	England	Nesting stone curlew very sensitive to people on foot, exclusion of dogs needed	Woodfield and Langston 2004, Brown and Langston 2001
Vesper sparrow, western meadowlark, American Robin	Colorado, US	No impact of dogs on paths, significant increase in response if any disturbance off the trails.	Miller and others 2001
Woodlark	16 Dorset heaths	Breeding density negatively correlated with disturbance by dogs or people.	Mallord 2005
Woodlark	South Dorset	42% predation on real nests, 69% on artificial nests. Crows are the main predator. Predation risk increases with increasing visitor use, and corvids increase similarly.	Taylor 2002

Experimental effects of dogs on breeding non-wader birds

The only paper found that experimentally compares the effects of dogs with or without a pedestrian on non-wading breeding birds is by Miller and others (2001) in a well used (2 million visits/year) open space in Colorado City. The authors used pine forests and prairie grassland, and conducted treatments on and off (>400m from) trails. The treatments were a lone pedestrian, one with a dog on a lead, a dog alone in the prairie only (a dog walking 20m in front of the pedestrian), and all on or off trails. The treatments were repeated between 88 and 463 times on vesper sparrow, western meadowlarks (in the grasslands) and American robin (a *Turdus* species, like the British blackbird) in the forest. The authors identified the zone of influence for each species in which they were flushed. In general, there was no difference between the treatments on the trails for the birds between a person with or without a dog, and dog alone reactions were less than either of these. However, there were greater and significant differences between the treatments on and off the trails, with much larger zones of influence, flush distances and distance moved when off trails compared with on the trails.

No differences were found for several American ground or forest birds exposed to dogs with or without walkers on trails. Off trail use had greater impacts than on trail disturbance.

Work by Fernández-Juricic and Tellería (2000) on blackbirds in three urban parks in Spain showed that dogs disturbed then less than did pedestrians and magpies. The blackbirds were less likely to flush, less vigilant, and less likely to stop feeding when disturbed by dogs compared with pedestrian and magpies in all three parks. This is a similar effect to that found by Miller and others (2001) for the related American robin. The American robin and the European blackbird are shrub nesting rather than ground nesting birds, and dogs might be expected not to be interpreted as a predation threat. However, the blackbirds in Spain were still affected by dogs, although not as strongly as by people.

Although Fernández-Juricic and Tellería found that blackbirds altered their feeding strategies by moving away from the disturbance (but mostly remaining in the park), and that breeding densities were less in the more disturbed areas, the contribution to this by dogs was not explored. Although these experiments were conducted during the breeding season, any effects on the breeding success of the species involved was not tested.

European blackbirds were also affected more by pedestrians than dogs in a Spanish park.

Miller and others (2001) interpret the results in relation to the ecology of the species observed. The dog is seen as equivalent to a coyote or fox, and these do not predate the bird species investigated. Dogs are therefore not seen as a significant predator and the sparrow, lark and American robin do not react significantly to it. The pedestrian, therefore, has a greater effect on these species. Of the species Miller and others (2001) studied, the blackbird is a shrub nesting species, whilst the sparrow and lark both nest on the ground. However, the experiments were only observing non-breeding behaviour in relation to disturbance, and did not examine any aspects of breeding success.

The authors considered that these birds seemed to have become habituated to the use of the trails, where recreational use was frequent and spatially predictable. However, off-trail use was infrequent and spatially unpredictable; the animals were not accustomed to it, and so reacted more severely.

These birds probably do not regard dogs as potential predators. But unpredictable off-trail use is more disturbing.

Heathland species

These findings are not generally shared by those investigating disturbance effects on some non-wader British species. Research into nesting nightjar and woodlark suggest that recreational disturbance could be having a significant effect, and that dogs could be implicated. Nightjar nesting densities seem to be negatively correlated with the amount and proximity of urban activities (Liley and Clarke 2003), with a potential for a 20% increase in the breeding population (assuming that habitat quality is

good) without urban influences. The factors that could be affecting numbers were cited as visitor disturbance, predation by crows, cats, foxes and the problem of summer fires.

Murison (2003) mapped nightjar territories in 2003 on ten Dorset heaths, and monitored visitor pressure. Out of 47 nests found, 60% failed, 93% of these due to predation, of which 63% were believed to be by corvids. Sites with no public access showed significantly better breeding success than those with open access, and it was also higher the further the nest was from paths and the more concealing vegetation there was around it. These results also suggest that predation and access could be linked, as for the breeding waders described above. Murison added that anecdotal evidence suggested that dogs off leads might be a particular cause of flushing, but she does not report on the numbers of dogs involved, apart from pointing out that the majority of the visitors to her heaths were dog walkers.

This research was extended by Woodfield and Langston (2004) who attempted to investigate the link between access and nest failure, by studying four heathland sites with high recreational use.

Nightjar and woodlark do show impacts of disturbance, and dogs are implicated.

In the 2003 breeding season they monitored all nest sites found, including using video cameras on eight. Ten out of 29 nests found failed, all at the egg stage. Strong negative (but not significant due to the small numbers involved) relationships were again found between location in relation to the path, and vegetation cover. The cameras recorded 12 flushing events during the day (which is significant bearing in mind that nightjar are crepuscular, and would normally not leave the nest at all during the day), one of which led to predation by a carrion crow and two adults that were flushed by a dog (one from eggs and one from chicks). Birds were calculated as being exposed to a 12.2% chance of being flushed per day. Since nightjar's eggs are white, they show up clearly when the bird is flushed, and may then be more vulnerable to predation by diurnal aerial predators such as corvids, particularly as nightjars demonstrate strongly when disturbed, which could attract the attention of predators. The adult and chicks have very cryptic colouration and are less conspicuous and, once the chicks had hatched, visitor use did not subsequently affect breeding success. However, dogs were noted as taking nightjar chicks, and flushing adults, although not always damaging or eating the eggs or chicks.

This series of research investigations suggest that dogs off leads and running around off paths are implicated in affecting the success of nightjar nests at the egg stage. The increased predation levels by corvids as a result of visitor and dog combined disturbance fits with findings for a number of waders, as described above, and for woodlark presented below.

The work on woodlark has reached similar conclusions to those for nightjar. Mallord (2005) studied woodlark on 16 Dorset heaths, and found that although woodlark density was lower where visitor use was high, the breeding success rate was higher due to density-dependent effects. The visitor counts recorded people and their activities separately, and therefore included dog walkers. Mallord found that the majority of the visitors were dog walkers (52%, but ranging from 33% to 90% on different sites), with little difference between weekends and weekdays. Most dogs were off a lead (90%). The relationship between woodlark density and visitor numbers was found for three measures of disturbance: people, dogs and disturbance events per survey, and these were also highly correlated suggesting each represented the other equally. Subsequent measures used for all the modelling work Mallord undertook therefore used the combined number of disturbance events divided by the area of the site.

Dogs not under close control can flush nightjar, and expose eggs to predation by crows.

He found that the probability of a suitable habitat being colonised was reduced to less than 50% at around only eight disturbance events per hour within sites with visitor use. Mallord gave no further information about the character of these disturbance events or the nature of the sites. Mallord calculated that there was a reduction of 34% in overall productivity because of lack of birds compared

with sites with no disturbance. The failure rate was high, at 53.3% with 78.6% of these predated, although the level of loss was not correlated with disturbance.

The egg stage had a significantly higher daily survival rate than the nestling stage. However, Mallord did not investigate the types of predators, nor seek to identify whether predation levels were higher on areas of highest visitor disturbance.

Woodlarks react equally to dogs, people and other disturbance events. Nestlings were more vulnerable to predation than egg stage.

Mallord (2005) also developed a model that predicted the impact on the woodlark population of disturbance. He found that the numbers of woodlark on a site depended on both the numbers of people and their spatial distribution. If the visitor numbers doubled but disturbance was evenly spread throughout the site then this would have a major negative effect on the population, but if disturbance remained patchy and path-based with the same pattern as that measured during his study, doubling of visitor numbers had little effect as the existing disturbance was already affecting territory distribution.

If human-based disturbance were removed altogether, Mallord (2005) predicted that there could be a 13% to 48% increase in woodlark population size depending on the density of territories. However, Taylor (2002) did investigate the role of predators in disturbance effects using artificial and real woodlark nests on 12 Dorset sites. Disturbance was measured in terms of numbers and location of people and dogs, and any corvids were also counted. Of the 1755 artificial nests used, 69% were predated, and of these 53% were by corvids, and 26% by foxes. Taylor found that the predation risk increased as the visitor use increased, as also did the correlation between predation levels and corvid but not fox abundance.

Woodlarks avoided highly disturbed areas. Increases in disturbance on the existing paths would add no further effect, but removing all disturbance was predicted to increase population by 13-48%.

Corvids were the main predator of woodlark nests, and predation increased with disturbance.

The situation with Dartford warbler, the third enigmatic heathland breeding species, is less clear. Liley and Clarke (2003) did not find any correlation between the breeding population and urban influences on Dorset heaths, but van den Berg (2001) did note a possible negative relationship with proximity to urban areas, and attributed this tentatively to disturbance. However, dogs were not separated out in either study.

No evidence of significant disturbance effects for Dartford warbler.

A local British Trust for Ornithology (BTO) recorder, responding to PAA's (2003) questionnaire on the effects on wildlife of the access closures associated with foot and mouth disease, commented that walkers and dogs, especially those that chase sticks, were seen as the main factors limiting habitat choice for nesting Dartford warblers, woodlark and nightjar.

Grouse species

In the uplands, breeding red grouse do not react to disturbance until the last moment (Hudson 1982), but Hudson, in a simple, but not replicated experiment, suggested that a dog off a leash and running around can disturb up to seven times more grouse in the breeding season than a dog on a lead. Neither Hudson nor Picozzi (1971) found any evidence of effects of recreational disturbance on grouse breeding success. Picozzi counted visitor numbers and dogs on access and non-access moors for comparison.

Red grouse breeding success not affected by disturbance, although more birds flushed from nest if dog running around out of close control.

The impacts on other grouse species could differ, however. Baydack (quoted in Sime 1999), experimentally disturbed sage grouse, sharp-tailed grouse and prairie chickens using a variety of stimuli (visual ones such as a snow fence and noise related stimuli which are not to relevant to this

report), including leashed dogs and visitor presence. These grouse all use leks, and mating takes place within a very short (2-3 week) timescale. Baydack found that human presence and dogs on leashes had the most effect on all three species. Male sharp-tails flushed from the lek, but remained within 400m of it, returning when the disturbance was removed within about 5 minutes. Females were displaced from the lek through all the disturbance activities. Male sage grouse were also flushed by human presence and returned, but 20-30 minutes later, or the next day.

Lekking grouse species in America impacted by disturbance, especially by dogs.

Baydack, and other authors quoted by Sime (1999) suggest that disturbance at the lek could have significant implications for population productivity, long-term viability and the perpetuation of the viability of the leks. Because females only attend a lek for a very short time, disturbance could potentially influence nesting chronology and fecundity for a local bird population.

No research on lekking grouse in Britain is available, but black grouse and capercaillie known to be sensitive to disturbance.

There have been no equivalent investigations into the effects of disturbance on black grouse or capercaillie leks in Britain. However, Summers and others (2004) calculated that capercaillies avoided areas close to tracks in two forests in Scotland, thus rendering significant parts of the habitat unavailable to them where track density was high. Dogs were counted in this study (see Table 2.3), but no effects were separated out since numbers of visitors and of dogs were low. More anecdotal are the comments in the questionnaire survey of land owners/occupiers views on the effect of foot and mouth disease access closures on wildlife (PAA 2003). Respondents highlighted how very sensitive black grouse are to disturbance by dogs, from which they will "fly for miles".

Other bird species

Other bird species have received little attention in relation to effects of disturbance, and only a few additional comments are possible on this subject. As far as water birds are concerned, the only species of duck that has been investigated is the eider. For eider duck crêches, Keller (1991) found on the Ythan Estuary in Scotland, that shore-based activity, which included fishermen, walkers and dogs, had a greater effect than water-based disturbance, and it was believed that dogs were responsible for this difference. The disturbance led to an increase in energy-demanding activities such as swimming, and a reduction in roosting, whilst feeding time was also reduced, with limited opportunities for compensatory measures due to the tidal cycle. This disturbance was found to increase predator encounters fivefold as a result of ducklings losing contact with their crêches. Predation levels were also higher on water than on land. Although, Keller did not feel that the population of eiders would be impacted by these levels of disturbance, Woodfield and Langston (2004) point out that the potential condition of the fledglings and subsequent breeding productivity are unknown.

Other work on common eiders has been undertaken in Canada (Bolduc and Guillemette 2003) and in Finland by Laurilla (1989) (both quoted by Woodfield and Langston 2004). Bolduc and Guillemette used experimental disturbance, but only from humans, to study effects on nesting eiders. They found that the greatest effect of just approaching by the researcher was early in the incubation period, and that more time spent off the nest increased the risk of predation. Laurilla compared breeding success in different zones of visitor use, and found greater levels of predation in those that were more heavily visited. This ties in with other studies on disturbance and predation, even though it was only by people, and not by dogs as well.

Eider ducklings predated five times more when disturbed, including by dogs. Population impact not known.

Stone curlew are believed to be very sensitive to disturbance.

Of other bird species, preliminary research has been undertaken into the effects of disturbance on stone curlew. Woodfield and Langston (2004) and Brown and Langston (2001) considered that stone curlew avoid all disturbance activities by humans and dogs.

Research into the breeding success of marsh harriers in relation to disturbance has been conducted by Fernández and Azkona (1993). Although the breeding success in terms of fledged birds was not affected by disturbance (which included fishermen, hikers, dogs and vehicles), the authors noted that the young were in poorer physical condition PA to check as less food had been provided. The nutritional condition of the chicks was measured via blood urea levels, a method that the authors say is more accurate than body mass or other indicators of malnutrition in birds of prey. Blood urea levels return to normal when the young are fed after a period of lack of food. Samples were taken from chicks at 38-40 days just before fledging. From the results obtained, the authors felt this could reduce lifetime reproductive success and the long-term survival of nestlings and adults.

Marsh harrier fledglings less fit due to disturbance, including dogs. Possibly avoid disturbed areas for nesting.

PAA (2003) reported questionnaire respondents who noted that marsh harrier had bred for the first time on a reserve on the Humber Estuary, and the same species had nested much closer to paths than usual in other reserves in Suffolk, Norfolk, the Humber Estuary and Kent, during the closure of access at the time of the foot and mouth outbreak in 2001. All these changes in marsh harrier nesting patterns were attributed to the lack of people and dogs.

As well as the research described above, there are some anecdotal comments that tend to corroborate or add to the types of impacts noted above. These principally are derived from Small and others 2002 and PAA 2003, both of whom conducted questionnaire surveys of site managers to find out if there were any observed effects of removing access during the foot and mouth closures in 2001. The bird species that were mentioned in the responses, where dogs were thought to be involved as a factor, are listed below:

- More skylarks where none nested before due to dog walking on three sites (Small and others 2002).
- More woodcock, nightjar and lapwing where no dogs were being exercised (Small and others 2002).
- Mallard, coot, moorhen (two sites) and Canada goose able to breed successfully, they usually fail due to dogs (Small and others 2002), also for little grebes on another site (PAA 2003).
- More buzzards (three sites), mainly due to dogs on leads or their absence (Small and others 2002 and PAA 2003).
- More ground-nesting birds in general – several sites (Small and others 2002).
- Greater spotted woodpecker breeding for first time on a site (PAA 2003).

3.4 Non-breeding birds

3.4.1 Waders

Lafferty (2001) recorded all shore birds over a year in 1999-2000 on a beach near Santa Barbara in California in relation to human-induced disturbance. The area is a prime shorebird feeding site, with a rich high-intertidal invertebrate assemblage which attracts a diverse and abundant shorebird community. 13,881 birds of 57 species were counted over 48 surveys, of which half were feeding. The birds used preferred sectors in which to feed, especially where there was exposed rock. The relative abundance of birds was not negatively correlated with the amount of human activity in a sector. The average number of people was 31.8 walkers or joggers, 18.9 people sitting, 4.8 dogs and 0.2 horses per sector, per survey. Other disturbance factors were also recorded, the highest of which were 7.6 crows on average per sector. There were 11 dogs per 100 people, giving an average of 2 dogs per kilometre, but this doubled at weekends.

Lafferty (2001) found that ten percent of all visitors were observed to disturb birds, and this involved on average 10 birds per person, 7 of which flew. 39% of all dogs were observed to disturb birds, involving an average 22 birds each, 16 of which flew. Where dogs were on leads (only 7% of the sample) this reduced the probability of disturbing birds and the number of birds per disturbance. About 9% of all dogs actually chased birds during the brief observation periods (2-10 minutes). The disturbance overall caused by dogs is shown in **Table 3.6**.

Table 3.6: Levels of disturbance to shorebirds by dogs

	Leashed dogs	Unleashed dogs	Unleashed and chasing	Total
Activity total	18	221	25	264
% of Birds Disturbed	11	34	100	39
No of events, no of disturbers	2, 2	61, 75	25, 25	88, 102
No of disturbed birds	11	1329	727	2229
Birds/disturbance (SD)	5.5 (6.3)	225 (40.9)	29.1 (28.8)	24.2 (39.2)
Birds/disturber	5.5	18.3	29.1	21.9
% Disturbed birds that flew	100	76	81	72

Source: Lafferty 2001 (Explanation for Table 3.6: Disturbed birds are those that move or fly, activity is the total counted, % that were disturbed was based on the 2-10min observation periods only, a disturbance event could be caused by more than one disturber.)

Lafferty found a substantial variation between species in the proportion that were disturbed. Neither the size of the bird, its guild, frequency of occurrence or density were related to the numbers that were disturbed of any species. In general a smaller proportion of land species were disturbed than other species, and a higher proportion of aquatic species that frequented the water's edge were affected, although the sample size was not large enough for this to be significant.

Studies on some American beaches show no significant impact of disturbance by dogs on a wide range of waders, although dogs disturbed birds more than human-based activities. Birds did not show habituation to disturbance.

The average distance at which birds reacted to humans increased with the proportion of birds that were disturbed on a particular day, suggesting that the disturbance was hyper-sensitising birds. This contrasts with the breeding dotterel in New Zealand that did seem to become partly habituated (Lord and others 2001). However, the reaction to dogs that Lafferty (2001) found was independent of the level of disturbance, possibly suggesting that being chased was always seen as threatening. Each bird was being disturbed dozens of times each day at the expense of feeding and resting time. For some of the species, this coincided with energetically demanding times associated with migration. Burger and Gochfield (1991) found that human activity altered the foraging rates of sanderlings, suggesting that species-specific reactions may be significant in some cases.

Burger (1993) (quoted by Thomas and others 2003) noted that the shorebirds she studied devoted some 70% of their time to feeding and 30% in avoiding disturbance or predators. When the human use increased, foraging time was reduced to 40% of their time. Thomas and others (2003) also noted this for sanderlings on the Californian coast, showing that number of people, type of activity, free-running dogs and proximity of people can all significantly reduce the time the sanderlings spend foraging, but the authors give no details on the activities and disturbance effects of dogs separately from the other activities tested.

Birds were seen to overcome this shortfall in a number of ways. Burger and Gochfield (1991) found sanderlings and Staine and Burger (1994) noted breeding piping plovers feeding on the East coast of America at night-times as compensation for daytime disturbance, while piping plovers also concentrated their diurnal activities in areas within busy beaches that were less disturbed.

Birds losing feeding time due to disturbance seem to feed at night or other times in compensation.

Lafferty (2001) commented that the disturbed birds mostly re-alighted within the section in which they were counted, and were not lost from the beach. However, he quotes two other authors who noted the same result until they examined bird numbers and disturbance at a larger scale.

Both then found that there were negative associations, suggesting that birds are lost from sites due to disturbance (Burger 1986). However, this can not be attributed just to the presence of dogs.

Birds vacate certain sites, possibly due to high general disturbance levels, not specifically to dogs.

Lafferty (2001a) also conducted detailed research on a rare and declining American wader, the western snowy plover. Using the same Santa Barbara beach in California and methods as described above, he evaluated the disturbance effects of dogs versus walkers or joggers on snowy plovers, and attempted to model the effect of removing dogs and people separately. He found:

- on weekdays, 12.7% of people and 23% of dogs disturbed the plovers at a rate of 20% of the roost per disturbing person and 26% of the roost per disturbing dog; each plover was disturbed on average 1.4 times/hour; 27% of plovers flew when disturbed;
- at weekends, 12% of people and 28% of dogs disturbed the plovers at a rate of 20% of the roost per person and 73%/dog; each bird was disturbed 2.2 times/hour, 17% flew on being disturbed;
- seven crows disturbed plovers at a rate of 29% of the roost per crow.

Only 21% of dogs were on leads despite there being a law requiring this. However, Lafferty (2001a) found that both leashed and unleashed dogs disturbed snowy plovers. Unfortunately there were not enough of each to test the difference between them. However, snowy plovers were noted as less easily disturbed than some other species, with a peak disturbance distance of 30m. Piping plovers, for example, are disturbed at twice the distance (US Fish and Wildlife Service 1996, quoted by Lafferty 2001a). Lafferty also found that the number of people and dogs did not significantly alter the probability of disturbance, but that at any particular distance dogs had a higher probability of disturbing plovers than humans. Unlike the aggregate species observation described above, Lafferty (2001a) found that snowy plovers did not become hyper-sensitised to disturbance as the levels increased during a day. However, feeding activity did decline with the abundance of beach users, and then increased again after dark.

Combining all the sources of human and non-human disturbances, Lafferty (2001a) calculated that plovers flew (the total number of plovers divided by the number that flew in relation to the disturber):

- 21% in response to other birds apart from crows;
- 28% in response to humans;
- 36% as a reaction to dogs;
- 40% in response to horses;
- 61% in response to crows.

Bearing in mind that the number of crows, horses and other birds were less than the numbers of humans and dogs, the results show the relative strength of effects.

The effects of dogs on snowy plover in America was greater than that of humans, but less than that of crows.

A study by Fitzpatrick and Bouchez (1998) in Northern Ireland (Belfast Lough) explored the effects of human disturbance on feeding oystercatchers, curlew and redshank on a 1km stretch of the Lough shore as the tide receded and turned. They categorised the human activity as sitting (there were a number of seats along this popular shore-line front), walking (ie slow moving), or more active (cycling, running etc), and whether dogs were present with people in each of these activity classes divided between the grassy upper zone to the exposed mussel beds at low tide. Most of the human activity took place on the grass strip and upper beach area, with little on the low tide area. In contrast with the studies described above, the authors found no significant effect of the zone in which dogs occurred and the vigilance, feeding or food capture rates for any of the species. Surprise was expressed at this result since dogs were seen chasing waders, and were exercised on the beach, but there was no quantifiably measurable effect.

Gill and others (2001a) also found no disturbance effects on black-tailed godwits feeding on estuarine mud along the East Anglian coast. The measures included people using the shore-based footpaths, plus dogs. There was no relationship between this and other disturbance activities on the number of godwits, (either at the local or aggregated scale), or the amount of their principal food left at the end of the winter season (a measure that could also identify any reduced use of a prime resource, and unused carrying capacity between sites).

Comparison between the studies is difficult since disturbance has often been measured in different ways, there is not enough information given on the numbers or behaviour of the dogs or humans (eg Fitzpatrick and Bouchez 1998), and there is insufficient study into the other factors that determine whether the site is ideal or sub-optimum for the birds. For example, in Fitzpatrick and Bouchez' study, the total number of people on the site and in different zones is not given, except to remark that there were usually more than five at a time. Around five would be a low level of use. Other sites studied could be more heavily used than this, although the figures are not always given. Dog numbers and variation with time are also not always provided. Some studies also do not mention the distance from the sources of disturbance and the birds being studied, nor describe the character of the activity such as whether people are walking randomly all over the site, or mostly along paths. Such lack of information makes it impossible to present a full comparison across habitat types, dog use and birds studied.

There is the additional issue over the detailed patterns of use in relation to the habitat involved in the different studies. For example, several of the studies (eg Lafferty 2001, 2001a) describe the use of the whole beach by visitors, whilst Gill and others (2001a) describe the feeding on mud flats (not a sandy beach) and these are less attractive to human visitors and dogs compared with walking on firm sand. Lafferty (2001a) gives disturbance distances of 20m for snowy plovers, whilst Gill (pers. comm.) confirms that the pedestrian use is confined to the shoreline, although distance to the godwits would have been variable. Differences in findings could therefore be related to habitat differences, and their relative attractiveness and use by people.

Finally, Robinson and Pollitt (2002) analysed the results of the WeBS[3] counts from 1995/6 to 1998/9 in relation to disturbance. Recorders noted the number of activities on their count sites. Only a small proportion (26%) of the recorders identified human disturbance. Walkers and dogs were the most frequently recorded forms of this at inland and coastal sites.

[3] WeBS is the Wetland Bird Survey, a joint scheme run by BTO, RSPB, Wildfowl and Wetlands Trust (WWT) and Joint Nature Conservancy Committee (JNCC).

The analysis showed that human forms of disturbance were not increasing between the years studied, but that there were strong seasonal differences, with more activities in the summer. Disturbance sufficient to force birds to move to another site were rare, but there were many local movements within sites as a response to disturbance. The authors suggest that infrequently recorded activities can disturb waterbirds much more than regularly experienced ones, suggesting a degree of habituation.

Other studies show no impacts of disturbance on wintering waders. Care is needed in interpreting these in terms of the levels of activity, the habitat, and the behaviour of the species.

3.4.2 Other birds

Very little relevant research on wintering geese or other wildfowl has been found, although there are several studies on human disturbance, dogs are rarely mentioned and their numbers of effects even less often quantified. For example, Riddington and others (1996) calculated the energy budgets for disturbed brent geese on the Norfolk coast, counting pedestrians with or without dogs, plus other forms of disturbance, but then amalgamated the pedestrian/dog data. They did find that pedestrians (with or without dogs included in the data) had the greatest effect on the birds, resulting in a 10.8% increase on average in their energy requirements. This covered the greater vigilance, and more flight and less feeding for disturbed birds compared with undisturbed ones. Unless able to feed for an extra hour at night, disturbance could be affecting brent geese distribution in the area, the authors conjectured. The birds mostly returned to the area where they had been disturbed but, if levels of disturbance were too high, flew to another nearby feeding area. They showed no habituation to the disturbance.

It could be inferred from the wader studies, and from the human disturbance work, that geese would be as or more sensitive to dogs than to humans. The latter work suggests that disturbance can result in reduced fitness, and then reduced breeding success in the following year, especially if the energetic costs of replacing that lost reacting to disturbance is difficult to achieve (Woodfield and Langston 2004).

3.5 Synthesis

The overview of disturbance in general presented above reflects what has been investigated by researchers and others into the potential effects of dogs as part of their activities on various parts of the wildlife spectrum. There is a wide variety of activities, recreational densities, species and habitats that have not been researched, although there is also a wide literature on the effects of other activities that can be drawn on where inferences and extrapolations may be useful or possible. It is worthwhile, therefore, attempting to synthesise the information into a more succinct framework to understand better what it all means, and what the implications might be for managing recreational activity involving dogs on high value wildlife sites.

As Woodfield and Langston (2004) point out, the bird species studied show differing levels of disturbance. The extent and methods of study differ, and the tolerance levels of disturbance are based on different counting methods making generalisations difficult. In the shoreline environment where there are no paths, dogs running freely are of particular concern.

3.5.1 Pre-incubation birds

The research presented suggests that there may be fewer pairs of breeding birds where disturbance levels are high (Yalden and Yalden 1990, Liley 1999, Woodfield and Langston 2004 and Mallord 2005), and that dogs are implicated in the disturbance zone in which birds do not settle. All the species affected are ground nesting birds. This effect has also been found for other types of recreational activity, for example fishing round flooded gravel pits (Tydeman 1977), and for walking and cycling within woodland (van der Zande and others 1984), so it might be predicted for recreational use that includes dogs. That Dowling and Weston (1999) found such significant

increases in breeding success when dogs (but not other types of recreational activity) were managed shows that dogs can have a significant effect, at least in this type of coastal habitat.

There is the possibility that birds that lek could be significantly affected by dogs and human visitors (Baydack in Sime 1999) during the lekking period, but no work on this has been found for British species.

However, apart from Dowling and Weston's management trials in Australia on a coastal wading bird, there have been no other studies that have quantified the effects of dogs on breeding success in other habitats. Given the greater behavioural reaction to dogs in terms of the longer distance that a bird is flushed, and a longer period spent away from a nest, it might be expected that ground nesting birds are more sensitive to dogs than people in the territory establishment phase as well, but this has not been confirmed or refuted in experimental studies.

3.5.2 Breeding phases

It is clear from the information collated that dogs, especially those off a lead, stimulate a greater behavioural response than walkers, and for some species, also than joggers. Only Eurasian dotterel did not show any behavioural response to any kind of recreational disturbance. Direct loss of nest or eggs to dogs, although occurring, does not seem to be significant from the studies described (although the 5% recorded by Pienkowski, 1984 could be important if the colony were under pressure from other factors as well). The increased levels of predation would appear to be the greatest risk. This is associated with corvids or gulls in particular, but there are other opportunistic predators in different habitats such as the jaegers in the tundra in Canada (Strang 1980). Corvids at least have been shown to be associated with human activity, and have colonised habitats along with the recreational visitors (Watson 1988, Murison 2003, Lafferty 2001). Picozzi (1975) has shown how crows can learn to associate a marker with a nearby nest, and Pienkowski (1984) noted them watching from vantage points as visitors and dogs disturbed the ringed plovers he was researching. Observations made during a number of the studies have identified the role that these opportunistic scavengers and predators can have on clutches. They are the prime egg predators where the predator has been identified in the studies.

Where experimental doses of dog activity or measures of dogs and other recreationists were undertaken, these showed that dogs consistently flushed ground-nesting birds (except Eurasian dotterel) off their nests earlier and for longer than other recreationists. This exposes the eggs and nests, especially where either are conspicuous (eg white eggs of nightjar) or uncovered, or where the parent displays conspicuously to the disturbing dog, to the attention of the opportunistic predator, resulting in significant levels of predation.

This pattern of events Pienkowski (1984) suggests is related to the fact that, at least in Britain, most diurnal predators are aerial (birds of prey), and the terrestrial ones tend to be nocturnal (especially in much disturbed sites). Yet dogs are mostly daytime visitors, and thus the reaction to an intruding terrestrial potential predator in the form of the dog exposes the bird to the aerial ones.

It is of note that on well managed grouse moors, where predator control includes that of crows, that there is less evidence of crow predation on exposed and disturbed nests, either of grouse or golden plovers (Pearce-Higgins and Yalden 2003).

The recent research into the effects of disturbance on heathland birds is less clear-cut in the overall findings than for various waders. However, the indications are that the effects are similar for nightjar and woodlark – both ground nesting species. Again predation is the key factor affecting breeding success, especially by corvids, and these are observed as being more closely associated with well-visited sites. However, predation was more of nestlings than eggs for woodlark, but of eggs for nightjar that have well camouflaged young.

People mostly keep to paths where the vegetation and topography make this the easiest route, especially where there is long old heather alongside (Picozzi 1971), and thus might be expected to flush birds less often than would dogs that stray off paths more. In addition, the natural tracking and exploratory behaviour of dogs would come into play whenever they are off the lead, and not under close (ie to heel) control.

Thus, although the research does not always directly identify dogs as having a greater impact on the birds in question than dog-less visitors or to the dogs' human companions, Current data suggests that this is likely. The high level of use of some of the heathlands close to residential areas, the very high proportion of visitors who are dog walkers, and the large numbers of dogs off leads all point towards this conclusion.

However, there is a suggestion from limited studies that other species such as blackbird species (the American blackbird, a shrub nesting species), and a sparrow and a lark from America (both ground nesting species), that dogs are seen as less threatening than humans for these species. However, the experiments were only observing non-breeding behaviour in relation to disturbance, and did not examine any aspects of breeding success. The question could be asked that as woodlark seems to be affected, whether skylarks in Britain might be as well since both are ground nesting. Walker (pers. comm.) has witnessed the loss of breeding skylarks at Saltfleetby and Theddlethorpe Dunes NNR at the same time as magpies and dog walkers have increased. Only further research on skylark, a priority Biodiversity Action Plan species, can confirm whether they are impacted or not.

There seems to be little evidence that dogs affect the fledging success rates of many of the species studied. Once eggs have hatched for some plovers (ringed plover, black oystercatcher), the numbers reaching independence are not seen to be affected by dogs, or walkers. However, there is the warning produced by Fernández and Azkona (1993) that marsh harriers affected by disturbance by walkers and dogs produced less fit young, although there were no detectable behavioural responses. This possibility is quoted by a number of authors, particularly since it is known that stress can result in reduced breeding fitness, and needs to be investigated in relation to disturbance by dogs for many other key conservation bird species.

There is also the possibility that the disturbance effect will be greater with more visitors plus their dogs, and interact with distance from the bird or its nest. Beale and Monaghan (2004) found this for walkers, but it has not been tested directly for dog activity. The modelling results presented by Mallord (2005) come close in his predictions of the effects of increasing visitor numbers in relation to their distribution patterns, but this does not take into consideration the proximity of the nests to these increased numbers of people and dogs.

In summary, therefore, dogs are implicated on certain sites where there has been a reduction in the numbers of many ground nesting bird species in what is otherwise suitable habitat, and for an increase in levels of predation on these species through flushing the birds from nests and allowing crows or other opportunistic predators to remove eggs or young. No other impacts have been described that are attributable to dog visitors to sites, but there are other possible implications on fitness that could affect population dynamics.

Dogs are implicated where there have been reductions in ground nesting birds from an otherwise suitable habitat. Opportunistic predation has been implicated as the main cause of this reduction.

3.5.3 Wintering birds

The studies seem to demonstrate that dogs do have a greater effect on wintering birds, than do walkers or, for some species, joggers. Different species seem to be more tolerant of approach than others, with disturbance distances that cause a reaction differing widely. There is also a suggestion for one species at least that this response distance is half that of the birds in the breeding season.

However, the research has focused nearly entirely on waders, with a little also on wildfowl. No research has been located that addresses any effects or impacts of dogs on a site for other birds. Since ground nesting birds have been found to be the most vulnerable, it might be expected that ground dwelling ones would be equally susceptible in winter. Species such as hen harrier that have collective roosts on the moorlands, and terrestrially feeding ducks and geese could be candidates for attention.

For the waders examined, there is no clear impact identified in any of the studies, in other words, effects that have significance at the population levels. However, there are a number of suggestions that birds have vacated sites when disturbance became too great, but none of these have quantified the reasons and separated out dogs from other sources of recreational disturbance. However, since the reaction to dogs by wading birds has shown greater flight, and greater reductions in feeding time, then it follows that if birds have abandoned sites for wintering or migration staging posts, then this could be attributed more to dogs than other recreational activities if both are present, and in significant numbers.

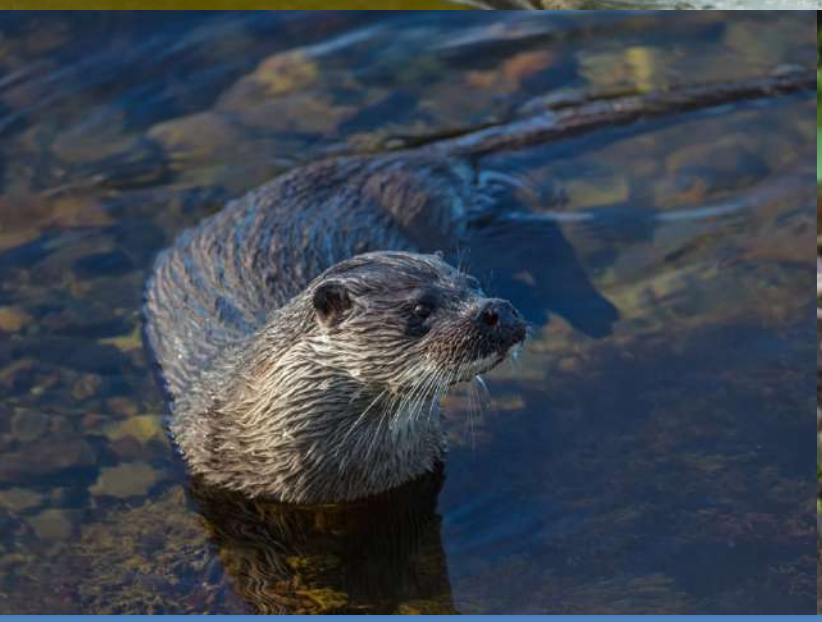
The reaction to dogs by those species affected has an energy cost, which is particularly important in winter if resource acquisition is limited. It may also be important if the winter is particularly severe, although this has not been mentioned in the research reports. In a number of case studies, the authors have found that compensatory feeding at night, or by other means seems to be replacing the energy lost to reactive behaviour caused by disturbance by dogs and other recreational use. However, it is reasonable to suppose that, in some cases, this displacement activity may place pressure on other birds of the same or other species (the former being more likely).

Whether dogs impact on species or not will also depend on the habitat involved, (for example the recreational use by walkers and their dogs on mud flats would be much less than a firm, sandy beach), the numbers of dogs involved, and the sensitivity of the species. Less sensitive ones may tolerate disturbance along a path or shoreline at 50m away from prime feeding areas, than more sensitive ones.

Dogs have a greater effect on wintering birds than people alone, but no impacts at the population level have been recorded.

Appendix D

Cambridge City Council emerging Biodiversity Strategy 2021 – 2030



Cambridge City Council Biodiversity Strategy 2021 – 2030

CAMBRIDGE CITY COUNCIL

Draft for consultation July 2021

avoiding or mitigating measures are put in place. If such measures are required, then their consideration at an early stage will mean that they are thoroughly integrated and planned. The checklist will also prompt officers to consider nature-based solutions to other project constraints, such as water management. It will help to encourage project planners to actively consider positive biodiversity interventions that can be delivered alongside other goals. This will help us to deliver biodiversity net gain across the city and help us to promote a corporate led approach to biodiversity.

The checklist will ensure that procurement actively considers the sustainability of services and goods providers and their potential impacts on biodiversity. The procurement process will also include biosecurity checks to eliminate risks of introducing pests and diseases or invasive species. These can present a significant risk to our habitats as we have experienced in recent years with the arrival of ash dieback and floating pennywort in the UK and Cambridge. We will develop biosecurity guidance and policy to inform the checklist.

Action: Develop biodiversity checklist

Biodiversity Net Gain

Cambridge City Council projects will seek to go beyond a 10% biodiversity net gain and will aim for a 20% gain. Where possible will use the biodiversity metric to help us establish a measurable net gain across our estate. Where it is not feasible to deliver these gains within our project sites, we will deliver them in other parts of our estate.

Action: Achieve 20% biodiversity net gain on Cambridge City Council projects

Environmental Management System

Our Streets and Open Spaces team will have a new operational Environmental Management System by summer 2021 which we will seek to have accredited to ISO14001. The system will help to ensure the biodiversity constraints and

opportunities, based on the principle of continuous improvement, are embedded into the work that the team undertake. It will help to ensure that positive steps for promoting biodiversity are enacted and that appropriate measures for managing existing features are always clear and available to the team .

Action: Implement Environmental Management System

The Cambridge Green Roof Project

We will undertake a systematic review of the buildings within Cambridge City Council estate to identify opportunities to retrofit green roofs. We will also ensure that new Cambridge City Council projects with flat roofs have green roofs installed. Green roofs are one of the most effective measures to integrate biodiversity into the fabric of our built environment. They offer excellent opportunities for invertebrates to thrive in unique habitats which are floristically rich with areas of bare ground - a combination that is generally scarce in Cambridge.

Action: Implement the Cambridge Green Roof Project

The Cambridge Swift Project

Swifts are charismatic birds which are regularly seen screaming and swooping through the skies of Cambridge. However, the species is suffering with a decline of nearly 60% since 1995. The drivers of this change are very difficult to establish but there is some concern that modern and refurbished buildings no longer contain the cracks and crevices within which the species breeds. The Cambridge City Swift Project will review all the Cambridge City Council estate to understand where we can appropriately retrofit boxes specifically designed for this species. As part of this project we will continue to work closely with Action for Swifts to encourage and advise others on suitable measures to enhance the populations of this species, and others such as house sparrow, in Cambridge.

Action: Implement the Cambridge Swift Project

Cambridge Citywide Tree Strategy 2016-2026

We will work across services to help deliver the biodiversity benefits associated with our adopted tree strategy, which seeks to achieve a 19% canopy cover across the city by 2030.

We will seek to plant and encourage the planting of a range of native and non-native species to improve resilience of the 'urban forest' to pests, disease and a changing climate. The strategy will help the city to mitigate and adapt to the effects of climate change through carbon storage, storm water attenuation and urban cooling. Strategic planting of trees can also help to alleviate and filter some of the effects of atmospheric pollution from vehicle emissions. By delivering these regulatory services, the urban forest will help buffer and mitigate the adverse effects of a changing climate on the network of sites with a high biodiversity value within the city. It is important to recognise that tree planting within these sites must be carefully planned in appropriate locations that will not have a detrimental effect, for example, on existing habitats such as chalk grassland, even when currently in poor condition.

Action: Promote biodiversity through implementation of the Citywide Tree Strategy

Peat free Cambridge

We are committed to ensuring that we are peat free in all the work that we do. The extraction of peat from the natural environment reduces its carbon storage capacity and has significant negative consequences for the climate emergency. We will ensure that peat is not used within our projects and maintenance activities. As part of this work we will encourage others throughout the city, such as our allotment holders, to find alternatives to peat to help us achieve our aim of a peat free Cambridge.

Action: To make Cambridge City Council peat free, and to encourage others to do so

Greater Cambridge Planning Service

Our planning function is carried out in partnership with South Cambridgeshire District Council through the Greater Cambridge Shared Planning Service. We set local policy and manage development in line with Government policies laid out in the National Planning Policy Framework. The current Cambridge City Local Plan was adopted in 2018. It includes a suite of policies to help ensure that new development in the area reduces its environmental impact by minimising carbon emissions, flood risk, pollution and pressure on resources such as water and helping to protect and enhance biodiversity. We are developing a joint Biodiversity Supplementary Planning Document that expands on policies to ensure that biodiversity is adequately protected and enhanced throughout the development process. Our planners have been able to work with developers and communities using these policies to secure good outcomes for nature, as demonstrated at Trumpington Country Park and Hobson's Park.

Revisions to the National Planning Policy Framework since the 2018 Local Plan was adopted have created new opportunities to achieve net gains for nature. The current Framework states that planning policy should identify and pursue opportunities for securing measurable gains for biodiversity. Using the Government's pilot biodiversity accounting tool, we are doing this, and have succeeded in securing biodiversity net gain on several major development sites (for example Newbury Farm, Netherhall Gardens and Hobson's Park). The Government has indicated that biodiversity net gain will become mandatory in the new Environment Bill, meaning that developers will be required to ensure habitats for wildlife are enhanced and left in a measurably better state than they were pre-development.

Greater Cambridge Local Plan - Through the Greater Cambridge Shared Planning Service we are preparing a new joint Local Plan, which will set out planning policy in Greater Cambridge (Cambridge City and South Cambridgeshire) for the next 20

years. Both Cambridge City and South Cambridgeshire District Councils recognise the pressure on the natural environment and are committed to exploring how the new Local Plan can do more to improve natural and semi-natural spaces, known in planning terms as 'green infrastructure', across the area of Greater Cambridge. This will include how we can make use of new powers to mandate biodiversity net gain. We have made biodiversity and green spaces one of the four big themes that will influence how homes, jobs and infrastructure will be planned in the new Local Plan. In a novel move which underlines the priority we are giving to our biodiversity and green spaces theme we included a Call for Green Sites in our Call for Sites process. A Call for Sites is a normal part of plan making, providing a way for landowners, developers, individuals, and other interested parties to suggest sites for development. The Call for Green Sites specifically allowed anyone to submit suggestions of land to grow and enhance the green space network; and provided an important signal to landowners of the importance of working with them to identify suitable land, such as for community forests.

Green Infrastructure Opportunity Mapping - To inform the development of policies to deliver the City and South Cambridgeshire doubling nature joint aspiration, we have commissioned a Greater Cambridge Green Infrastructure Opportunity Mapping study. The baseline report provides robust evidence on the quantity and quality of existing green infrastructure assets and networks within Greater Cambridge and identifies broad opportunity areas to enhance and expand the network. Later stages of the study will identify a range of deliverable projects to enhance the green infrastructure network. The baseline report can be viewed on the Greater Cambridge Shared Planning website. The final report will be published in autumn 2021 to support the Greater Cambridge Local Plan Preferred Options consultation. Plan making takes a long time due to the need to do it rigorously and in dialogue with our communities. As the new Greater Cambridge Local Plan nears adoption it will carry ever greater weight in planning decisions. However, it is not expected to be finally adopted until 2023.

Making policies stick - An important aspect of our influence through policies is in how we ensure that they are implemented effectively. Through the Development

Management process our planning team ensures that planning applications address matters relating to the protection and enhancement of nature, and provision of green space. They impose planning conditions to make otherwise unacceptable developments acceptable, and negotiate planning obligations, also known as section 106 agreements, to secure measures that are needed.

Tackling water quality and scarcity - We know water is an important issue to our local communities, and we have commissioned an Integrated Water Management Study to inform the new Greater Cambridge Local Plan. The interim study (published in November 2020) highlights that there is no environmental capacity for additional growth levels, being tested for the new plan, to be served by increasing abstraction from the chalk aquifer which supplies much of the water to the Cambridge area. It also shows that water quality in the surface water bodies assessed under the Water Framework Directive is at best moderate with three bodies assessed as poor. This is mainly because of abstraction, wastewater treatment (point source discharges) and agricultural diffuse pollution. The study will help us to develop a sustainable development strategy for the Local Plan and robust policies on water quality and efficiency, and we are working collaboratively with a number of bodies on this, including Water Resources East who are planning regional solutions to address these issues.

New Supplementary Planning Documents - We are developing a new Biodiversity Supplementary Planning Document to support current Local Plan policies to protect and enhance biodiversity, and to provide a framework by which mandatory biodiversity net gain can be achieved across all development within the district. We aspire to achieve 20% net gain through development while recognising we cannot require this unless and until adopted in planning policy.

Action: Project and enhance biodiversity through our statutory planning functions

Climate actions: A biodiverse Cambridge is more resilient to climate change and more, higher quality green infrastructure assists with urban cooling and

carbon capture. This will be achievable though improvements to our estate and encouraging wider engagement with these themes through our statutory planning functions. Green roofs ensure buildings are more sustainable, helping with energy efficiency and water management, as well as promoting biodiversity. Greater tree cover will mean more urban cooling. Helping to make our city peat free will ensure the conservation of key carbon sinks.

The core

The Lawton Report encourages 'bigger, better and more joined up'. The aim of this theme is to focus on our core sites, many of which are situated within the Cambridge Nature Recovery Network. Here we aim to focus on 'bigger and better' by improving biodiversity management of our core greenspaces, and wherever possible making more space for nature at these locations.

Many of these sites fall within the Cambridge Nature Recovery Network and our work there will help us make a meaningful contribution to this initiative to deliver a joined up and resilient biodiversity network. The City Council will work to achieve a measurable biodiversity net gain in these core locations to contribute to our commitment to double nature.

Local Nature Reserves, County Wildlife Sites and City Wildlife Sites

We will prepare/review and implement Management Plans for all Cambridge City Council owned Local Nature Reserves, County Wildlife Sites and City Wildlife Sites. Opportunities for biodiversity net gain are set out in the Cambridge City Council Biodiversity Audit and the Greater Cambridge Chalk Stream Project. We will ensure that resources are allocated to help achieve these goals.

In some locations, particularly the accessible Local Nature Reserves the emphasis will be on striking the right balance between recreation and biodiversity. In other locations it will be important to reassess the grazing regimes to ensure that they are compatible with ambitions to improve the floristic diversity and conditions of the

Appendix E

South Cambridgeshire District Council Doubling Nature Strategy

South Cambridgeshire District Council

Doubling Nature Strategy

2021

Our approach

Although we directly control only a tiny area of land in the district, there are many ways we can influence what happens on land we do not control. Our approach is to use our widening circles of influence to protect and enhance nature in the district.

- We will be an exemplar to others on our own estate through tree planting and nature enhancing measures. This includes our main office at South Cambridgeshire Hall and the communal land associated with our Council housing.
- We will make the most of our direct influence on the natural environment as the local planning authority. We aspire to achieve 20% biodiversity net gain through development. We cannot require this unless and until it is adopted in planning policy or mandated at national level but will encourage all partners to work with us to achieve this aspiration ahead of policy and legal obligations.
- We will use our wider influence through formal and informal partnerships with businesses and community.

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