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Evidence to support Appropriate Assessment of development plans and projects in south-east Dorset

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Summary

We provide a summary of the evidence base for the wide variety of impacts associated with urban development adjacent to heathlands and we describe how an Appropriate Assessment should consider these issues.

We focus on the impacts of recreational disturbance to the Annex 1 breeding bird species, namely nightjar, woodlark and Dartford warbler. Much of the research concerning these species and disturbance has been conducted in Dorset. For both woodlark and nightjar, the numbers of birds on a site negatively correlates with the amount of housing surrounding the site, such that sites surrounded by high densities of housing support fewer birds. Within sites, woodlark density has been shown to be negatively related to counts of people. Studies of nightjar breeding success have shown that a greater proportion of nests fail on more urban heaths and that nests closer to footpaths are more likely to fail. Studies of Dartford warblers have shown that, for territories dominated by heather (but not those dominated by gorse), breeding success is negatively related to the number of people walking through a pair’s territory. There is also evidence that young Dartford warblers may be particularly vulnerable to predation from cats associated with houses adjacent to the heaths.

These disturbance impacts must be considered within the context of other significant urban effects, which may act synergistically together. The greater the cumulative intensity of these effects at a site, the less significant its conservation interest is likely to be. Wild fire is a key pressure and has a serious impact on ecological integrity, destroying heathland vegetation, which—together with associated faunal communities—can take 4-20 years to re-establish. Wild fires have a higher incidence on urban heaths. Nearly 60% of uncontrolled fires can be attributed to arson; the timing of such fires suggests that children are predominantly responsible. Urban heaths may have higher densities of urban predators, notably domestic and feral cats, foxes, hedgehogs, crows and magpies. In addition to their disturbance effects, dogs may chase livestock, disturb aquatic wildlife, cause physical damage to water body structure, and enrich soil through fouling. Heathland plant communities and some associated invertebrates are vulnerable to human trampling by horses, cycles, motorcycles or feet. Ongoing fragmentation and isolation of Dorset heaths are problematic: smaller, more isolated fragments have fewer heathland indicator species and poorer characteristic heathland plant communities. Fragmentation appears to be a key cause of the decline of British sand lizards and smooth snakes. Roads exacerbate habitat fragmentation and pose barriers to invertebrate mobility. Ground and surface water pollution and air pollution have negative impacts on vegetation communities. Fly-tipping may cause eutrophication.

Visitor studies have shown that the heaths are widely used for by local residents for recreation. People travel to the sites principally by car or by foot, and visit the heaths for dog walking (the main reason for people’s visits), walking, cycling, horse riding and a range of other activities. Some sites, especially in Purbeck, also attract tourists from well outside the local area.

We have mapped 61 different heathland “patches”, totalling some 10,718 ha, of which 5441 ha is within the Dorset Heathlands Special Protection Area (SPA). These patches represent distinct pieces of heathland and forestry with extensive public access. All patches at least contain some land designated as SPA or are directly adjacent to the SPA. There are some 531 access points onto the patches and over 5200 car-park spaces. Most sites have open access and the only substantial areas with no public access are the sites owned by the Ministry of Defence (MoD), or are contaminated sites such as Holton Heath, which we have not

considered. The designated boundaries of the SPA rarely match access boundaries and therefore we have used the boundaries of where people can go to define sites. This approach also allows us to include entire patches of extensive commercial forestry blocks such as Wareham Forest and Ringwood Forest. These forests have extensive public access and also contain patches of SPA heathland. These sites also hold large populations of Annex 1 bird species such as nightjar distributed throughout the forestry.

Using existing visitor count data and interview data for different access points on both the Dorset and Thames Basin Heaths, we have explored the factors that influence the number of people using particular access points.

The numbers of visitors on foot is related to the amount of housing around the heath; using the amount of housing at different distance bands from the access points, our model explains 22% of the variance in visitors arriving on foot. The number of visitors travelling to access points by car could not be explained by the amount of housing surrounding sites, suggesting that people who drive to the heaths often live some distance away, an inference confirmed by visitor data (29% of visitors to the Dorset Heaths lived over 5 km from the access point at which they were interviewed). Given that people are prepared to travel these distances and that so many of the heaths are close together, car-drivers have a wide choice of location. Only 5% of people travelling to the heaths by car choose to travel to their nearest access point with parking. There was considerable variation in the number of car-drivers visiting different sites, and we found that car-park size was the best predictor of visitor numbers. This does not necessarily imply that car-park size limits visitor numbers (indeed, regression equations suggest that car-parks are not full). It is possible that car-park locations and sizes reflect places that people choose to visit or access patterns that have become ingrained within the local population. For car-parks of a given size, there was some evidence that visitor rates declined with distance (i.e. a greater proportion of people living close to the heaths visit them). There was also evidence that the decline was shallower for larger car-parks, suggesting that, compared to small car-parks, large car-parks attract a higher proportion of people living further away from the heaths.

We use this understanding to develop a model to predict visitor numbers to any access point. Foot visitors are predicted by the amount of housing surrounding the heath and car-visitors by car-park size or by a combination of car-park size and housing within 10km (we present both approaches). Using these models we predict, across all patches, c.20,000 person visits per 16 hours in August, which we suggest may equate to c.5 million person visits per annum. For every person visiting on foot there are 2.2 car visitors. We map the spatial distribution of this visitor pressure within sites and reveal that it is related to the size and shape of sites, the location of the access points, the distribution of parking spaces and the distribution of housing.

We also map other (non-heathland) sites within 5 km of the heaths that we believe may attract the kind of visitors that visit the heaths. We have mapped c.3,400 ha of land (excluding the New Forest) with existing access that is currently used or promoted for recreational use – including beaches, downland, commonland, estuary shoreline, country parks and urban greenspace. We estimate more than 3000 car-park spaces are associated with these sites. Many of these alternative sites are also important for nature conservation (at both national and international levels). The current level of visitor pressure onto the heaths must therefore be understood in the context of this existing range of additional land available for people to visit. Any increase in housing is likely to increase the visitor pressure on these other sites, and further work is necessary to identify which sites have the capacity to absorb additional visitor pressure.

The current levels of visitor pressure on Dorset's heathlands are having an impact on the conservation of the European designated sites. For example, Natural England currently class a higher proportion of the more urban heaths as being in 'unfavourable condition'. This is despite the various conservation initiatives, access management and education programmes that have been put in place in recent years.

We take the housing allocation figures from the Regional Spatial Strategy and other scenarios for the period until 2026 to predict the resulting increase in visitor pressure. We tentatively suggest that visitor levels to the heaths may increase by a total of 13% as a result of new housing. We show that the increase in visitor pressure will vary across the sites and locally within sites, with potential increases in visitor pressure of up to 30% in some areas. Change is likely to be greatest at sites with large car-parks or close to the urban extension sites. We highlight Parley, Studland, Canford, Upton, Bourne Valley, Alder Hills, Talbot Heath, Hengistbury, Hurn Forest and Cannon Hill.

Assuming an overall increase of visitor numbers of 13%, and given the area of heath / forestry is 10,718ha, we cautiously suggest that a further 1400ha of access land would be necessary to maintain comparative visitor levels as they are. Applying the same approach to only the visitable parts of the SPA gives an additional land area of some 650ha. These figures (1400ha and 650ha) are a crude and simple guideline for the level of additional access land necessary to maintain the status quo (in the absence of other mitigation). The 1400ha assumes it is necessary to provide mitigation for all visitable land associated with the SPA, such as commercial forestry. The 650ha figure is based on the assumption that it is necessary only to mitigate for the areas designated as SPA. This is likely to be difficult to justify on most sites as it will be difficult to allow an increase in visitor pressure to occur only on selected parts of a single site.

In reality further work is needed to address which mitigation and avoidance measures should be implemented and where. For additional sites to be successful in attracting people away from the heaths we suggest that they must be reasonably large (40ha will encompass the average dog walk on a heath) and have convenient access, good parking and include semi-natural habitats, ideally with some tree cover. We highlight some potential areas, acknowledging that these may help dilute the pressure on heaths rather than avoid it entirely and that it may be difficult to secure suitable sites. In addition, we suggest a suite of possible mitigation measures that may be worth considering in a site-specific context, such as access management, wardening and environmental education. The maps of current and predicted visitor distributions should provide a means to guide the implementation of these measures.

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1 Introduction

1.1 Dorset holds some 7500 ha of heathland (see Rose et al., 2000), much of which is designated as being of European importance, within the Dorset Heathlands Special Protection Area (SPA), the Dorset Heaths Special Area of Conservation (SAC) and the Dorset Heaths (Purbeck & Wareham) and Studland Dunes SAC. There is a body of evidence that development adjacent to heathland sites can impact deleteriously on the interest features of such sites (see Underhill-Day, 2005 for a review). These effects of urban development are relatively complex and our understanding is still developing. However, it is clear that the distribution and density of housing in relation to the heathland areas is important in determining the scale of the effects (for example see Liley & Clarke, 2003). This has important consequences for future development.

1.2 The report has been commissioned in light of advice provided by the then Office of the Deputy Prime Minister (ODPM) to chief planning officers, dated 28 February 2006 and concerning the application of Appropriate Assessment under the Habitats Directive to Development Plans, and also the discussion paper ('Appropriate Assessment of Plans') dated June 2006.

1.3 This report relates to the draft Regional Spatial Strategy of June 2006 (RSS), as it applies to south-east Dorset and focuses on the European heathland sites which could be potentially affected by the RSS and subsequent Local Development Framework (LDF) development policies. The aim of the contract is to provide the detailed analysis and evidence-base necessary for Appropriate Assessment of plans or projects to be carried out. For the avoidance of confusion, we stress that this document is the evidence base, not the Appropriate Assessment itself, which is carried out separately by the Competent Authority.

1.4 This document therefore aims to:

- Describe application of Appropriate Assessment;
- Present and summarise the evidence for urban effects on Dorset's heaths;
- Show the current level of visitor pressure across the whole of the Dorset heaths;
- Predict how this will change as a result of the implementation of development policies in the RSS, in the absence of mitigation;
- Highlight policy directions, geographical restrictions and mitigation proposals which will achieve the outcome of no adverse effects on the heaths; and
- Summarise further work which might be necessary.

1.5 The report is structured as follows:

- Conservation Context and the Application of the Habitats Directive;
- A summary of the evidence base and current visitor pressure;
- Evidence to support the effectiveness and limitations of existing mitigations;
- Predictions of the effects of development proposed within the RSS; and
- Recommendations for further work.

1.6 We present the detailed statistical analysis as Appendix 2 in this document. Maps play an important part in the results of this work, providing a visual portrayal of the spatial distribution of visitor pressure, alternative sites and housing. For convenience, the maps are bound in a separate document.

2 Conservation Context and the Application of the Habitats Directive

2.1 Habitats and Species of Principal Importance for Biodiversity

2.1.1 Heathlands are a rare and declining type of habitat that is now classified as being of principal importance for the conservation of biological diversity in England. The list of habitats and species of principal importance for the conservation of biological diversity is published by the Secretary of State for the Environment, Food and Rural Affairs. The duties of the Government, in relation to these principal habitats and species, are set out in (Office of the Deputy Prime Minister) Circular 06/2005. In an international context, heathlands are also of limited distribution. Other than Britain, lowland heaths are confined to Europe, mostly to those countries on the coastal edge of western Europe. Characteristically, heathlands are on sandy, free draining and nutrient poor soils. It is these conditions, along with a history of human intervention, that has created the conditions for the unique assemblage of heathland plants. Adapted to this habitat are a number of specialist species, most of which are invertebrates, but also mammals, birds and reptiles. With specialist habitat requirements, these species are reliant upon the heathlands for their existence, and are therefore of nature conservation concern following the serious decline of heathland during the last two hundred years.

2.2 Conservation Objectives of the Special Protection Area

2.2.1 The conservation objectives are important because they are the basis for assessment under Regulation 48 of the Habitats Regulations (see below).

2.2.2 The conservation objectives for the SPA are: "To maintain, in favourable condition, the habitats for the populations of Annex 1 bird species (nightjar, woodlark, Dartford warble, hen harrier and merlin) of European importance, with particular reference to lowland heathland." Maintenance implies restoration if an interest feature is not in favourable condition.

2.2.3 Article 4.4 of the EC Directive on the Conservation of Wild Birds (79/409/EEC) also notes that:
In respect of the protection areas referred to in paragraphs 1 and 2 above, Member States shall take appropriate steps to avoid pollution or deterioration of habitats or any disturbances affecting the birds, in so far as these would be significant having regard to the objectives of this Article.

2.3 Conservation Objectives of the Special Areas for Conservation

2.3.1 A further international designation applies to those heaths within Dorset which form part of either the Dorset Heathlands SAC or the Dorset Heaths (Purbeck & Wareham) and Studland Dunes SAC. SACs are designated under the provisions of the EC Habitats Directive[1]. They are designated to protect habitats and species of animals other than birds. In the case of these SACs, the key interest features are the high quality Annex 1 heathland habitats themselves, including some of the finest examples in Britain of:

- Northern Atlantic wet heaths with *Erica tetralix*;

[1] Council Directive of 21/5/92 on the conservation of natural habitats and of wild fauna and flora (92/43/EEC)

- European dry heaths; and
- Depressions on peat substrates of the Rhynchosporion

2.3.2 In addition the Dorset Heaths (Purbeck & Wareham) and Studland Dunes SAC contain additional Annex 1 habitats:

- Embryonic shifting dunes;
- Shifting dunes along the shoreline with *Ammophila arenarua*;
- Atlantic decalcified fixed dunes (*Calluno – Uliceta*);
- Humid dune slacks; and
- Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*).

2.3.3 Additional habitats that are qualifying features, but not a primary reason for selection for both SACs are:

- Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*);
- Calcareous fens with Cladium mariscus and species of the *Caricion davallianae*;
- Alkaline fens; and
- Old acidophilous oak woods with *Quercus robur* on sandy plains.

2.3.4 Besides the SAC habitats, the two SACs are the Dorset stronghold of the southern damselfly *Coenagrion mercuriale*, an Annex II species that is also a primary reason for their selection as SACs. Great crested newts *Triturus cristatus* also present as a qualifying feature, but not a primary reason for site selection.

2.4 Application of the Habitats Regulations

2.4.1 European Sites are Special Protection Areas (SPA) classified under the EC Birds Directive 1979 and Special Areas of Conservation (SAC) designated under the EC Habitats Directive 1992[2]. As a matter of policy the Government expects public authorities to treat all Ramsar sites as if they are fully designated European Sites for the purpose of considering development proposals that may affect them[3]. For ease of reading all SPA, SAC and Ramsar sites to which the procedures for assessment apply are referred to as 'European sites'.

2.4.2 The *Conservation (Natural Habitats &c) Regulations* 1994[4] as amended (the Habitats Regulations) apply the obligations of the EC Birds and Habitats Directives in British law. The regulations set out the way in which the European sites should be protected. The Regional Spatial Strategy (RSS) and Local Development Documents (LDD) and all relevant planning applications, are referred to below as 'plans or projects', reflecting the wording of the Directives and Regulations. When making or reviewing any part of the RSS or a LDD, or when considering planning applications for any kind of new

[2] European Community 1979. *Council Directive of 2/4/79 on the conservation of wild birds* (79/409/EEC) and European Community 1992. *Council Directive of 21/5/92 on the conservation of natural habitats and of wild fauna and flora* (92/43/EEC)
[3] Office of the Deputy Prime Minister, 2005, Planning Policy Statement 9 *Biodiversity and Geological Conservation* paragraph 6
[4] *The Conservation (Natural Habitats &c) Regulations 1994*

development, the South West Regional Assembly or the local planning authority (LPA) (together referred to as 'the planning authorities') must apply the regulations.

2.4.3 ODPM Circular 6/2005 (2/2005 DEFRA)[5] explains in detail how the Regulations should be applied to individual projects, such as planning applications. More recent Government guidance relates to the application of the Regulations to RSS and LDDs[6].

2.4.4 On 20th October 2005, the European Court of Justice (ECJ) ruled in Case C-6/04[7] that Article 6(3) and (4) of the Habitats Directive, and therefore, Part IV of the Habitats Regulations applies to development plans, because they are to be considered as 'plans or projects' within the meaning of the Directive. Prior to the judgment, the UK Government interpreted the Directive as meaning that only plans or projects that are submitted for some kind of consent, permission or other authorisation such as a planning permission were subject to the Regulations.

2.4.5. The Court found that "*section 54A of the Town and Country Planning Act 1990*, [subsequently superseded by section 38 of the Planning and Compulsory Purchase Act 2004] *which requires applications for planning permission to be determined in the light of the relevant land use plans,* [that is, in accordance with the development plan unless material considerations indicate otherwise] *necessarily means that those plans may have considerable influence on development decisions and, as a result, on the sites concerned*".

2.4.6 Consequently, the Habitats Regulations are being amended[8]. Two of the principal requirements of the amended Regulations are that:

a) before a RSS is published by the Secretary of State under S.9(6) of the 2004 Act[9], or

b) before a LDD is adopted under S.23 of the 2004 Act

2.4.7 the Regional Assembly or the LPA, as the case may be, shall apply the requirements of regulations 85A-E. The essential requirement of regulations 85A-E is for the planning authority to assess the potential effects of the RSS or the LDD on European Sites in Great Britain. The site affected could be in or outside the South West Region. The Regulations apply irrespective of when the plan was started. The whole process of assessing the effects of a RSS or LDD on European sites is referred to here as the 'Habitats Regulations assessment', to clearly distinguish the whole process from the step within it commonly referred to as the 'appropriate assessment'.

2.4.8 If the RSS or LDD is likely to have a significant effect, alone or in combination with other plans and projects (including outstanding planning applications), on one or more

[5] Office of the Deputy Prime Minister, Circular 6/2005, Department for Environment Food and Rural Affairs Circular 2/2005, *Biodiversity and Geological Conservation: Statutory obligations and their impact within the planning system*.

[6] Department for Communities and Local Government, 2006, *Planning for the Protection of European Sites: Appropriate Assessment under the Conservation (Natural Habitats &c) (Amendment) (England and Wales) Regulations* 2006. *Guidance for Regional Spatial Strategies and Local Development Documents*

[7] Commission of the European Communities v United Kingdom of Great Britain and Northern Ireland (C-6/04: 2005 ECJ)

[8] The *Conservation (Natural Habitats &c) (Amendment) (England and Wales) Regulations* 2007

[9] The Planning and Compulsory Purchase Act 2004, Part 6

European sites it must be subject to an “appropriate assessment” as required by Article 6(3) of the Habitats Directive and regulation 85B of the Habitats Regulations.

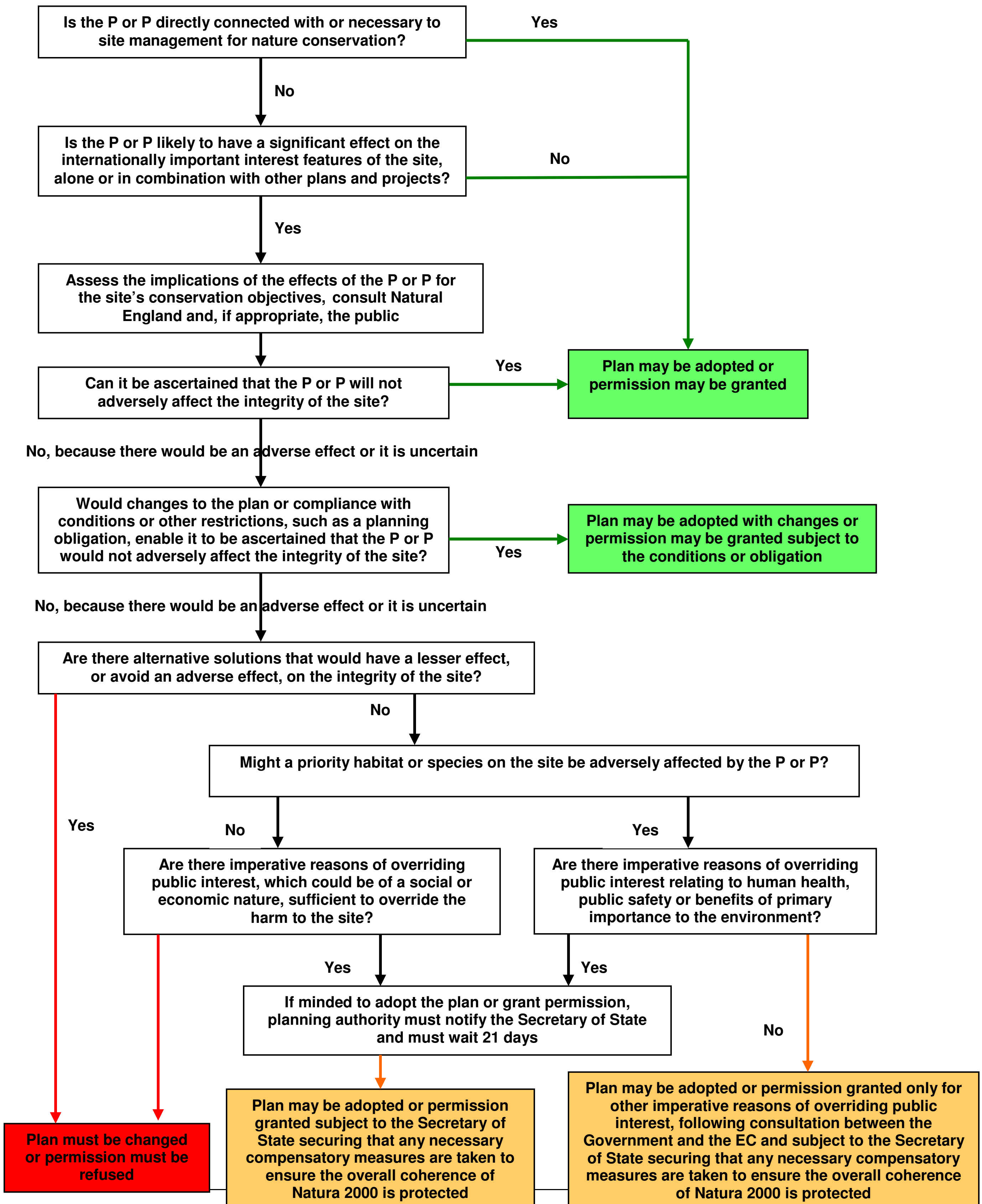
2.4.9 Depending on the outcome of the Habitats Regulations assessment, the planning authority may need to amend the plan to eliminate or reduce potentially damaging effects on the European site; and/or may need to consider alternative solutions that would have a lesser effect on the relevant site; and/or consider if there are imperative reasons of overriding public interest sufficient to justify the potential effects on the European site(s) affected. The Government is likely to expect that a RSS or LDD will only need to proceed by way of these later tests in the most exceptional circumstances, because a planning authority should, where necessary, adapt the plan as a result of the Habitats Regulations assessment, to ensure that it will not adversely affect the integrity of any European site.

2.4.10 Ideally, the assessment of RSS or LDD under the Habitats Regulations should be undertaken from the earliest stages of its preparation, so that the assessment influences the evolution of the plan. However, in cases where production or review of the plan has already begun, the assessment should be carried out as soon as practicable and in any event, before publication of the final RSS[10] or adoption of the LDD. Where a planning authority chooses to consult the public under the provisions of regulation 85B(3), the consultation will need to be undertaken during the normal consultation period on the review, if a further consultation stage is to be avoided.

2.4.11 Figure 1 below outlines the decision making process of the Habitats Regulations for plans and projects. Essentially, the Habitats Regulations require all plans or projects with the potential to affect a European site and not directly connected with and necessary to its management for nature conservation, to be assessed. Those that are likely to have a significant effect on the site, alone or in combination with other plans or projects, must be subject to a more detailed assessment in order to ascertain whether the plan or project would adversely affect the integrity of the site.

[10] See regulation 85A of the Habitats Regulations

FIGURE 1 FLOWCHART OF THE WHOLE DECISION MAKING PROCESS UNDER THE HABITATS REGULATIONS 1994 FOR ALL PLANS AND PROJECTS (P or P)



2.4.12 If the proposal would be likely to have a significant effect on the European site, alone or in combination with other plans or projects, the planning authority must undertake an 'Appropriate Assessment' of the implications of the proposal for each of the interest features for which the European site is classified or designated, in light of the site's conservation objectives. The planning authority must consult Natural England. The Regulations restrict the adoption of the plan or the grant of permission for the project if it cannot be ascertained that the proposal, alone or in combination with others, would not have an adverse effect on the European site. It should be noted that, unlike in most other planning decisions, the Habitats Regulations apply the precautionary principle as a matter of law. The Appropriate Assessment should conclude that the plan or project will not have an adverse effect on the integrity of the European site before it is adopted or given consent. If the effects are uncertain, the precautionary principle applies and it must be assumed that the plan or project will have an adverse effect on the site.

2.4.13 Assessing significant effects is a challenging part of the application of the Habitats Regulations. Whilst there is some guidance available, there has been no definitive explanation as to the scale of effect that should be regarded as significant, or how large scale an effect needs to be before it may be regarded as potentially adversely affecting the integrity of a site. In order to assist in future case work, English Nature commissioned a research study[11] to examine published guidance and to conduct a review of previous legal judgments and Inspectors' decisions and reports in cases where the spatial scale of impacts was material to the conclusions reached.

2.4.14 The research showed that published guidance explains the general approach to considering whether an effect is likely to be significant, but most does not attempt a quantification of what is a significant effect; none suggest what possible thresholds there might be.

2.4.15 The study looked at thirteen cases in detail where small scale effects had been considered; all were considered to be significant. There were six examples where authoritative decision makers judged that a land take or habitat loss of less than 1% was significant:

- London Gateway Port, Essex 0.1%
- Quay 2005, Hull 0.01% (in fact 0.03% when calculated correctly)
- Gilwern to Hafodyrynys Pipeline, South Wales 0.15%
- Dibden Bay Terminal, Southampton 0.76%
- The Outer Harbour, Immingham 0.145%
- Santoña Marshes, Spain 0.5%

2.4.16 All these have the authority of being Secretary of State decisions except Santoña Marshes which is a judgment of the European Court of Justice. All concluded a likely significant effect and all determined or implied an adverse effect on integrity. There is a need to take into account a number of other factors in some cases, but the research

[11] Hoskin, R. and Tyldesley, D. (ongoing) *How the scale of effects on internationally designated nature conservation sites in Britain has been considered in decision making: A review of authoritative decisions*. Natural England Research Report 2006

showed that useful conclusions can be drawn. These are summarised in the following paragraph.

5.3.7 Each case should continue to be determined on its merits, because it is rare for the Secretary of State or an Inspector to have to determine a simple case of a single, permanent land take or loss of habitat from a site. However, it is equally clear that decision makers have held that very small scale losses or changes in habitat are likely to be a significant effect. Indeed they have concluded that very small scale losses, substantially less than 1%, would be an adverse effect on integrity; or at least they could not ascertain whether there would be no adverse effect on integrity.

2.4.18 The study report recommended that unless a particular loss of habitat could be regarded as so trivial as to be *de minimis*, it is capable of being a significant effect and may also be an adverse effect on the integrity of the site. Bearing in mind the precautionary principle embedded in the legislation, applied consistently by Secretaries of State and endorsed in court judgments, habitat loss or change of a very small scale, including losses in the order of 0.1% or less of a site, can clearly be regarded as an adverse effect on the integrity of a designated site. By definition, the larger the European or Ramsar site, the larger an area would be that is represented by 0.1%, and thus the more important it may be in supporting individual plants or animals, or ecosystems, for which the site is classified, designated or listed. The value of each and every part of a large site is further emphasised when it is considered that all parts of large areas such as estuaries are potentially important because they are very dynamic and different parts of the system, used at differing times for different reasons by the birds for which they were classified. For habitats that are rare, such as certain types of heathlands, peatlands or orchid-rich calcareous grasslands, every part of a large site is an important part of a globally scarce resource and part of a functional ecosystem.

2.4.19 Equally, whilst a 0.1% loss from a smaller site may represent a small area in spatial terms, it can be important to the ecological functioning of the site which, being a smaller unit, is likely to depend in spatial terms on much smaller ecosystems or communities. The argument that a small loss does not matter is one that can be repeated until substantial losses have been incurred. This insidious reduction of habitat is as potentially damaging as a single larger loss. Such arguments are supported by the decisions examined in the research.

2.4.20 The cases identified and examined concentrated on single projects (albeit some had many component parts). Only two explicitly referred to combined effects with other projects. However, it is logical to conclude that the decision makers would come to the same conclusion about the significance of an effect irrespective of whether the effect was caused by one, ten or a hundred projects. In other words, where small scale effects are caused by a combination of even smaller-scale effects, the overall effect is still significant and can result in an adverse effect on integrity. Thus, even projects that may appear, *prima facie*, to be *de minimis*, may not be when their effects are combined with other similarly very small scale effects.

2.4.21 By way of example, in relation to the disturbance effects of recreational visits to the Dorset Heaths, we can consider the effects of a new dwelling located within walking distance of the heaths. It is likely to result in one additional visitor to the heaths on one day; that would be a *de minimis* effect on the interest features of the SPA. However, that visit is likely to recur on other days, perhaps every day, increasing the effects of the first extra visit. The continuing effect of that visitor over time may not be a *de minimis* effect. In any event, even if a significant effect is not likely to arise from the development that generated this extra visitor, its effects, which are real but below the threshold of the likelihood of a significant effect, must be added to the effects of other equally insignificant extra development. It is the totality of the effects 'in combination' that must be assessed. Decision makers have consistently found that the combined effect of additional, conventional dwellings, around the Thames Basin Heaths, is likely to be significant[12].

2.4.22 If plans and projects are to avoid being subject to 'appropriate assessment' and potentially to the tests of regulation 49 or 85C of the Habitats Regulations, the aim should be to avoid any significant disturbance, deterioration or habitat loss, other than trivial or inconsequential loss, from international sites.

2.4.23 Measures to avoid or reduce the effects of a development plan or proposal on a European site (here referred to as avoidance measures and mitigation measures respectively[13]) can be proposed as part of the plan or planning application and the planning authority will take these into account in the assessment. Avoidance measures eliminate the likelihood of any effects on the European site. Mitigation measures would be designed to reduce likely significant effects to a level that is insignificant or in a way that makes them unlikely to occur. It may be that a plan or project could have an adverse effect on site integrity, but changes to policy wording, conditions, restrictions or other legally enforceable obligations, would ensure avoidance or mitigation measures can be included in the project to remove the potential for adverse effects on site integrity.

2.4.24 Figure 2 below provides further explanation of the earlier parts of the decision making process under the Regulations to illustrate the effect of avoidance and mitigation measures when considering plans and projects.

2.4.25 The difference between avoidance and mitigation measures is not an academic one. If avoidance measures are proposed, and they are considered to be fully effective and guaranteed by being built into the implementation of the plan, or by way of legally enforceable conditions or obligations, then the plan or project is not subject to the further tests of the Habitats Regulations (following the route of boxes 1 – 2 – 3 in Figure 2 below). However, because the Regulations require projects to be considered both on their own and in combination with other projects, to see if their combined effects would be likely to be significant, mitigation measures may not be enough to enable a proposal to pass the tests of the Regulations. The plan's or project's effects will still have to be combined with others and the combined effects may still be significant even though the mitigation measures reduced the effects of the one plan or project to insignificant levels (following boxes 1 – 5 – 6 – 10 in Figure 2).

2.4.26 A plan should not be adopted or planning permission should not be granted for projects that

[12] Hoskin, R. and Tyldesley, D. (ongoing) *The Thames Basin Heaths Special Protection Area: a review of planning appeal decisions 2005 - 2006.* Natural England Research Report 2006

[13] The principle of a step-wise approach (starting with avoidance then considering mitigation then compensation measures) is incorporated into the key principles of PPS 9, at paragraph 1(vi)

a) are likely to have a significant effect and have not been assessed to determine whether there would be an adverse effect on the integrity of the site; or

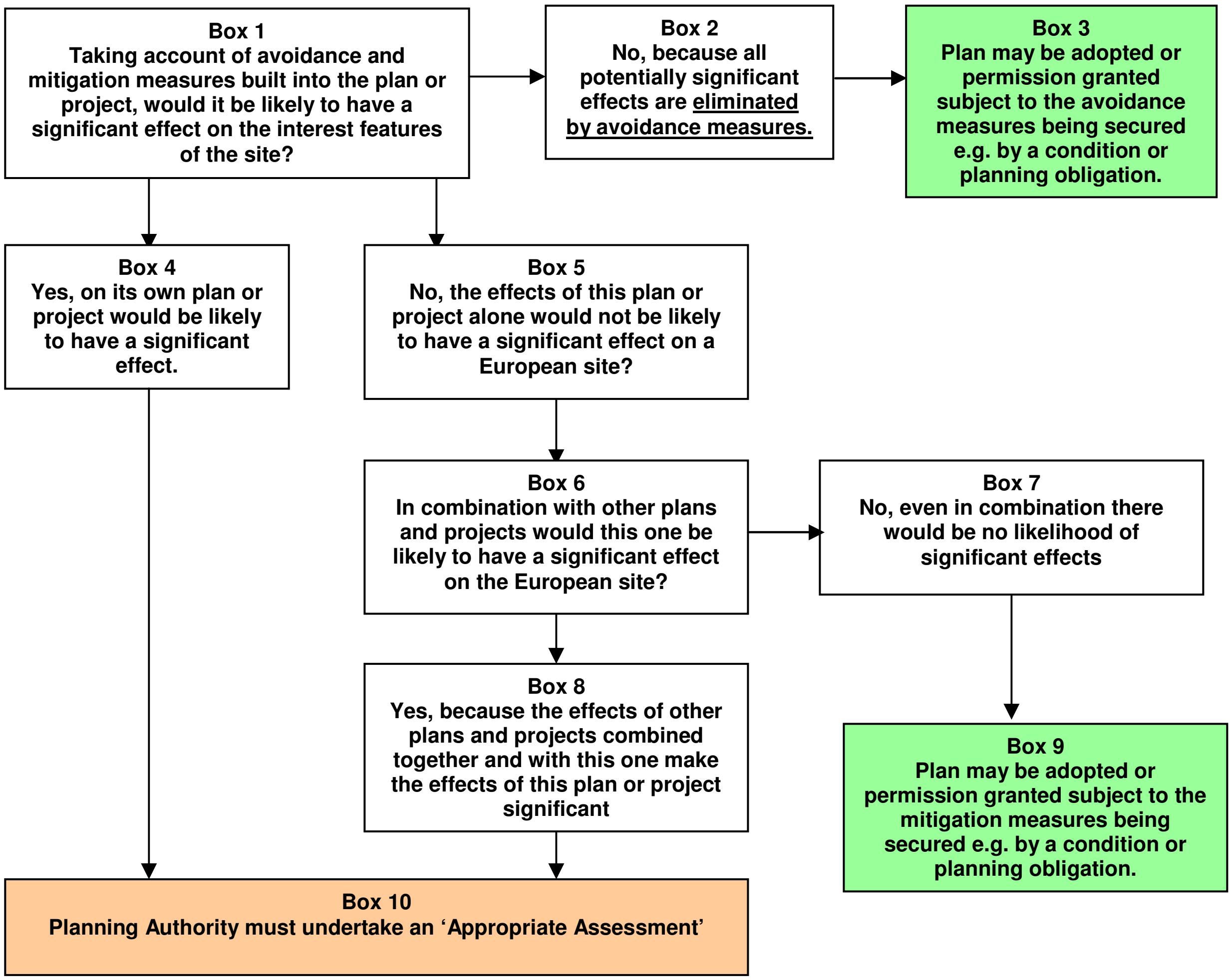
b) have been assessed and it cannot be concluded that there will be no adverse effect on integrity;

unless the project passes further stringent tests set out in Regulation 49 or 85C (see Figure 1 below).

2.4.27 Where it cannot be concluded that there will be no adverse effect on integrity, the planning authority must first consider whether there are alternative solutions that will have a lesser effect or avoid an adverse effect. If such alternatives exist, the plan cannot be adopted or planning permission cannot be granted as a matter of law[14]. For most allocations and developments, particularly residential proposals, it will be clear that there are alternative solutions that will have a lesser effect, or avoid an adverse effect on the European site, because there will be alternative sites on which dwellings could be built. It is therefore unlikely that a residential proposal that may or would have an adverse effect on the integrity of the European site could be permitted as a matter of law.

[14] *The Conservation (Natural Habitats &c) Regulations* 1994 Regulation 49(1) and 85C(1)

FIGURE 2
FURTHER DETAIL ON THE EARLY STAGES OF ASSESSMENT UNDER THE HABITATS REGULATIONS



2.4.27 As indicated above, the Habitats Regulations require that, where a plan or project alone would not be likely to have a significant effect on a European site, it must be considered whether it would be likely to have a significant effect in combination with other plans or projects[15]. An Appropriate Assessment will then need to incorporate all those plans or projects deemed likely to have a significant effect in combination, in order to ascertain if there will be no adverse effect on the integrity of the European site. This is an important consideration, particularly in relation to residential developments. The Circular states[16] that when considering the combined effects with other proposals it is necessary to consider the following:

a) Outstanding consents that are not fully implemented;

b) Ongoing activities or operations that are subject to continuing regulation (e.g. discharge consents or abstraction licences); and

c) Other proposals that are subject to any kind of authorisation, licence, permission or consent.

2.4.28 To these must now be added all land use plans subject to Regulation 85A and any other plans which have a considerable influence on the outcome of decisions about individual projects, for example, Shoreline Management Plans. It is also important to consider plans and projects across the whole European site, not merely the part, or the component SSSI, closest to the proposed development.

2.4.29 The Circular clarifies that the 'in combination' requirement applies to those proposals that require planning permission and also any other relevant plans and projects that may not necessarily require planning permission. However, any plan or project that would have no effect on the European site, because it has avoidance measures built into it, or applied to it before the planning authority applies the Habitats Regulations in the assessment process, would not be included in these 'in combination' assessments. Self-evidently, if a proposal is likely to have no effect on the European site it cannot have a significant effect either alone or in combination.

▪ The scope of an Appropriate Assessment for a plan or project likely to have a significant effect on a European site would typically include (but may not be limited to):

- How the plan or project may affect the interest features of the European site;

- Identification of the impacts of the proposal in combination with other plans and projects within or near to any part of the European site;

- Identification of impacts requiring avoidance or mitigation;

- Avoidance or mitigation measures in place prior to adoption of the plan or determination of the application, including those proposed as part of the plan or

[15] *The Conservation (Natural Habitats &c) Regulations* 1994 Regulation 48(1)(a)
[16] ODPM Circular 06/2005. *Biodiversity and Geological Conservation – Statutory Obligations and their Impact within the Planning System* Paragraph 16.

project and those that may be added by the planning authority by way of changes to the plan or conditions or restrictions when granting planning permission; and

- Residual impacts after avoidance and mitigation measures have been taken into account.

2.4.31 So, in order for a plan to be adopted or new development to proceed, it is necessary to ensure that when a plan is published or a planning application is submitted, sufficient avoidance measures are included to enable the planning authority to be confident that the proposal would not have any effect on the European site. That is, owing to the avoidance measures proposed, the plan or project would not have any effect on the European site (boxes 1, 2 and 3 in Figure 2). It would not, therefore, be likely to have a significant effect in combination with other projects. If this can be established, the plan or project would not be subject to Appropriate Assessment under the Habitats Regulations and the planning authority can proceed to adopt the plan or determine the application in the normal way. Avoidance measures in this context may mean the practical provision of the measures themselves, or a commitment to make a contribution to the strategic provision of avoidance measures already being provided by the planning authority through a separate strategy.

3 A summary of the evidence base concerning 'urban effects' and existing visitor pressure

3.1 Disturbance effects of Annex 1 bird species on the Dorset Heathlands SPA

Overview of disturbance

3.1.1 Human disturbance of birds has become a key issue for both conservationists and researchers. Disturbance involves any human activity that can potentially influence a bird's behaviour or survival. There have been many studies demonstrating such an influence, by a variety of mechanisms, and for a range of species. However, there is still contention about the applicability of the methods of study and the impacts on bird populations.

3.1.2 There are a variety of ways in which disturbance may occur. For example, birds may change their behaviour by stopping feeding, flying to alternative sites, leaving their nests, or mobbing the cause of the disturbance. This may increase stress levels. Direct mortality may also occur, for example there are examples where nests of beach-nesting waders have been trodden on by visitors or chicks predated by dogs. Birds may also suffer reducing breeding success with fewer broods or chicks reared. Several studies have shown that important factors are distance from and intensity of the disturbance, although some species have become habituated to disturbance where disturbance levels are high. Much of the scientific research has focused on behavioural responses, for example showing that birds fly away when a human approaches. Such studies are likely to have little application for site managers and often give conflicting messages of species "susceptibility" to disturbance.

3.1.3 It is difficult to identify when disturbance is an issue for those responsible for managing access. An impact on population size is the best measure of whether disturbance is having an impact. Unfortunately, very few studies have addressed population consequences of disturbance. The most common and widely reported effect of disturbance is for birds to avoid or reduce their use of otherwise suitable habitat (for example, by not settling on territories in highly disturbed areas). Nest predation rates have been shown, for some species, to be higher as a result of disturbance. Diurnal predators, such as crows and gulls, can be attracted to areas with high numbers of people and increased activity from adult birds around nests (caused by repeated flushing of incubating adults) may reveal the nests to predators.

3.1.4 The Dorset Heaths SPA is designated due to the presence of three breeding Annex 1 bird species (nightjar *Caprimulgus europaeus*, woodlark *Lullula lullula* and Dartford warbler *Sylvia undata*) and two over-wintering species (hen harrier *Circus cyaneus* and merlin *Falco columbarius*). We consider the evidence for disturbance effects for each of the three breeding species.

Nightjars

3.1.5 The nightjar is a bird primarily of the heathland/woodland edge, especially deciduous woodland but also conifer plantations. Breeding densities tend to be higher in plantations which are close to large tracts of heathland, and numbers of nightjars tend to increase with greater length of woodland edge (Lake, 2004; Morris *et al.*, 1994). They are aerial feeders, feeding on moths and other night-flying invertebrates. They will often feed away from heaths, travelling up to 7km from the nest each night to feed in areas such as floodplains or orchards likely to hold lots of invertebrates (Alexander & Cresswell, 1990; Bowden, 1990a; Cramp & Simmons, 1977 - 1995). Although difficult to see, due to their cryptic camouflage and nocturnal habits, they are easy to hear. The males sing at dawn and dusk, and the singing, described as churring, carries well.

3.1.6 Until recently, the species had undergone a very long-term population decline and range contraction, associated with the loss of lowland heathland, and possibly the availability of invertebrate food (Burgess, Evans & Sorensen, 1989; Holloway, 1996; Sharrock, 1976). National surveys of churring males have been conducted across the UK at approximately 10 year intervals since 1981 (Table 1). The most recent survey, in 2004, found that nightjar numbers had increased most markedly in Hampshire and Dorset (with both counties holding well over 700 males each), but that declines had occurred in some parts, especially north-eastern England and possibly in Scotland. The increases in numbers have been attributed to the protection of heathland, management of existing sites and recent dry summers (Conway *et al.*, (in prep)). In 2004, Dorset held approximately 18% of the UK population.

Table 1: County and national totals of nightjars (Data sourced from Conway *et al.*, (in prep); Green, 2004; Lake, 2004; Morris *et al.*, 1994)

	1981	*1992*	*2004*
Dorset	225	536	751
UK	2100	3093	4131

3.1.7 The species is a summer migrant, arriving on breeding sites from the beginning of May. The first nests appear from mid-May, reaching a peak in early June. Females will re-nest and nests occur into August. Nightjars require bare ground for nesting (Bowden, 1990a), in some parts of the country selecting sites protected by small trees (Burgess *et al.*, 1989). Nests sites are typically small areas of bare ground within a clearfell or in heather (Liley *pers obs*). Typically, two eggs are laid, the nest being little more than a tiny scrape. The adult is cryptically coloured, but the eggs are pale and conspicuous when the adult is not present. The adults will remain sitting on the nest until approached to within a few metres (adults typically flying at c. 10m when eggs are present and from even as close as 2m once the eggs have hatched, Liley *pers. obs.*).

3.1.8 Liley & Clarke (2003) looked at the relationship between the amount of urban development surrounding heathland sites in Dorset and the numbers of nightjars that occur on each heath. The work used the nightjar survey data from 1992 (when all the heaths in Dorset were surveyed for nightjars) and looked at the number of nightjars on 33 different heaths. The heaths represented a range of rural heaths, with very little housing and few people living nearby, to the more urban heaths located close or within the conurbations of Poole and Bournemouth. By using aerial photographs of each heath it was possible to calculate the amount of developed land within distance zones surrounding each heath. The actual numbers of houses around each heath was also calculated by using postcode data (which gives the number of houses in each postcode). The analysis showed that the more development there was around a heath, the fewer nightjars were present (Figure 1).

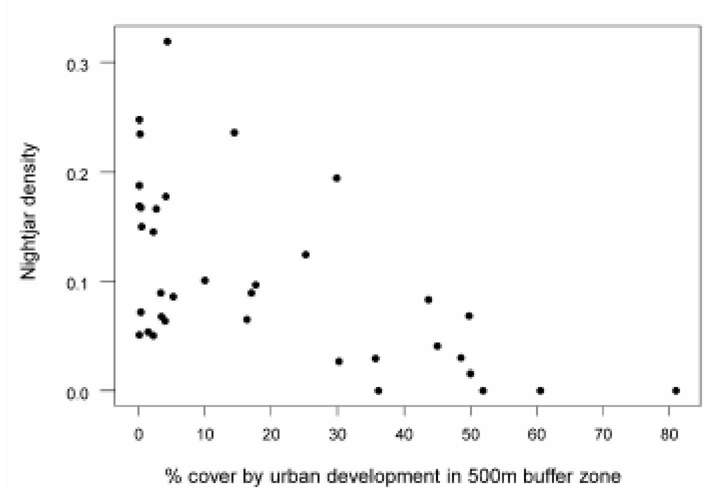


Figure 1: Density of nightjars (per hectare) per site in relation to the amount of development surrounding each site (the percentage of land that is developed within 500m of the heath boundary).

3.1.9 In 2004, all the Dorset Heaths were again surveyed for nightjars. The analysis above was repeated (D. Liley et al ?, unpublished) and the same effect was found.

3.1.10 Liley & Clarke's original analysis also considered the size of heaths, the amount of woodland surrounding each heath and the degree of fragmentation in order to check that some other factor was not causing the relationship shown in Figure 1. None of these other factors were found to be significant, apart a positive effect from the amount of woodland surrounding each site; when assessed together, both the amount of urban development and the amount of woodland were individually significant after allowing for the effect of the other factor.

3.1.11 While Liley & Clarke's work clearly shows some kind of urban effect, the work does not identify why nightjars occur at lower densities on the more urban heaths. Over the summer 2002, English Nature commissioned the RSPB in Dorset to look at nightjar breeding success on some of the heaths included in Liley & Clarke's analysis. The RSPB work (Murison, 2002) found 47 nests on eight different heaths. Nineteen of these nests (40%) were successful and the chicks fledged. The principal cause of failure for the 60% of nests which were unsuccessful was egg predation (monitored eggs either disappeared or were found destroyed). Although it is notoriously difficult to identify which predator is responsible, it was thought that many nests were predated by birds, probably crows. Murison's work showed that the sites where the most nests failed were the more urban heaths, and also that nests closer to footpaths were more likely to fail from predation. Nightjar eggs are pale, clearly visible to the human eye, and as there is no nest as such, they are very exposed when the adult is absent.

3.1.12 It is the adult bird incubating the eggs that provides the camouflage and protection from predators. Murison suggests that disturbance from people and perhaps, especially dogs, may flush the adult birds from the nest, exposing the eggs to predators such as crows.

3.1.13 Follow-up work by the RSPB (Langston *et al*., 2005; Woodfield & Langston, 2004) used video-cameras on nests to determine how often adults were flushed from nests and what was flushing them. The study recorded nightjars flushed from nests twelve times, although it was not always possible to determine what had flushed the birds. Dogs were certainly responsible for flushing the adult on two occasions. The cameras recorded one predation event, by a crow. The results from this work would seem to support the results found in the other two studies, and suggests that high levels of recreational access, and in particular dogs, may reduce nightjar breeding success.

3.1.14 There is therefore clear evidence that the numbers of nightjars on sites are related to housing levels and that the human disturbance can impact on breeding success. Nightjar numbers have also increased across the Dorset Heaths.

Woodlarks

3.1.14 Woodlarks require areas of bare ground and very low vegetation for foraging (Bowden & Hoblyn, 1990; Bowden, 1990b; Mallord, 2005). They nest on bare ground, sheltered by tussocky vegetation. Suitable habitat is often found along firebreaks and paths, and nests will often be in such areas, potentially very close to walkers and their dogs (Liley, *pers. obs*.). Woodlarks feed on foot, catching spiders and other invertebrates of bare ground. Scattered bushes and trees or brash piles are often used for song perches.

3.1.15 Historically, populations of woodlarks have fluctuated, particularly as a result of habitat change and severe winter weather, from which recovery is slow (Cramp *et al.*, 1977 - 1995; Holloway, 1996). In the 1920s to 1950s, the population was expanding its range, but subsequent, rapid range contraction led to concentration in five regions of England: south west England, New Forest/Dorset, Hampshire/Surrey border, Breckland and the Suffolk Sandlings (Sharrock, 1976; Sitters, 1986; Sitters *et al.*, 1996). Since the 1986 population census coincided with a period of low numbers (241 territories were recorded), it was expected that the optimum habitats would be occupied. There was considerable variation in habitat use between the five regions, probably reflecting availability, with the main use as follows: south west England – agricultural land, particularly unimproved grassland and marginal habitats; New Forest/Dorset and Hampshire/Surrey border – heathland; Breckland/Suffolk Sandlings – forestry plantations (Sitters *et al.* 1996).

3.1.16 The 1997 national survey of woodlarks showed a substantial recovery in numbers from 1986, confirming the indications of intervening sample surveys. The species has undoubtedly benefited from the availability of clear fells and restocks, and heathland restoration projects also are considered to have aided their recovery (Wotton & Gillings, 2000). Analysis of data from Breckland suggests that the population increase in recent years may be as a result of climate change, which has led to the breeding season starting earlier and therefore making available more time in which to breed (Wright *et al.*, 2005). Of the 1426-1552 woodlark territories located in 1997, over 85% were on heathland or in forestry plantations. Of the 39% territories found in forestry plantations, 77% were in young plantations, especially of 2-3 years in age. A further national survey was conducted in 2006, but as yet results are unavailable.

3.1.17 Woodlarks are thought to be partial migrants in the UK, most moving away from breeding areas, but at least a proportion of these birds remain in southern England (Lack, 1986; Wernham *et al.*, 2002). The proportion that remains on the breeding sites can occasionally be heard singing throughout the year, but territorial activity begins in earnest from early February. In optimum habitats, territories may be only 1.5–2ha (Gimingham, 1992). Woodlarks tend to return to the same area, or within 0.5km, each year and young birds occupy territories close to their natal site (Bowden & Green 1991). Apparently suitable habitat is also more likely to be colonised if it was previously occupied or close to areas used by woodlarks. The first nests appear in early March and nesting continues until July. Pairs will re-nest within the same season.

3.1.18 Mallord (2006b; 2005) spent four years studying the impact of disturbance on a woodlark population on 16 heathland sites in Dorset. These sites all had historical records of breeding woodlarks, and together encompassed a range of visitor access levels. Mallord found that the density of woodlarks within a site was negatively correlated to disturbance levels, with lower densities where disturbance levels were higher. In addition, within sites, the probability that a territory would be occupied declined with increasing levels of disturbance. However, there was no effect of disturbance on nest survival, and the number of chicks raised per pair actually increased at higher levels of disturbance. This was because birds in areas of high disturbance were nesting at lower densities, and at these low densities chicks seemed less likely to starve and more fledged. Overall, Mallord estimated that if there was no disturbance on any of the sites, 34% more woodlark chicks would be raised.

3.1.19 Using a similar approach to that used by Liley & Clarke (2003) for nightjars, Mallord (2005) also looked at the numbers of woodlarks on sites in relation to the amount of urban development surrounding each site. He found that the number of woodlarks found on a site was determined by the amount of suitable habitat within the site, and the extent of adjacent urban development (Figure 2). He suggested that urban development could be operating in three distinct ways; firstly, by increasing site isolation and thus reducing the probability of colonisation; secondly, by reducing the amount of foraging habitat available to birds off-site; and thirdly, as a surrogate for recreational disturbance, to which it is strongly related.

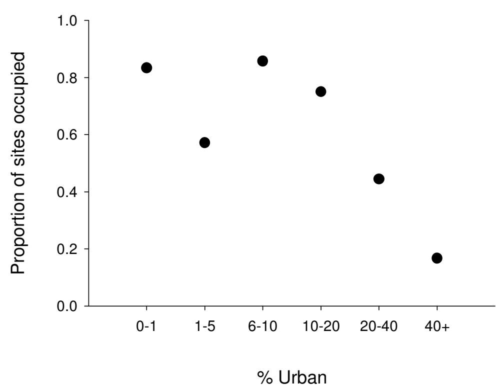


Figure 2: The proportion of heathland sites occupied by woodlarks and the amount of urban development surrounding each site. Taken from Mallord (2005).

Dartford warblers

3.1.20 Primarily a bird of southwest Europe, the Dartford warbler is on the northerly edge of its range in western France and southern England (Bibby, 1979a; Gibbons & Wotton S., 1996). It is one of the few warblers in Britain that does not migrate in winter. As such, it is very susceptible to severe winter weather, which causes the population to crash and contract in range (Lack, 1986); prolonged snow-lie poses particular problems (Westerhoff & Tubbs, 1991).

3.1.21 The Dorset heaths and New Forest comprise the core of the range and offer the best conditions for survival; they have milder winters even when other areas are exceptionally cold (Gibbons, Reid & Chapman, 1993; Holloway, 1996; Tubbs, 1963). It is estimated that, in 1988, the New Forest alone may have accounted for nearly 75% of the British population of Dartford warblers (Westerhoff *et al*., 1991). Adults tend to be very site faithful, even when harsh conditions prevail as a result of cold weather or fire damage to heathland, but young birds disperse widely and so facilitate recolonisation after population crashes (Bibby, 1979a).

3.1.22 The Dartford warbler is considered to be vulnerable to severe winters and heath fires in the short term and to habitat fragmentation in the long term (Bibby, 1979b). This species has shown marked fluctuations in numbers and range in response to periods of severe winter weather and mild winters (e.g. Sharrock, 1976). In the 19th century, the breeding range extended from East Anglia and Kent west to Cornwall (Witherby *et al*., 1938), but in the 1960s, after a series of cold winters the population was down to just eleven pairs, with just four in Dorset (Green, 2004). Recent years have seen a rapid increase in numbers with an almost four-fold increase between the 1984 and 1994 national surveys (Gibbons *et al*., 1996) and an extension of range with recolonisation of parts of East Anglia. In 2002, the species was downgraded from red to amber listed as a result of the population increase (Gregory *et al*., 2002). A series of mild winters is thought to have been at least partly responsible for the increase. Robins & Bibby (1985) raised concerns about the future of Dartford warblers in Dorset, as a result of the loss and fragmentation of heathland leading to more isolated breeding territories which may not be viable in the long term.

3.1.23 The fluctuating populations of Dartford warbler have been monitored at intervals by means of local and national surveys in 1974, 1984 and 1994 (Gibbons *et al*., 1993; Gibbons *et al*., 1996). The 1984 survey followed several cold winters and so recorded a lower population than during the 1974 survey. However, there was not a decrease everywhere. Surrey saw a recovery in numbers and Cornwall was recolonised after an absence of 40 years. Some losses were due to the growth of forestry plantations on heathland; once conifers overtop heather and gorse, the birds cease using young forestry plantations (Bibby, 1979b; Moore, 1962). The post-1960 period, during which numbers of Dartford warblers have been monitored regularly, has been characterised by periodic losses of the birds in the Thames Basin and Western Weald following cold winters (Westerhoff *et al*., 1991). Outlying areas are recolonised as the population recovers, but increasingly disparate fragments of heathland may severely hamper this process, particularly where fragments are small.

3.1.24 The preferred habitat of Dartford warblers comprises dry heath with dense, mature heather, c. 30-50cm high, with thickets or scattered bushes of mature gorse *Ulex* spp., c. 1-2m high (Bibby, 1979a; Bibby & Tubbs, 1975; Moore, 1962; Robins & Bibby, 1985; Tubbs, 1963; Westerhoff & Tubbs, 1990). This combination can be achieved by periodic, controlled burning (Moore, 1962; Westerhoff & Tubbs, 1990). Controlled burns on a six-eight year rotation were recommended by Tubbs (1967) to provide suitable conditions in the New Forest for Dartford warblers, which colonise heather of at least three-five years old (Moore 1962).

3.1.25 Areas with over 50% gorse cover were found to be favoured, with breeding densities over ten times higher than areas with no gorse (Bibby, 1979a). In 1988 in the New Forest, Westerhoff & Tubbs (1991) found breeding densities of 20 per km^2 on dry and humid heath and 33.8 per km^2 in gorse thickets, where particularly high breeding densities occur. Catchpole & Philips (1992) found that whilst territories containing more gorse produced more young, these territories also suffered the most adult losses because the gorse distribution was closely associated with roads and some adults were believed killed by passing cars. Gorse is closely associated with past human activity and so favours boundary banks, old tracks, old gravel workings, the sites of old fields and plantations, i.e. areas of disturbed ground (Moore, 1962; Tubbs, 1963; Westerhoff *et al*., 1991). Although there is considerable variation between territories, gorse and heather are both important for nesting, whilst gorse is particularly important for foraging.

3.1.26 Dartford warblers are insectivorous all year round and largely resident, although they can be partial migrants (Bibby, 1979c; Wernham *et al*., 2002). Consequently, they require fairly large territories to supply adequate food. The average territory size is approximately 2.5 hectares (Bibby, 1979a; Catchpole, 1991; Catchpole *et al*., 1992), although large areas of heath tend to support relatively higher densities than small heaths (Bibby & Tubbs, 1975). Gorse has a higher density of invertebrate fauna than heather and is used more for foraging than its relative abundance would suggest (Bibby, 1979a). The adults select large prey items, mostly beetles, spiders, lepidopteran larvae and bugs. Nestlings are fed on caterpillars, grasshoppers and spiders. Feeding conditions tend to improve during the summer and so later clutches tend to be larger. Although the nesting season is quite long from first egg dates in late April to last young fledged in early August, many pairs start too late in the season to have a chance of a second brood. Consequently, Bibby found an average of 1.25 broods per pair.

3.1.27 Young Dartford warblers leave the nest prior to fledging, at about 12 days old, but remain in the vicinity for several days (Bibby, 1979a; Cramp et al., 1977 - 1995). Bibby observed a high level of nesting success, approximately 80% of nests rearing one or more young (1979a).

3.1.28 Dartford warblers have been intensively studied in Dorset by Giselle Murison as part of a PhD, funded by English Nature, to investigate the effects of human disturbance and urban development on the species. This work is ongoing, but the results to date (Murison *et al*., in press,) differentiate between territories in different habitat types. Three habitat types are recognised: heather-dominated territories, heather territories with significant areas of European Gorse *Ulex europaeus* and territories containing Western gorse *U. gallii*. Productivity was significantly affected by the timing of breeding in all habitats, but disturbance only appeared to have a significant impact on the productivity of birds in heather territories. Disturbance events in heather territories delayed breeding pairs for up to six weeks. This significantly decreased both the number of successful broods raised and the average number of chicks fledged per pair. Nests situated close to territory boundaries in heather territories, with high numbers of disturbance events, were more likely to fail outright. Murison determined that an average of between 13 and 16 people passing through a heather territory each hour would delay breeding pairs sufficiently to prevent multiple broods. In addition, recoveries of ringed birds have provided conclusive evidence that domestic cats do predate Dartford warblers and that on some sites a large proportion of the year's young are lost to cat predation (Murison pers. comm.).

3.2 Other effects of urban development, including SAC features

Overview of other effects of urban development

3.2.1 Human disturbance to birds has become an area of particular focus, with the publication of various key papers on the Annex 1 bird species in recent years. However, disturbance effects are not the only impact of urban development and should not be considered in isolation. The other 'urban effects' include a wide range of impacts including: deliberate and accidental fires, litter, predation from people and pets, eutrophication and dumping / fly tipping. Attention was formally drawn to these issues in a report on the Dorset heaths to the Council of Europe in 1998 (Molenaar 1998), which prompted the UK Government to commission a study of heathland fires in the county (Kirkby & Tantrum 1999). Urban effects were later summarised by Haskins (2000) and extensively reviewed by Underhill-Day (2005). So as to provide a single-source and self-contained evidence base, we use section 3.2 to summarise the key points of Underhill-Day and other sources as specified he reviewed (see also Table 2).

3.2.2 Many of these urban effects may operate synergistically to influence the conservation interest of any one site. Two examples illustrate this: fire removes vegetation cover, which increases rates of reptile predation by cats; fragmentation reduces mean site size and populations, thereby both increasing the vulnerability of fauna and flora to competition from non-heathland species and lowering their chances of recolonisation. This means that it is difficult to single out a particular effect in explaining the rarity or absence of a species or suite of species. It is therefore important to consider all the urban impacts together, and it is for this reason that correlations of fire occurrence (Kirby & Tantrum, 1999) or bird numbers (Liley & Clarke, 2002; Liley *et al.*, 2003; Mallord, 2005) with housing levels around sites are particularly appropriate in identifying general urban effects.

Wild fires

3.2.3 While controlled fires have been part of beneficial heathland management in Dorset for hundreds of years, wild (i.e. unmanaged) fires are another matter. Wild fires and fires on urban heaths have been increasing sufficiently in incidence to cause widespread concern; unlike controlled fires, wild fires are not targeted at specific stages in the heathland cycle, restricted to a pre-determined size ora specific season (winter for controlled fires).

3.2.4 Kirkby & Tantrum (1999) analysed 3333 fire incidents in Dorset during 1990-1998. There was a clear peak during April-August, the period when potential damage to heathland fauna and flora is at its greatest.

3.2.5 Kirkby & Tantrum revealed a clear link between fire frequency and urban areas. Most fires were in east Dorset, particularly around Bournemouth/Poole, the highest concentrations being around the urban fringes: 70% of fires were in the associated 100km square SZ, which covers just 7.5% of the county's area, and 24.4% of the county's heathland. Fires were more likely to be reported from SSSIs which had densely developed areas within 500m of their boundaries. Fires appeared more likely to occur on areas which had more than 15% of their surrounding 500m developed, presumably due to easier access. Of the 26 SSSIs with the highest number of fires, 70% were in or adjacent to urban areas. The most frequently burnt sites were Canford and Upton Heaths, and Turbary, Ham and Kinson Commons.

3.2.6 Kirkby & Tantrum's survey of the causes of fires revealed 59% were arson, 17% were camp fires, 8% from management fires getting out of control, and 7% from spreading bonfires. There was a widespread belief that children were responsible for igniting most wild fires: fires were more likely at weekends, during school holidays and in the afternoon and evening.

3.2.7 Fire has a serious impact on ecological integrity. The effects of fires on wildlife depend on their extent and frequency. The effect of individual fires depends on date, fire temperature and duration, and the type of habitat burnt. Fire destroys heathland vegetation, which, depending on substrate and fire characteristics, can take 4-20 years to re-establish, most areas going through successional grassland stages, and some on better soils ending up in woodland rather than heathland. Particularly hot, slow-moving fires can destroy seedbanks and even the peat layer, thus extending the time taken for heathland vegetation to re-establish.

3.2.8 Invertebrate communities also re-establish successionally (although large fires may wipe out populations of poor dispersers). At first, bare ground species and predators predominate. Species with restricted niches (e.g. living in litter or the heather canopy) take ten years or more to recolonise and are particularly threatened by large fires. Such species are particularly threatened by re-burning once vegetation is tall enough to allow a fire to spread; such re-burning is characteristic of urban fires. Some studies have shown a reduction in species richness following a fire in bugs, herbivorous beetles, moths and soil mites, whilst increases in richness and numbers have been noted in grasshoppers, ground beetles, hunting spiders and ants.

3.2.9 Large fires remove both nesting cover and foraging habitat for insectivorous birds such as Dartford warbler and stonechat. These only survive burning episodes if habitat islands survive a fire unburnt. Regular re-burning (as frequently the case in urban areas) could suppress populations indefinitely. However, once vegetation has re-established (six years in one study), densities of Dartford warbler appear to be higher than in adjacent, unburnt habitat. Recolonisation is by immature birds, as adults appear restricted to their territory all their lives.

3.2.10 A summer heathland fire will kill many reptiles in the burnt areas; those that survive are susceptible to predation in the immediate aftermath of the fire. Recolonisation from adjacent unburnt areas can take 5-25 years. Smooth snake *Coronella austriaca* populations are denser in heaths older than 20 years, so are particularly susceptible to the effects of fire.

Cats and other urban predators

3.2.11 Although there have been no surveys of the cat population and its impacts in Dorset, UK-wide data is available. There are thought to be about 9 million cats in the UK, and an average of 320-330 per 1000 households. If reflected regionally, we conjecture that this ratio would give a rough estimate of the Dorset cat population of 100,000, based on 303,000 Dorset households (National Statistics for 2001, cited on www.dorsetforyou.com). A more detailed estimate would need to take into account variance in cat-ownership variables such as income (as incomes increase, so does cat ownership), working status (working housewives are more likely to own a cat than non-working housewives) and age (old people are less likely to own a cat).

3.2.12 Cats are prolific predators: conservative estimates of prey caught are 9300 items per 1000 households or roughly 29 prey items per cat. The two largest UK studies, combined, suggest cat prey comprises 73% mammals, 22% birds, 3% fish and herpetofauna and 2% insects. While there are no data on the effect of cats on heathland vertebrates in Dorset, cats have been recorded hunting in sand lizard *Lacarta agilis* colonies (Henshaw, 1998) and catching Dartford warblers. Recent research on the latter has revealed high predation rates of Dartford warbler chicks by pet cats (Murison *pers. comm.,* unpublished doctoral research). Underhill-Day presents records of cats from 15 Dorset heathlands – and evidence suggests that they roam up to 1500m (particularly at night), so urban heaths are well within territory ranges of urban cats. At an average 29 prey items per cat, we conjecture that the total number of prey items taken by Dorset cats may be of the order 2.9 million pa, although only a small proportion of these are likely to be taken on heaths. There is no evidence of the impact of cats on overall prey numbers, but there is some evidence that while populations overall are largely unaffected, numbers can be reduced locally.

3.2.13 The proximity of some heaths to urban areas may also result in an increase in the densities of other urban predators, notably foxes and hedgehogs, on those heaths (Taylor, 2002). On heaths with human activity, there is evidence of higher densities of avian predators such as crows and magpies (Marzluff & Neatherlin, 2006; Taylor, 2002,).

Trampling

3.2.14 Heathland plant communities are more vulnerable to human trampling than grassland plant communities. Trampling on heathlands may be by horses, cycles, motorcycles or feet. In grassland, motorcycles are more destructive than horses on sloping ground and on level ground if ridden above 20km/h (Weaver & Dale 1978): the same may apply to heathland. The ecological effects of trampling comprise: soil compaction, changes to soil hydrology or chemistry, changes to the soil invertebrate community (and an overall reduction in invertebrate numbers), changes in plant communities and—with heavy use—soil erosion and creation of bare ground.

3.2.15 The degree of damage depends on several factors: soil type, slope, drainage and hydrology; the composition of the initial vegetation; and the scale, frequency and seasonality of its wear. Nutrient-poor, coarse-textured inorganic soils (such as heathland sands) are particularly vulnerable to compaction, especially when wet. Wet communities are more vulnerable than dry communities, although they may recover more quickly. Bogs or vegetation with lichen and mosses are particularly intolerant of trampling (Anderson & Radford, 1992; Winning, 1994).

3.2.16 Evidence from Brittany (Gallet & Rozé, 2002) suggests: that dry heaths are more resistant to trampling than wet; dry heaths, Dorset heath and gorse are more resistant in winter than summer; repeated trampling causes more damage than a series of single trampling events; damage to wet heath is greater in dry conditions, but recovery is quicker; and recovery from winter trampling is greater on wet heaths than dry.

3.2.17 Trampling also affects some invertebrates: horse trampling damages populations of some Hymenoptera and Diptera on bare ground on southern heaths (Miles, 2003).

Non-disturbance effects of dogs

3.2.18 Roughly half the visitors to Dorset heathlands bring an average of 1.5 dogs with them. Between 40-90% let their dogs off the lead, and 40% clean up dog excrement. In addition to disturbance to birds and direct predation (see section 3.1), dogs chase livestock (which causes trampling), disturb aquatic wildlife, cause physical damage to water body structure, and possibly chemical pollution and enrich soil through fouling. The inevitably local enrichment (eutrophication) effects—caused by inputs of nitrogen, phosphates and potassium—may last up to three years in grassland communities, and may have a similar duration of effect in heathlands; the enrichment effect on nutrient-poor soils such as heaths is significant. Dog fouling declines with distance from paths.

Fragmentation

3.2.19 Urban pressures add to the ongoing fragmentation and isolation of Dorset heaths. Whilst the area of Dorset heathland dropped between 1978 and 1996 (from 7913 to 7373 ha), the number of heath fragments greater than 4ha rose from 137 to 151 during the same period (Rose *et al.*, 2000; Webb, 1990). In 1978-87, most losses of heath were due to agricultural expansion or urban development. From 1987-1996, most losses were due to vegetation succession.

3.2.20 Smaller, more isolated fragments tend to have higher species-richness (due to edge effect attracting non-heathland species, itself a threat), but fewer heathland indicator species and poorer characteristic heathland plant communities. Spider species with poor powers of dispersal are confined to larger fragments: in smaller fragments, they have a lower probability of occurrence, lower abundance and lower chance of recolonisation. Smaller fragments will have smaller populations and smaller and fewer suitable areas for the survival and colonisation of heathland plant specialists. Such smaller populations are at greater risk of extinction due to other urban effects (or chance events). Fragmentation appears to be the main cause of the decline of British sand lizards. With their poor colonisation ability, fragmentation increases their susceptibility to fire and predation (Presst *et al.*, 1974). Fragmentation has also been a major factor in the decline of the smooth snake (Spellerberg & Phelps, 1977). Liley & Clarke (2003) showed that there was a linear relationship between fragment size and nightjar, woodlark and Dartford warbler numbers: the larger the heathland area, the more of these heathland birds.

Roads

3.2.21 Roads exacerbate habitat fragmentation. Studies have shown that roads pose greater barriers to arthropod and other invertebrate mobility than do grassy tracks (Mader, 1984; Mader *et al.*, 1990). Roads also result in road kills – of birds, mammals, reptiles and invertebrates. Increased levels of noise and light pollution are also associated with roads, and these are considered to affect birds and invertebrates generally (Reijnen *et al*., 1997) and may do so on heathlands.

Other urban effects

3.2.22 Ground and surface water pollution from hard surfaces, spills and dumping pose a pressure to macroinvertebrates in watercourses and vegetation communities (Armitage *et al.*, 1994). Air pollution from industrial uses, fires and vehicles has a negative impact on vegetation communities (Bobbink *et al.*, 1998). Fly-tipping of household and garden rubbish may cause eutrophication of soils and watercourses (Liley, 2004;

Urban Health LIFE Project website[17]). Urban noise may affect birds whose songs are adapted to long-distance transmission, such as nightjar and woodlark. High ambient noise levels were found at one nightjar nest site (Underhill-Day, 2005).

Table 2: Summary of key negative impacts of development close to European heathland sites. Further details on disturbance to birds is given in the text (section 3.1). The table summarises the report of Underhill-Day (2005), with some additional references. See the text (section 3.2.3 onwards) for a full discussion of the effects in the table. Key references are given only where particularly relevant in addition to Underhill-Day (2005).

Effect	Description and Impact	Species / species group affected	Key references
Fragmentation	Loss of supporting habitats	Nectar feeding invertebrates; nightjar, woodlark	(Alexander *et al.*, 1990)
	Lack of connectivity between sites preventing movement / genetic exchange between sites	Invertebrates, plants, reptiles, birds and mammals	
	Smaller site size increases edge effects from non-heathland species	Invertebrates and plants	(Webb, 1989; Webb, 1990; Webb & Thomas, 1994; Webb & Vermaat, 1990)
Predation and increased mortalities	Access by pet cats, some of which feed on the heath	Birds, invertebrates, reptiles and amphibians	(Barratt, 1995; Woods, 2002)
	Different densities of mammalian predators such as foxes present on more urban heaths	Birds, reptiles, mammals.	(Taylor, 2002)
	Increase in crows and magpies on sites with greater human activity	Birds, invertebrates, reptiles and amphibians	(Marzluff & Neatherlin, 2006; Taylor, 2002)
Roads	Road kills from traffic	Birds, invertebrates, reptiles and amphibians	
	Increased levels of noise and light pollution	Birds, Invertebrates	(Reijnen, Foppen & Veenbaas, 1997)
	Roads are barriers to species mobility	Invertebrates	(Mader, Schell & Kornacker, 1990)
Disturbance to birds	Areas with high visitor pressure not settled by breeding birds, resulting in low densities	Nightjar, woodlark and Dartford warbler	
	Adults flushed from the nest by people / dogs	Nightjar	
	Pairs breed later and fewer times, resulting in reduced breeding success	Dartford warblers	(Murison *et al.*, in press,)
Pollution / Hydrology	Ground and surface water pollution from roads and hard surfaces, spills and dumping.	Vegetation communities, macroinvertebrates in watercourses	(Armitage, Blackburn & Symes, 1994)
	Air pollution from industrial uses, fires and vehicles	Vegetation communities	(Bobbink, Hornung & Roelofs, 1998)
Trampling	Soil compaction	Plant communities and species. invertebrates	(Taylor *et al.*, 2006)
	Soil erosion from walkers, cyclists and horse riders	Plant communities and species, some invertebrates benefit	
	Damage to breeding and wintering sites	Invertebrates and reptiles	
	Creation of extensive path network increases spatial disturbance	Birds, reptiles	
Vandalism	Damage to signs, fences, gates		
Eutrophication	Enrichment of soils from dog excrement.	Plant communities and	(Bonner & Agnew,

[17] http://www.dorsetforyou.com/index.jsp?articleid=340710

		species, invertebrates	1983)
	Dumping of household and garden rubbish.		(Liley, 2004)
	Enrichment along road corridors, effects of dust, salt, run-off	Plant communities and species, invertebrates	(Angold, 1997)
Fires	High fire incidence on urban heaths. Direct mortality of fauna. Temporary removal of breeding and foraging habitat	Birds, invertebrates, reptiles and amphibians	(Kirby *et al.*, 1999)
	Long term vegetation change from repeated fires	Vegetation communities	(Bullock & Webb, 1994)
Restrictions on management	Stock grazing, gates left open, dogs chasing animals, injury to stock		
	Objections to management eg. tree clearance		(Woods, 2002)
	Increased costs of wardening		
Negative public perception	Disregard of access and activity restrictions, hence trampling, dog fouling, fire lighting, illegal motorcycling etc	Vegetation communities, birds, invertebrates, reptiles and amphibians	

3.3 The reasons why Dorset's heathland attract people, the numbers of visitors and their patterns of access, based on research into human access patterns

3.3.1 The most comprehensive survey of visitors on the Dorset Heaths is that by Clarke *et al.* (2006), which compares visitor numbers and visitor data, patterns of access and reasons for visiting across 20 different access points within the Dorset Heaths. Additional information on visitor access on the urban heaths comes from the ad hoc interviews conducted by wardens on the Urban Heaths (Liley & Underhill-Day, 2006c; Rose & Clarke, 2005). Results of postal surveys of residents adjacent to heathland areas are described by Atlantic Consultants (2003; 2005). Wider context from other heathland sites is provided by studies such as Liley *et al.* (2006a) which explored access patterns on the Thames Basin Heaths using methods identical to that used in Dorset by Clarke *et al.* (2006), thereby allowing direct comparison. Analysis comparing visitors to heathland SPA and non-SPA sites can be found in Liley *et al.* (2006b).

3.3.2 In the Clarke *et al.* study, 80% of the 632 people interviewed in total were mainly using the heaths to walk their dog(s). There was no significant difference in the proportion of visitors coming to walk their dog when comparing sites with and without car-parking.

3.3.3 There were some marked differences between sites in the proportion of visitors visiting to walk their dog (Table 3). At Godlingston and Hartland, some of the interviewees were tourists, and at Hartland many of the people interviewed were visiting specifically to birdwatch from the hide overlooking Middlebere and Poole Harbour. At Turbary, 51% of the people interviewed were using the heath as a short cut to reach the shops, their place of work or relatives' houses. Therefore some sites appear to attract other people, in addition to dog walkers, and some sites, such as Avon Heath South Park, would appear to attract particularly high numbers of dog walkers.

Table 3: Proportion of people visiting different sites to walk their dogs (from Clarke et al., 2006)

Heath access point	*Total no people interviewed (over 16 hours)*	*% dog walking*
Avon Heath south park	81	99
Canford Gravel Hill	41	95
Tadnoll	26	92
Parley	50	90
St Catherines	50	90
Lions Hill	19	89
Talbot Heath	17	88
Ferndown	22	86
Sopley	36	86
Winfrith	20	85
Holt	39	85
Belben Road	17	82
Upton	49	82
Great Ovens Sandford	25	80
Black Hill Bere Regis	8	75
Stoborough New Rd	24	63
Morden	29	59
Hartland Tramway	28	36
Turbary common	39	36
Godlingston	12	25
Total number	632	80

3.3.4 While dog-walking is the main reason people visit the heaths, there is a wide range of other reasons why people visit. The two visitor surveys on the Dorset and Thames Basin Heaths interviewed people that were visiting to jog, keep fit, ride their horse, watch birds, take the children out or simply to walk. At Holt Heath in Dorset a running group (29 people) were encountered, and other organised activities included a group involved in a battle enactment and a group flying model airplanes. Particularly unusual, and unexpected, reasons included one family that were planting an ornamental tree (on part of Stoborough NNR overlooked by their house) and another person who was walking their pet cat. Table 4 summarises the range of different activities recorded during the Thames Basin and Dorset Heath visitor surveys.

Table 4: Numbers of people visiting the heaths for different activities on the Thames Basin Heaths and on the Dorset Heaths. Data for the Thames Basin Heaths is that used in Liley *et al.* (2006a) where data are for 2062 people (1144 interviews) and the Dorset data is that used in Clarke *et al.* (2006), involving 973 people (632 interviews). Both surveys used the same methodology. The top part of the table gives the categories used in the interview, and the lower part gives some of the "other" reasons people gave.

	TBH	*%*	*Dorset*	*%*
Dog-walking	1,210	59	716	74
Walking	666	32	123	13
Jogging	90	4	55	6
Cycling	119	6	28	3
Horse Riding	32	2	24	2
Picnic	79	4	4	0
Other	213	10	119	12
'Other'				
Taking the children out	70	3	16	2
Flying model aircraft or kites	19	1	7	1
Fishing	14	1	0	0
Short cut to work	14	1	4	0
Exercise / keeping fit	9	0	2	0
Mushroom picking	9	0	2	0
Orienteering	5	0	0	0
Nature watching	4	0	19	2

3.3.5 Clarke *et al.* (2006) found that the distance travelled on the heaths in Dorset and the penetration distance (defined as the distance from the access point to the point half-way around the route walked on the heath) are related to the area of the heath, as people tended to walk shorter distances on the smaller heaths. Neither the average distance walked on a heath or the penetration distances were correlated with the presence of parking facilities at the access points, so although heaths with parking will attract more people arriving by car, such people do not walk any less or further than other visitors once at the heath. The average total distance walked by dog-walkers was 2181 m, with an average penetration distance onto the heath of 698 m. Eighty-three per cent of dog walkers did not penetrate further than 1 km onto the heath. Results from the Thames Basin Heaths (Liley *et al.*, 2006a) were similar, although distance walked and penetration distance were not related to heath area there, probably because the heath patches were mostly larger than many of the small heath patches in Dorset. The two datasets were combined to form a single probability distribution of penetration distance to be used for all points (see Appendix 2).

3.3.6 Some sites are well known, well publicised and popular tourist destinations. These sites will attract a different type of visitor to the mainly local people interviewed in the surveys described above. Studland and Hengistbury Head are both coastal sites with popular beaches and a range of tourist facilities, such as cafés. Few of the inland heaths attract high numbers of tourists, but there are some exceptions (see Dickinson, 2006, in press. for details of sites and trips done by tourists in Purbeck). Arne RSPB reserve has a car-park and the footpaths lead to viewpoints and the harbour shoreline.

The reserve is well publicised locally. The Hartland Moor area, with various trails, bird hides etc is also popular.

3.3.7 The relative numbers of tourists to residents in the tourist hot-spots is high. For example, an estimated 2,330,000 day and 490,000 staying visitors visit Purbeck each year (Purbeck Heritage Committee, 2002), while the local population of Purbeck is 44,000 residents (Buro Happold, 2003). Only certain heathland sites, such as Studland, are likely to attract tourists.

3.3.8 Moors Valley Country Park is also likely to attract a different range of visitors to the other heaths. The country park has a wide range of facilities, including a visitor centre, adventure play area, narrow gauge steam railway, golf course, play trail, tree top trail, cycle hire and aerial walkway ("Go Ape") which is advertised on television.

3.4 Intensity of existing visitor pressure on Dorset's Heaths

3.4.1 Including all the associated forestry and other "visitable" areas, the Dorset Heaths total some 10,718 ha, which can be split into 61 'patches'. Of this total area, 5441 ha are within the Dorset Heaths SPA. There are a total of 531 access points onto these 'visitable' patches, and a total of 5,215 car-park spaces. These data are summarised by district in Table 5. These patches are shown in Map 1, and map 2 shows them in relation to the SPA, SAC and Ramsar boundaries.

Table 5: Total areas of patches within each district and details of car-park spaces etc. The totals in this table do not match those in paragraph 3.4.1 as part of the Ringwood Forest patch is within Hampshire.

	Area of patches within District (ha)	*Number of access points onto patches*	*Total number of car-park spaces on patches*	*% of District within 5km of a patch*
Poole	581	82	276	100
Bournemouth	112	30	1,293	100
Christchurch	709	31	65	96
Purbeck	5,785	196	2,317	96
East Dorset	2,971	174	1,225	61
West Dorset	32	5	8	9
North Dorset	0	0	0	4
TOTAL	10,190	518	5,184	

3.4.2 Certain sites have particularly high numbers of car-park spaces, and are geared to take high numbers of visitors; the sites with the most car-parking spaces are summarised in Table 6. Studland and Hengistbury Head are both coastal sites that attract tourists as well as local people and the car-parks all provide beach access in addition to access to the heaths. It can be seen that the sites with the most parking spaces are not necessarily close to the local population centres.

Table 6: The ten patches with the most car-parking spaces, highlighting the large car-parking capacity at certain locations

Patch	*Area (ha)*	*No. of access points*	*Total no. of car-parking spaces*	*Notes*
Studland and Rempstone	1502	29	1732	Series of large car-parks provide access to beach and heath
Hengistbury Head	72	6	1277	Two large car-parks
Ringwood Forest and Moors Valley	1514	31	871	Large car-park at Moors Valley Country Park
Ham Common	25	9	152	Car-park and viewpoint over Poole Harbour
Avon Heath North Park	142	6	134	Large car-park at visitor centre
Wareham Forest	1808	32	130	A series of car parks such as Cold Harbour, Lawson's Clump and Sherford Bridge
Stoborough and Hartland	461	21	92	Various parking locations, mostly unofficial along the roadsides, but also including Sunnyside Farm
Moreton Plantation and Bryants Puddle Heath	541	25	81	Car-parks include Clouds Hill National Trust car park
Arne: Combe, Grip and Shipstal	122	6	75	RSPB reserve car-park
Upton Heath and Beacon Hill	249	17	61	Various access points with parking.

3.4.3 Using the combined data from the two visitor surveys of the Dorset Heaths (Clarke *et al.*, 2006) and Thames Basin Heaths (Liley *et al.*, 2006a), we have explored the factors which influence the numbers of visitors to particular sites. These two visitor surveys focused on access points across the two SPAs and were conducted in an identical fashion. Forty-six access points (20 in Dorset and 26 in the Thames Basin Heaths) were surveyed. At each people were counted leaving over a 16 hour period in late summer (August / September). The 16 hours were split equally between a weekday and a weekend day and involved identical time periods on each day (0700-0900; 1000-1200; 1300-1500; 1700-1900). In our analysis we considered people arriving by car and on foot separately. The analyses allow us to predict the number of people that might be expected to visit a heathland access point, based on the features of that access point and the amount of housing in the surrounding area. This approach can then be applied to all access points to estimate the total number of visitors to the Dorset Heaths. Full details of our modelling approach are given in Appendix 2.

3.4.4 Our analysis indicates that:

- People visiting a particular access point on foot can be predicted from the number of people living around the access point. People living close to the heath are more likely to visit than those living further away.
- People travelling by car are best predicted by the number of car-park spaces (whether in formal car-parks or space to park on verges, alongside gateways etc.) available at the access point. We refer to this model as "C3" (see Appendix 2 for full details).

- The importance of car-park size is difficult to interpret, and this result does not necessarily mean that car-park size is limiting visitor numbers. For example, it is possible that the distribution of car-parks and car-park size has developed to reflect where people tend to visit.
- If we assume that car-park sizes will remain fixed and use the model based on car-park size, then the (C3) model predicts that addition of new housing in the surrounding area will have no impact on the numbers of people travelling to a site by car. This is unlikely to be the case, especially if car-parks are not actually full all the time.
- While car-park size is the best predictor of visitor numbers arriving by car there is still considerable variation between access points. Taking into account car-park capacity, there was some indication that the numbers of visitors were related to housing, at least in that the proportion of residents visiting did show a decline with distance from the access point, and this proportional visitor rate was higher for access points with more car-parking space. Moreover, for the larger car-parks the rate of decline of visitor rates with distance was shallower. In other words larger car-parks attract relatively more people living further away than small car-parks.
- This approach provides an alternative means of predicting visitor numbers by car (Model "C5"), based on observed visitor rates in relation to both housing levels within distance bands and car-park capacity. This model predicts higher visitor numbers, by car, to sites with more housing surrounding them and to access points with more car parking spaces. Using this approach, the assumption is that as housing numbers increase, the number of visitors (arriving by car) will also increase. Clearly there is a point at which no more cars could fit within the car-park, and therefore there must be a 'ceiling' at which no more increase can occur.
- We therefore present the results from using both models – C3 and C5. We suggest that these two models, based on the available data, provide the best approach to predicting changes in visitor numbers. This is because both models, when applied to the actual data from the 46 access points, predict a total number of visitors that falls within the observed range. By using both models to explore the impact of further development we are, in a sense, providing an estimate of a maximum and a minimum change in visitor numbers that might be expected. Assuming that car-park size remains the same, the minimum figure is based on model C3 and predicts that there would be no net increase in car-drivers, whilst the maximum figure is based on model C5 which predicts that visitor numbers would increase in proportion to the increase with residents and involves the implicit assumption that car-park capacity would never limit the number of people that visit by car.

3.4.5 Using these equations we predict visitor numbers to the Dorset Heaths (Table 7). These predictions suggest that for every person that walks to the heath there are 2.2 that drive (ratio calculated using the output from model C3) and that in total approximately 20,000 person-visits occur on the patches during a 16 hour period in August (i.e. the time period used in the visitor surveys). It is very difficult to extrapolate these estimates to give an annual figure as we only have survey data for the late summer. In order to provide a crude estimate of total visitor numbers per annum, we converted the numbers to a day rate by dividing the total by 16 (to give an hourly rate) and multiplied this hourly rate by 12, to give the number of visits over the average daily daylight period 7am – 7pm. These figures, per day, can be extrapolated to a yearly total by multiplying by 365. These yearly totals are, of course, based on the number of visits per day during August, and are therefore—we acknowledge upfront—likely to be an overestimate as days are longer (thus pre- and post-work visits more likely), the weather more amenable and paths drier than at other times of the year. However, it is possible that August totals are actually likely to be lower than in other summer months – as August should see an exodus of local residents on holiday that is not matched by the inflow of tourists (as most heaths are not on the tourist route). Using August data as a basis for extrapolation is, consequently, not unreasonable. Whilst such extrapolation to annual totals is clearly a significant leap of understanding, we stress that it is based on the best data currently available. Moreover, providing an indicative annual total enables direct comparison with national parks and other visitor attractions that helps put the values in context. Based on this approach, the annual totals for the Dorset heaths are in the region of 5 million visits. The survey data show that most visitors come to walk their dog, an activity which would be likely to occur in all bar short winter weekdays; however, with no actual data for the winter period, these estimates are the best that can be produced. Given the obvious health warnings for these indicative annual figures, we suggest caution in their use and recommend that comparisons between sites be based on the figure for August daily visitor rates.

Table 7: Predicted numbers of visits to the Dorset Heaths. Full details of how these predictions are calculated are given in Appendix 2. The total for 16 hours matches the visitor survey data. The daily figure column is calculated by assuming a day equates to 12 hours. The figures for the number of car visitors and the number of foot visitors are those that would have been predicted to have been interviewed were the survey conducted across every single access point. The predicted total number of visitors accounts for those people not interviewed and those arriving by other means of transport.

	For 16 hours period in August	*Daily figure*	*Estimated visits per annum*
Model C3 Predicted total number of visitors	20,211	15,158	5,532,761
Model C5 Predicted total number of visitors	17,450	13,088	4,776,938

3.4.6 A breakdown of individual sites (Table 9) shows a wide variation between sites. The two models produce similar results in terms of which sites receive high numbers of visitors and which sites receive low numbers of visitors. The rural, isolated heaths with very limited parking facilities (such as Bank Gate Common at Arne, Stoke Heath, Grange) receive the fewest visitors and the sites that receive the most visitors are the urban heaths (Canford, Bourne Valley, Turbary etc.) and the sites with the large car-parks (Hengistbury and Studland). Model C3 ranks Studland as the site that receives the most visitors whereas Model C5 ranks Turbary Common as the site with the most visitors. This highlights the difference between the two models. Both models estimate foot visitors in the same way. With those people that drive, Model C5 only considers people that drive from within 10km, and therefore does not account for the high numbers of visitors travelling large distances to sites such as Studland or Hengistbury. The estimates for these sites, from Model C5, are therefore for “local” visitors rather than the total numbers *per se*. By contrast, Model C3, being based solely on car-park size, assigns very high visitor numbers to sites such as Studland and Hengistbury, which have very large car-parks.

3.4.7 With knowledge of how far people walk away from an access point during their visit, we can then estimate the distribution of visitors across the visitable patches, and map visitor pressure across the Dorset Heaths. We do this by dividing the area of the patches into 50x50m cells. Then for each cell we calculate its distance from each access point. Full details of this approach are presented in Appendix 2. Maps 3-7 present these maps, at various scales and showing models C3 and C5.

3.4.8 By examining the cumulative frequency distribution of the visitor pressure values for pixels within sites it is possible to determine the percentage of the area of different sites above or below particular levels of access. This is a means to identify which sites have high visitor pressure across a large proportion of their area. Turbary Common, Bourne Valley and Talbot Heath are the three sites which stand out as having high visitor pressure across their entire area (Table 8).

Table 8: Spatial distribution of current visitor pressure within each Dorset heath patch based on car visitor model C5; table shows percentage of 50m pixels below a selection of visitor pressure levels (visits per 16hrs). The table is produced to highlight the range of visitor pressure within sites and allow comparison. For example 43% of week common receives 1 visitor or less per 16 hours, very different to Ham Common where 48% of the site receives 100 people per 16 hours.

Patch name	*Patch area (ha)*	*Visitor density per 50m cell*								
		0.2	0.5	1	2	5	10	40	100	200
King Barrow, Alderholt	9	0	0	0	0	95	100	100	100	100
Ringwood Forest and Moors Valley	1514	11	24	44	67	87	96	100	100	100
Horton Common	96	0	0	0	37	100	100	100	100	100
south of Horton Common	16	0	0	0	14	98	100	100	100	100
Three legged Cross	32	0	0	0	0	3	49	100	100	100
Verwood	25	0	0	0	0	22	91	100	100	100
Dewlands	14	0	0	0	0	0	0	0	5	95
Holt Heath & Whitesheet	541	20	20	20	32	90	100	100	100	100
Ferndown Forest	263	0	0	0	15	43	87	100	100	100
Slop Bog and Uddens	44	0	0	0	0	0	0	8	96	100
Parley	153	0	0	0	0	0	1	69	88	100
Hurn Forest	494	6	22	32	42	58	84	100	100	100
Town Common & St Catherine's	172	0	0	0	0	3	38	88	100	100
Week Common	112	2	28	43	89	99	100	100	100	100
Week Common II	9	0	0	0	0	72	100	100	100	100
Ferndown	64	0	0	0	0	0	0	0	76	100
Lion's Hill	43	0	0	0	0	0	32	100	100	100
West Moors Plantation	126	0	0	0	0	3	48	96	100	100
Hengistbury Head	72	0	0	0	0	4	19	32	62	99
Turbary Common	40	0	0	0	0	0	0	0	0	0
Bourne Valley	38	6	6	6	6	6	6	6	6	6
Bourne Valley / Talbot Heath	36	2	2	2	2	2	2	2	2	27
Alder Hills	5	16	16	16	16	16	16	16	63	100
Canford Heath	381	0	0	0	0	0	15	83	98	100
Dunyeats	31	0	0	0	0	0	0	86	100	100
Mount Pleasant	13	0	0	0	0	0	0	0	94	98
Corfe Hills School	6	0	0	0	0	0	0	0	75	96
Avon Heath North Park	142	0	0	0	0	42	70	100	100	100
Avon Common	4	0	0	0	0	0	33	100	100	100
Avon Heath South Park	104	0	1	28	59	95	100	100	100	100
Upton Heath and Beacon Hill	249	0	0	0	0	0	1	84	98	100
Lytchett adjacent to sewage station	7	0	0	0	0	0	0	12	96	100
Lytchett	4	0	0	0	0	0	0	100	100	100
Ham Common	25	23	23	23	23	23	23	23	48	99
Sandford Heath	65	0	0	0	0	57	87	100	100	100
Wareham Forest	1808	52	72	84	93	100	100	100	100	100
BlackHill, Bere Regis	71	19	19	19	31	100	100	100	100	100
Worgret Heath	35	0	17	34	73	100	100	100	100	100

Patch name	*Patch area (ha)*	*Visitor density per 50m cell*								
		0.2	0.5	1	2	5	10	40	100	200
Stoke Heath	24	41	81	96	100	100	100	100	100	100
Moreton Plantation and Bryants Puddle Heath	541	14	50	78	97	100	100	100	100	100
Tadnoll, Winfrith and Knighton	226	1	26	43	78	98	100	100	100	100
Warmwell	31	0	0	0	56	99	100	100	100	100
nr Dorey's Farm, edge of Lulworth Ranges	8	0	0	16	90	100	100	100	100	100
edge of Lulworh Ranges, nr East holme firing range	4	0	0	0	20	67	100	100	100	100
Grange Heath	60	5	48	87	99	100	100	100	100	100
Stoborough (RSPB)	221	1	1	11	42	86	100	100	100	100
Blue Pool	73	3	3	7	86	99	100	100	100	100
Stoborough and Hartland	461	22	29	47	73	99	100	100	100	100
Arne: Bank Gate Cottages, north of triangle	7	0	0	80	90	100	100	100	100	100
Arne: Bank Gate	3	0	0	0	0	93	100	100	100	100
Arne: Combe, Grip and Shipstal	122	0	0	0	38	79	98	100	100	100
Arne: Arne Heath	52	0	26	81	100	100	100	100	100	100
Arne: Crichton's Heath	29	12	52	68	93	98	100	100	100	100
Studland and Rempstone	1502	46	57	69	74	86	93	99	100	100
Scotland	16	12	12	18	88	100	100	100	100	100
Leybrook Common	5	0	0	0	0	50	75	100	100	100
Merritown	83	0	25	66	79	92	96	100	100	100
Hethfelton Plantation	171	61	82	90	94	100	100	100	100	100
Combe Heath	41	0	61	95	98	100	100	100	100	100
Higher Hyde and Gallows Hill	129	30	88	96	100	100	100	100	100	100
Corfe Hills Golf Course	43	0	0	0	0	0	0	61	100	100
All patches		22	22	34	46	59	76	84	95	98

3.5 Assessing the accuracy of the estimates

3.5.1 The totals in Table 9 can be compared with other visitor data on particular sites. For example, at Avon Heath North Park we predict 110,000 person visits per annum using Model C3 and 48,000 person visits per annum using Model C5. There is a large discrepancy between the two models because the site is one with a large car-park (134 spaces in total for the patch) and it is not surrounded by high levels of housing in its immediate vicinity. The site's main access point is a large pay and display car-park adjacent to the visitor centre. There is a further car-park at Birch Road and various access points on foot. The visitor centre alone received 47,000 visitors in 2005 (S. Davies pers. comm.), a total derived from a beam counter located inside the visitor centre. As many visitors (especially those coming regularly) will not enter the visitor centre, and there is also another car-park, the actual number will be considerably more than 47,000, and is likely to be closer to the 110,000 estimated by Model C3. Estimates of visitor numbers to Hengistbury Head are in the region of 1 million people (estimates range between 490,000 and 1,250,000), with two-thirds of visitors local to south-east Dorset (Griffiths, 2004). This is more than the 577,000 predicted by Model C3 and considerably more than the 234,000 predicted by C5. Hengistbury Head has nearly 1300 car-park spaces, which is considerably higher than any of the car-parks for which we have actual visitor survey data, and the car-park will of course attract many people from outside the 10km used in the C5 model. Whilst previous estimates of visitor numbers to Studland place the number of visits over 1 million per annum (Dickinson *pers. comm.*), we suggest 878,000 visits per year using the C3 model and 151,000 visits using the C5 model. The Studland patch has a total of over 1700 car-park spaces and attracts thousands of people from a wide radius, beyond Dorset, to visit the beach. The location is relatively rural, with few people living nearby, hence the low estimate generated by Model C5. It is therefore clear that Model C3 is effective in predicting visitor numbers to sites with large car-parks, while Model C5 (which incorporates the number of people living within a 10km radius) underestimates total visitor numbers for such sites. This is because these sites are attracting people from a very wide geographic area.

3.5.2 Unpublished visitor data for Moors Valley Country Park gives total car-numbers at this site, using the car-park, at 192,000 in 2004, and suggests that the average number of people per vehicle is 3.8, indicating that over 700,000 people visit this site per annum (Rothnie, *pers. comm*.). Most of these visitors use the Country Park rather than the heathland. Nevertheless, this is the main access point onto the Ringwood Forest area, which we predict would receive 486,000 visits per annum with Model 3 and 151,000 visits with Model C5. Visitor numbers at Blue Pool (using the main car park) in 1999 were 48,000. We predict 50,000 using Model C3 and just 5,000 using Model C5. These estimates would all suggest that the model predictions are, at least for these larger sites, are approximately correct using Model C3, but that Model C5 is consistently deriving low estimates for these sites, especially where, as with Blue Pool, there are very few people living nearby.

3.5.3 Visitor data is rarely available for the smaller sites. It is therefore impossible to check the estimates made for these. Sites such as Stoke Heath, Worgret Heath, Higher Hyde, Coombe Heath, Warmwell, Grange and the areas alongside Lulworth Ranges are rural heaths rarely visited. Stoke Heath is accessed down a farm track, and even finding the heath is difficult. The car-park at Higher Hyde (Dorset Wildlife Trust) is hidden from the road and not signposted: in approximately 20 visits to this site the authors have never seen another car in the car-park or met another visitor. For these sites actual visitor pressure is very low. Both models predict low visitor numbers for these sites, but where there is some parking, Model C3 clearly does overestimate visitor numbers. For example Stoke Heath, where there is room to park one car on the track leading to the heath, is predicted to receive 2,800 visits per annum using Model C3 and 490 visits using Model C5. For Grange, where there is more room to park, Model C3 predicts 14,000 visits per annum and Model C5 predicts 1,600 visits per annum. Model C5 clearly estimates visitor numbers to the more rural, isolated heaths more accurately.

3.5.4 The 46 surveyed access points on which the predictions of visitor numbers are made include only two very large car-parks, both in the Thames Basin Heaths SPA, one at Lightwater Country Park with 120 car-parking spaces and the other at the Lookout, with 200 spaces. Therefore we have obviously been forced to extrapolate our derived relationships between car-borne visitor numbers and car-park spaces to make predictions for other access points with very large car-parks, such as some of those described above.

3.5.5 We therefore suggest caution in the use of these models. We suggest that they are appropriate to provide relative values for sites and to approximate the relative spatial distribution of visitors within the heaths. The analysis shows that there is considerable variation between sites and access points. Model C5 accounts for housing levels (within 10km of the site) and seems to predict visitor numbers best for the rural, isolated heaths but is clearly inaccurate with large car-parks which attract people from considerable distances – for such access points the model only estimates the number of local people that might visit. Model C3 provides the more accurate estimates for large car-parks, and is the simplest equation, but it would appear to over-estimate visitor numbers to rural heaths, especially those where there is plenty of room to park. The two models are therefore best used in conjunction, with Model C3 being treated with caution for rural sites and Model C5 being treated with caution for sites with large car-parks (such as Studland, Hengistbury and Moors Valley).

Table 9: Predicted visitor numbers per site

				Model C3			*Model C5*		
	Area (ha)	*No. Access Points*	*No. CP Spaces*	*Visitors per 16 hours in August*	*Density (people per ha)*	*Annual Total*	*Visitors per 16 hours in August*	*Density (people per ha)*	*Annual Total*
Alder Hills	5	1	24	122	26	33,391	204	44	55,804
Arne: Arne Heath	52	2	0	12	<1	3,279	7	0	1,934
Arne: Bank Gate	3	2	2	21	6	5,731	5	1	1,410
Arne: Bank Gate Cottages, north of triangle	7	1	0	6	1	1,548	2	<1	557
Arne: Combe, Grip and Shipstal	122	6	75	245	2	67,172	62	1	16,945
Arne: Crichton's Heath	29	1	0	6	<1	1,614	4	<1	1,175
Avon Common	4	1	1	15	4	4,017	14	4	3,873
Avon Heath North Park	142	6	134	405	3	110,944	175	1	47,901
Avon Heath South Park	104	2	16	69	1	18,833	31	<1	8,530
BlackHill, Bere Regis	71	7	2	57	1	15,549	22	<1	6,075
Blue Pool	73	7	52	184	3	50,335	17	<1	4,710
Bourne Valley	38	16	33	981	26	268,501	1,922	51	526,090
Bourne Valley / Talbot Heath	36	13	21	605	17	165,676	1,437	40	393,350
Canford Heath	381	24	22	748	2	204,798	1,464	4	400,652
Combe Heath	41	3	3	31	1	8,487	4	<1	1,094
Corfe Hills Golf Course	43	7	8	159	4	43,581	283	7	77,444
Corfe Hills School	6	5	0	165	29	45,168	250	43	68,383
Dewlands	14	11	10	375	27	102,790	398	29	108,870
Dunyeats	31	5	5	98	3	26,960	197	6	53,801
edge of Lulworh Ranges, nr East holme firing range	4	2	0	11	3	3,142	4	1	1,185
Ferndown	64	21	33	596	9	163,052	869	14	238,003
Ferndown Forest	263	10	14	183	1	50,168	229	1	62,732
Grange Heath	60	3	8	50	1	13,789	6	<1	1,646
Ham Common	25	9	152	532	21	145,535	402	16	110,097
Hengistbury Head	72	6	1277	2,109	29	577,447	853	12	233,500
Hethfelton Plantation	171	3	7	49	<1	13,403	10	<1	2,685
Higher Hyde and Gallows Hill	129	3	14	71	1	19,429	7	<1	1,911
Holt Heath & Whitesheet	541	25	46	343	1	93,994	213	<1	58,214
Horton Common	96	5	1	37	<1	10,151	34	<1	9,307
Hurn Forest	494	19	52	353	1	96,515	357	1	97,606
King Barrow, Alderholt	9	3	1	24	3	6,648	12	1	3,159

	Area (ha)	No. Access Points	No. CP Spaces	Model C3 Visitors per 16 hours in August	Model C3 Density (people per ha)	Model C3 Annual Total	Model C5 Visitors per 16 hours in August	Model C5 Density (people per ha)	Model C5 Annual Total
Leybrook Common	5	1	18	66	13	17,976	21	4	5,620
Lion's Hill	43	4	1	64	1	17,620	77	2	21,200
Lytchett	4	1	4	56	13	15,424	69	16	18,860
Lytchett adjacent to sewage station	7	2	10	101	14	27,512	111	15	30,499
Merritown	83	2	0	13	0	3,644	24	0	6,690
Moreton Plantation and Bryants Puddle Heath	541	25	81	432	1	118,323	56	0	15,445
Mount Pleasant	13	5	8	186	14	50,857	244	18	66,907
nr Dorey's Farm, edge of Lulworth Ranges	8	1	0	6	1	1,634	3	0	760
Parley	153	21	26	682	4	186,715	901	6	246,770
Ringwood Forest and Moors Valley	1,514	31	871	1,774	1	485,504	551	0	150,947
Sandford Heath	65	4	12	104	2	28,404	62	1	16,952
Scotland	16	3	4	35	2	9,556	5	0	1,378
Slop Bog and Uddens	44	10	8	271	6	74,251	383	9	104,930
south of Horton Common	16	1	0	9	1	2,393	9	1	2,576
Stoborough (RSPB)	221	18	20	231	1	63,272	93	0	25,345
Stoborough and Hartland	461	21	92	483	1	132,113	94	0	25,596
Stoke Heath	24	1	1	10	0	2,834	2	0	491
Studland and Rempstone	1,502	29	1732	3,207	2	877,843	550	0	150,557
Tadnoll, Winfrith and Knighton	226	15	54	317	1	86,732	48	0	13,067
Three legged Cross	32	4	6	70	2	19,237	61	2	16,760
Town Common & St Catherine's	172	11	21	314	2	85,849	489	3	133,963
Turbary Common	40	24	16	1,318	33	360,672	2,606	64	713,421
Upton Heath and Beacon Hill	249	17	61	755	3	206,741	1,007	4	275,599
Verwood	25	2	2	29	1	7,865	31	1	8,416
Wareham Forest	1,808	32	130	683	0	187,071	149	0	40,740
Warmwell	31	3	8	51	2	13,887	11	0	3,014
Week Common	112	2	2	22	0	6,115	19	0	5,128
Week Common II	9	2	0	12	1	3,418	10	1	2,608
West Moors Plantation	126	8	12	224	2	61,362	262	2	71,815
Worgret Heath	35	2	2	23	1	6,300	8	0	2,265
TOTAL	10,718	531	5215	20,211		5,532,772	17,450		4,776,963

3.6 Comparison with the Thames Basin Heaths SPA

3.6.1 The Thames Basin Heaths SPA, located to the southwest of London, on the M3 corridor, is subject to similar issues as the Dorset Heaths SPA. Both are designated for the presence of breeding nightjar, woodlark and Dartford warblers. The growth in homes planned for the South East of England is likely to increase development pressure on the Thames Basin Heaths SPA. The Thames Basin Heaths SPA spans 11 separate Local Planning Authorities (LPAs) around and therefore a strategic approach to development has been instigated. This is the Thames Basin Delivery Plan, which aims to safeguard the SPA through establishing a strategic, sub-regional approach to mitigating the impact of housing developments across the 11 LPAs around the SPA. It is useful to consider the differences between the two SPAs, in terms of their geography and visitor numbers in order to guide the need for an approach, similar to the Thames Basin Heaths Delivery Plan, in Dorset.

3.6.2 The Dorset Heaths and Thames Basin Heaths SPAs differ in the way they are designated. Both SPAs include heathland and coniferous forestry. In the Thames Basin Heaths the sites are relatively large and entire blocks of commercial forestry have been included within the SPA. In Dorset, large areas of such forestry (often supporting nightjar and woodlark) have been excluded from the SPA, yet small patches of open heath or clearings within these blocks are designated. We overcome these differences by applying a standard mapping approach to the two SPAs, mapping "visitable" patches which encompass the SPA and surrounding land. These patches are areas which are visitable to the public, such as nature reserves, commons, forestry plantations etc, and we map the entire site rather than just the SPA boundary.

3.6.3 Using these mapped areas it is possible to compare geography and, by applying the Model C3 to the Thames Basin Heaths, it is possible to compare estimates of total visitor numbers to the two regions.

3.6.4 The Dorset Heaths cover a much larger area (over 10,000 ha), and there are many more "patches" than for the Thames Basin Heaths – the Dorset Heaths therefore have a much greater perimeter (Table 10). There are more access points onto the Thames Basin Heaths, despite the smaller perimeter, but interestingly, the number of access points with parking per kilometer of perimeter is approximately the same, at one access point with parking per c.1.5 km of perimeter. There are more houses (at a higher overall density) in the 5 km surrounding the Thames Basin Heaths patches, but there are fewer total parking spaces.

Table 10: Comparison of the size and general features of the Dorset and Thames Basin Heath sites

	Dorset Heaths	*Thames Basin Heaths*
Number of 'visitable patches'	61	23
Total area of patches (ha)	10,718	7,348
Total perimeter (km)	441	253
Number of access points	531	729
Number of access points with parking	277	158
Total number parking spaces	5,215	1,998
Number of houses within 5 km of patches	229,410	287,903
Land area (ha) within 5 km of patches (inc. the patches)	101,031	76,335
Number of houses (within 5 km) per ha of heathland	21.4	39.2

3.6.5 For the Thames Basin Heaths the median visitor pressure value is 10.4 visits per pixel, compared to 4.3 for Dorset, suggesting that visitor pressure levels are higher on the Thames Basin Heaths. Both areas receive similar total estimated numbers of visitors – in the region of 18,000 visits (per 16 hours in August) for the Thames Basin Heaths and around 20,000 for Dorset (Table 11), yet due to the differences in area, distribution of access points, distribution of parking and area of valley mires, the median visitor pressure in Dorset in considerably lower. However, some parts of the Dorset Heaths, such as the more urban heaths and parts of sites such as Studland, receive very high visitor levels, which are much higher than any of the sites in the Thames Basin Heaths.

Table 11: Comparison of predictions of visitor pressure or the Thames Basin and Dorset Heaths (using Model C3).

	TBH	*Dorset*	*Dorset, excluding Hengistbury & Studland*
Total no. grid squares	29,498	42,969	36,666
Total area of covered by grid (ha)	7374. 5	10,742.25	9,166.5
Total predicted visitors per 16 hours in Aug.	17954	20211	15,3295

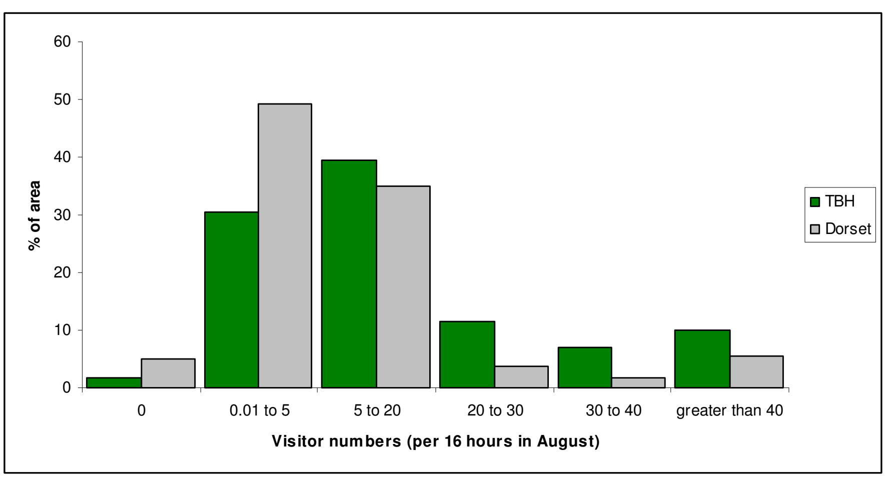


Figure 3: Frequency distribution showing the percentage of the visitable patches of the Thames Basin Heaths and Dorset Heaths at a given visitor pressure. The X axis is cut-off at 200, yet, to encompass the entire range of values for the Dorset Heaths it would need to have a maximum of over 2000.

3.7 Types of greenspace currently used for activities that affect heathland wildlife interests

3.7.1 The use of greenspace for recreational activities is likely to depend upon the accessibility of sites, the range of different sites available to a population, other users and the actual size of sites, as much as the actual habitat and the activity involved. It is therefore difficult to draw generic conclusions about the use of greenspace for different activities, and it is important to understand the local context. There is little evidence on the use of greenspace within Dorset and this area would benefit from further research. We draw from the evidence that is available.

3.7.2 It seems intuitive that people will visit urban parks and urban greenspace for different reasons than they visit large heathland sites of nature conservation importance. Urban greenspace and formal parks will attract people for different reasons to more open countryside. For example, Dunnett et al. (2002), in a comprehensive study of park use across England, asked both users and non-users what would be in their ideal urban green space. The most frequently mentioned component was vegetation, followed by water, play opportunities, comforts like seating, toilets and shelters, good access–particularly an issue for people with disabilities–sport, and events. Refreshments of a good quality and reasonable price, environmental quality issues such as litter bins, lighting and vandalism, and specific features such as sculptures and mazes were also mentioned. Animals were considered to be important for children, opportunities for wheeled activities were desired by women and young people while the presence of identifiable and approachable staff was also a feature of the ideal urban green space. People visiting heathland sites do so because they appreciate the naturalness, peace and quiet, wildlife, views and scenery (Atlantic Consultants, 2003; 2005). Urban greenspace sites, especially formal parks and gardens, are therefore unlikely to attract the people that visit heathland sites.

3.7.3 We therefore suggest that a proportion of visitors to heathland sites visit them because they represent open countryside. In section 3.3 we highlight the different reasons people visit heathland sites and we now consider particular site features that will attract particular types of visitors. Dog walkers account for the majority of visitors, and the other visitors (still a significant proportion) visit for such a wide variety of reasons that it is convenient to split visitors into dog walkers and 'others'. For these 'others' we simply address some of the particular activities (running, cycling and walking) for which information is available on typical use of sites.

Dog walkers

3.7.4 Dog walkers will visit a variety of different sites, and many will have a selection of preferred walks. Specific studies of dog walkers' behaviour and attitudes shows that owners' choice of walk locations can be governed by their perceptions of their pet's happiness. Favourite sites are those where dogs are perceived as most happy – where they are permitted to run off lead, where they can socialise with other dogs, where there is little danger of road traffic (Edwards & Knight, 2006). Dog walkers also choose to walk where they anticipate meeting other dog walkers. Dog walkers tend to see themselves as members of a group with shared attitudes and norms, and meeting others when out walking provides a sense of safety within this group that was not experienced when walking in more remote areas.

3.7.5 Seventy-seven percent of the dog walkers interviewed by wardens on the urban heaths of Dorset stated that they visited other types of sites besides heathlands to walk their dog (Liley *et al.*, 2006c). The most popular alternatives site were pine plantations, local parks and footpaths / bridleways (Table 12).

Table 12: Number and percentage of interviewees visiting alterntive types of site. Interviewees were able to give more than one answer. Data from (Liley *et al.*, 2006c) summarising 277 interviews with dog walkers on urban heaths in Dorset. Interviews conducted ad hoc by wardens. The categories were given as options to the interviewee.

Alternative types of site	**Number (%) of interviewees**
total using local park	86 (31)
total using local oakwood	45 (16)
total using local pine plantation	90 (32)
total using local grassy fields	72 (26)
total using footpaths / bridleways	86 (31)

3.7.6 The study by Liley *et al.* (2006b) compared the factors that influenced the choice of site for visitors (mostly dog walkers) to SPA sites in the Thames Basin with those choosing to visit non-SPA sites, which included more urban, formal sites. Visitors to the SPA selected sites for convenient car access and provision of car parking, whereas visitors to non-SPA sites gave higher scores to the presence of surfaced paths, way-marked routes, a variety of routes and the presence of viewpoints. Dog walkers visiting SPA sites gave a higher weighting (than those visiting sites outside the SPA) to the ability to let their dog off lead, to not having to clear up after their dog and to the absence of livestock. People visiting the SPA spent longer on SPA sites than other sites. There were also differences in interviewees' choices of photographs of ideal sites. Visitors to the SPA preferred sites with soft sandy paths and sites with undulating topography, whereas more visitors to non-SPA sites preferred pictures of an urban park and an artificial lake. These differences suggest that visitors to SPA sites may be positively selecting these sites because they offer convenient car access and semi-natural, relatively 'wild' places to walk.

3.7.7 We know from the visitor survey data (see section 3.3) that dog walkers will typically do a circuit of over 2km when on the heath, and therefore alternative sites must be large enough to accommodate such a route.

Other visitors

3.7.8 Among the joggers interviewed on the Dorset Heaths was a party of 25 people from the Poole Runners Club, who were recorded running on Holt Heath, near Wimborne. The club website[18] reveals that the group meets at 8.30am every Sunday morning and use a variety of different locations – starting their runs at Littledown, Ferndown, Wimbourne, Wareham Forest and Sandbanks Ferry (for the 'Purbeck run'). It would appear that each of these starting points, apart from perhaps from Littledown, would be likely to take the runners through heathland sites, but clearly the routes must also involve non-heathland habitats and conifer plantations. The club clearly uses sites outside Poole for the bulk of its Sunday runs.

[18] http://home.freeuk.net/poolerunners/quarterly_running_list.htm

3.7.9 As part of the current government campaign "walking the way to health"[19], various authorities and borough councils offer regular guided 'brisk' walks. These are typically between one and two miles, on level ground and are promoted for health benefits. The website lists sites used for these walks and these include Upton Country Park, Poole Park, Baiter, Sandbanks, and Avon Country Park. This shows that whilst heathland sites are used for such activities, alternative sites are also used.

3.7.10 Cyclists, as a group, include a variety of different users from families with children to dedicated mountain bike enthusiasts, and this is reflected in the wide range of routes and distances cycled by the cyclists interviewed in the various heathland visitor surveys (e.g. Clarke *et al.*, 2006; Liley *et al.*, 2006a). Mountain bike enthusiasts may visit areas with purposefully designed trails, jumps etc. Within Dorset such facilities are available at Puddletown Forest. Others may simply require long routes with good scenery and the ability to cycle off-road. Popular routes are advertised on the web and indicate the kind of sites preferred – in the Dorset Heaths area such routes include a 40km circuit around Corfe that includes the Purbeck ridge and coastline[20]. Sites with undulating topography, off-road tracks, varied terrain and a suitably large area are clearly preferred; heaths, forestry and coastal areas are probably the ideal locations. For family cycles, safety and shorter routes are likely to preferred.

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[19] http://www.whi.org.uk/index.asp
[20] http://mbruk.co.uk/mbruk_mtbroutes_southernengland.htm

3.8 The relationship of existing green space and its use to the location of the present population

3.8.1 We mapped the principal other sites in the broad area of the heaths (we included all sites within 5 km of the visitable patches) which may attract recreational users in the same way that the heaths do. By “other sites” sites we do not mean sites which could be developed to attract people away from the heaths, we are simply highlighting the current distribution of alternative sites with extensive public access. We map these sites as they are important in understanding the context of the current access patterns to the heaths and only by considering these sites in relation to the heaths is it possible to determine the range of access sites available to the human population in the study area.

3.8.2 The alternative sites were identified using the following approaches:

- Consultation with representatives from the relevant local authorities and green space audits, where available;
- Contact with local dog walkers living in the area;
- Contact with a local professional dog walker (found through the internet) who provided a list of sites he visited; and
- Authors’ local knowledge of the area.

3.8.3 Small urban sites and formal parks were not included, but the list did include some of the large parks within Bournemouth and Poole. The list is largely subjective and it was beyond the scope of this contract to consider the entire footpath and public right of way network, but the list is believed to be reasonably comprehensive and will provide an approximation of the location of key greenspace sites. The boundary of each site was mapped within the GIS, using the OS Mastermap (provided under copyright by Dorset County Council) as a base. For most sites the boundary was clear and distinct. Some of the locations used by the dog walkers were, however, harder to map as they would involve a network of footpaths across farmland or along a riverbank. For such locations an attempt was made to map the ‘visitable’ area. For each site an estimate of car-park spaces was made using aerial photographs (UKP coverage provided under licence by Dorset County Council).

3.8.4 A total of 43 other sites were mapped and these sites together cover some 3,420 ha in area (Maps 8-11). We did not include the New Forest, the western fringe of which is likely to attract visitors from Dorset, as it is outside the county and encompasses a huge area. Compared to the other districts / boroughs, Purbeck has by far the largest area of visitable heathland patches and also the largest areas of alternative sites, with large stretches of coast and chalk grassland (the Purbeck ridge) providing land with access provision (Table 13).

Table 13: Areas of heathland and existing alternative sites by district. Note that the area of alternative space includes non-heathland sites of international importance for conservation.

	Area of heathland patches (ha)	*Car park capacity for heathland patches within the District*	*Area of alternative sites*	*Car park capacity on alternative sites*
Poole	581	276	172	551
Bournemouth	112	1293	365	799
Christchurch	709	65	201	930
Purbeck	5,785	2317	1774	652
East Dorset	2,971	1225	325	10
West Dorset	32	8	539	80
	10,190	518	3,377	3,022

3.8.5 The individual sites are listed in Table 14 and shown on Map 8. These sites are all outside the Dorset Heaths SPA, but many are of conservation importance in their own right, as Table 14 shows. Fifteen of the sites listed are SSSI and ten of these are European Protected sites in their own right, falling within the Poole Harbour or Avon Valley SPAs or the various SACs along the Dorset coast. Within England, a high proportion of access land is designated for nature conservation, and the figures for the alternative sites reflect the national picture, where most land that is available for public access is also important for nature conservation. These sites may therefore not necessarily be able to accommodate additional visitor pressure without some conservation impact, and, indeed, it is possible that existing visitor pressure is having an impact. Among the alternative sites we have identified, the sites that are not designated as SSSI are all small, with Puddletown Forest being the only reasonably large site with no nature conservation designation. There is a need for a detailed audit and assessment of these sites and a) the extent to which they may attract the same types of visitors as may visit the heathlands, and b) the levels of current access and whether there is potential for any of these sites to accommodate additional visitors.

3.8.6 The existing visitor pressure on the heathland sites must therefore be considered in the context of these sites. The current visitor levels to the heathland sites occur despite the existence of this range of alternative sites; were there no access to these sites, it is perhaps likely that the visitor levels to the heaths would be higher.

Table 14: Other sites with potential to attract the same kinds of visitors as the SPA sites. The alternative sites have been selected through contact with local dog walkers and various other sources. Parking spaces are largely estimated from aerial photographs and are crude estimates. All sites are within 5 km of the "visitable" area of the SPA. The totals at the table end exclude the New Forest.

Site Name	*District / Borough*	*Car-park spaces*	*Area (ha)*	*Designation*	*Notes*
Wareham Common	Purbeck	5	30	SSSI	Links to Wareham Walls, popular with local dog walkers
Dancing Ledge to Chapman's Pool	Purbeck	160	406	SSSI, SAC, World Heritage Site	World Heritage Coast, most visitors likely to be tourists, may be used by local people for occasional longer walks at weekends etc.
Corfe Common	Purbeck	3	130	SSSI, SAC	Parking limited but large car park in village. Livestock may deter dog walkers.
Durlston Country Park	Purbeck	130	61	SSSI, SAC, World Heritage Site	World Heritage Coast, most visitors likely to be tourists, may be used by local people for occasional longer walks at weekends etc or regularly by people in swanage.
Purbeck Ridge, East of Corfe Castle	Purbeck	15	373	Part SAC, part SSSI	Likely to attract tourists and local people seeking longer walks at weekends etc. Steep climb to reach the top of the ridge.
Purbeck Ridge, west of Corfe Castle	Purbeck	12	79	Part SSSI	Likely to attract tourists and local people seeking longer walks at weekends etc. Steep climb to reach the top of the ridge.
Chapmans Pool to Kimmeridge	Purbeck	175	118	SSSI, SAC, World Heritage Site	World Heritage Coast, most visitors likely to be tourists, may be used by local people for occasional longer walks at weekends etc. Beach access in places restricted by tide.
Swyre Head and Snedmore Hill	Purbeck	25	23		World Heritage Coast, most visitors likely to be tourists, may be used by local people for occasional longer walks at weekends etc.
Lulworth Ranges, coastal strip inc Tyneham	Purbeck	0	263	SSSI, SAC, World Heritage Site	World Heritage Coast, most visitors likely to be tourists, may be used by local people for occasional longer walks at weekends etc. MOD access restrictions.
Lulworth Cove to West Bottom, inc Durdle Dor	Purbeck	400	275	SSSI, SAC, World Heritage Site	World Heritage Coast, most visitors likely to be tourists, may be used by local people for occasional longer walks at weekends etc. Expensive parking.
Stanpit	Christchurch	30	71	Part SSSI	Area of fields and marsh to the north of Christchurch Harbour, popular with dog walkers and bird watchers.
Purewell Meadows, Avon Valley	Christchurch	0	75	Part SSSI, part SPA	Local Nature Reserve and Green Space, comprising fields and grazing marsh.
Christchurch Seafront, Mudeford Quay and Highcliffe	Christchurch	900	47	Part SSSI	Beaches, promenade, children's play area etc. Dogs must be under control but can be off lead.
Throop	Christchurch	12	12		Riverside car park and network of footpaths around River Stour.
River Stour, Christchurch	Christchurch	0	6		Footpath along river
Longham	East Dorset	10	6		Ferndown, Stour and Forest Trail linking to Dudsbury area. Riverside footpath. Parking in hotel car-park.
Pamphill	East Dorset	20	69		Riverside footpaths from car-park, on outskirts of Wimborne. Popular with local dog-walkers.
Didlington	East Dorset	0	104		Circular path around edge of Crichel Estate. PRoW and limited parking, occasionally used by dog walkers.
Holt Wood and Holt	East Dorset	0	145	Part SSSI	Roadside parking, extensive network of public footpaths through

Forest					woodland.
Ringstead Bay	West Dorset	40	166	Part SSSI, part SAC	Beach / cliffs, within World Heritage Coastline. Most visitors likely to be tourists, may be used by local people for occasional longer walks at weekends etc.
Puddletown Forest	West Dorset	40	395		Area of forestry, with car-park and roadside parking. Some attraction to tourists (Thomas Hardy's birthplace).
Queen's Park	Bournemouth	160	59		Predominantly a golf course, but extensively used by dog walkers.
King's Park	Bournemouth	200	50		Formal park and gardens, links to littledown. Contains a skate park.
Littledown	Bournemouth	0	7		Formal recreation area, with children's play area, model railway etc.
Berry Hill / Muscliffe	Bournemouth	0	14		Part of Stour Valley Way, riverside path.
Redhill Common	Bournemouth	35	18		Historic green space, with mixture of formal and informal park. Dogs on leads in some zones.
Littledown Park	Bournemouth	60	12		Playing fields etc linking to the park
Talbot Trust Woods / Slade Farm	Bournemouth	0	15		Playing fields and some woodland.
Millham's Mead	Bournemouth	10	46		Stour Valley Way, riverside path, circuits along PRoW.
Upper park	Bournemouth	0	8		Thin strip of parks and gardens, less formal than the lower parks.
Kinson Common	Bournemouth	24	19	SSSI, SAC	Dry and wet heath, woodland and marsh in urban setting.
Alum Chime	Bournemouth	60	7		Tropical gardens, children's play area, wooded walk etc with car park at beach
Meryick Park	Bournemouth	300	62		Large formal park, with golf course, playing fields, bowls etc.
Bournemouth and Poole Sea front	Poole		58		Beaches and promenades, dog restrictions in some places.
Pugs Hole	Poole	0	8		Mixed woodland.
Baiter	Poole	286	25		Park along shore of Poole Harbour, popular with dog walkers. Circular walks possible around Poole Park, linking with the more formal gardens. Mudflats offshore are part of Poole Harbour SPA.
Holes Bay Waterfront	Poole	0	6		Linear footpath and some grass along shore of Poole Harbour. Mudflats offshore are part of Poole Harbour SPA.
Hamworthy Park	Poole	45	10		Ammenity grassland etc and beach front. Mudflats offshore are part of Poole Harbour SPA.
Branksome Chine	Poole	130	20		Wooded chine and leading down to beach.
Luscombe Valley	Poole		60		Local Nature Reserve has circular path through grassland, woodland and reeds.
Upton Country Park	Poole	90	16		Grade II Listed House open to the public with associated country park and gardens stretching to Poole Habour shoreline
Delph Woods	Poole	?	33		Woodland with 2km circular walk and car-park.
TOTAL		3377	3407		

3.9 Evidence on where impacts arise from

3.9.1 A high proportion of visitors to heathland sites travel by car. For example, the proportion of visitors travelling by car in the Clarke *et al.* (2006) study was 59%. The majority of car-drivers are relatively local, with most (e.g. 72% in the Clarke *et al.* survey of the Dorset sites (Table A2.1) and 70% in the Liley *et al.* survey in the Thames Basin) of car drivers travelling less than 5 km.

3.9.2 Across the range of sites included in the Clarke *et al.* study, more than half (59%) of all people arrived at access points by car and a further 36% arrived by foot. Relative use of cars compared to arriving on foot varied enormously between access points. This was because sites varied in both the car-parking provision (which ranged from large car-parks to no parking provision) and in the number of people living within walking distance of the site. Where car-parking was provided, 85% of visitors came by vehicle. Across all access points surveyed, 59% of visitors arrived by car: none had come from within 300 m, 8% came from within 1 km of the access point and 31% came from within 2 km. Half the people coming by car lived more than 3.7 km away. In contrast, of the people who walked to the site, 75% come from within 500 m, and 89% had had come from within 1 km of the access point.

3.9.3 We present the home postcodes of people interviewed during the various visitor surveys in Maps 6-9. These maps of postcodes clearly indicate that the heaths attract people from a wide geographical area. Some caution is required in interpreting these maps as interview locations vary, and interviews were neither conducted on all heaths, nor for the same duration on each heaths. An overview of all visitor postcodes (Map 12) illustrates some clear clustering around heaths, with particularly dense clusters between Ferndown and Parley, on the western edge of St. Catherine's, in the northern parts of Bournemouth Borough, and the eastern and central parts of Poole. These clusters do, of course, reflect the sites where the interviews were conducted, but also reflect that people living in these areas clearly visit the heaths. It is noticeable that relatively few people gave postcodes in the areas of Poole and Bournemouth close to the coast, including central Bournemouth. The travel time from these areas to the heaths is considerable.

3.9.4 Maps 13 and 14 use different colours to highlight the locations where people were interviewed. These highlight some interesting patterns of access to the heaths:

- There is a large spread of postcodes recorded from people visiting Canford, including postcodes from central Poole;
- There is a record of people from Poole visiting Hartland in Purbeck;
- There are two cases of people from Hamworthy and one case of a resident of Corfe Mullen travelling to Morden, in Wareham Forest;
- There is a broad spread of postcodes for people interviewed at Avon Heath South Park, these appear to run on an east – west axis, from Ringwood to Wimborne, reflecting the route of the A31;
- People living in Charminster and Littledown are travelling north-east to visit Sopley; and
- People from Southbourne are visiting St. Catherine's.

3.9.5 A comparison of particular catchments for different access points highlights the distance people travel. In Map 15, polygons have been drawn round all the postcodes for people visiting Sopley (the Forestry Commission's Ramsdown Car Park) and all the people visiting St. Catherine's (an access point in a cul-de-sac with no car-park). These data are from the survey documented by Clarke *et al.* (2006) and the same amount of time was spent interviewing people at each access point. It can be seen that many more postcodes are plotted for the St. Catherine's access point, and while the catchments for both access points extend into Bournemouth, Sopley would appear to have a much larger catchment that almost entirely covers the St. Catherine's access point, which appears to only attract people living relatively close.

3.9.6 These postcode maps highlight that the patterns of access are complex. Car drivers clearly do not necessarily travel to the nearest access point with parking. There is a high population density surrounding many heaths, and the heaths are quite clustered. Residents of most postcodes within the urban conurbations who travel by car to visit the heaths have a choice of sites within a reasonably short journey time. It would appear that some access points attract people from a wider radius than other access points. We have reanalysed the data collected by Clarke *et al.* (2006) to explore the extent to which people who drive to the heaths chose to visit their nearest access point with parking. We mapped all access points onto the heaths, and then, within a GIS, divided the area around the heaths into voronoi (also called thiessen) polygons, based on the distribution of access points with parking. The resulting map drew a polygon for each access point with parking that defined its 'catchment' (i.e. the area of land closest to the given access point rather than any other access point). Using these polygons we are then able to calculate that just 5% of people that drove to the heath and were interviewed as part of the Clarke *et al.* survey had actually chosen to visit their nearest access point with parking (Table 15). Map 16 shows an example of the voronoi polygons for sites in the north-east of the study area, centred on St. Leonards and Parley.

Table 15: Visitor numbers by car to different sites and the number that lived closer to that access point than any other access point with parking. The totals of adults, visiting by car, are those that gave valid postcodes in the Clarke *et al.* study. The number for whom the access point is their closest was calculated by plotting voronoi polygons around all access points with parking and then calculating the number of visitors whose postcodes fell within the voronoi polygon of the visited access point.

	total adults by car	*Number for whom the access point is their closest access point with parking*	*%*
St Catherines	46	0	0
Sopley	33	0	0
Avon Heath S. Park	90	0	0
Parley	19	3	16
Holt	33	0	0
Turbary common	2	0	0
Hartland Tramway	41	0	0
Canford Gravel Hill	48	0	0
Talbot Heath	7	1	14
Morden	22	0	0
Upton	6	0	0
Stoborough New Rd	4	3	75
Tadnoll	34	5	15
Winfrith	9	0	0
Lions Hill	3	1	33
TOTAL	397	13	3

3.9.7 Using the Dorset visitor data there were no statistically significant correlations between either the total number of visitors, or visitor groups, with the number of houses within any fixed distance up to 10 km (Clarke *et al*., 2006; section 3.14). There were no statistically significant correlations between either number of visitor groups or total number of visitors and the size of the heath in terms of either the length of perimeter or area which was deemed “visitable” (Clarke *et al*., 2006; section 3.13).

3.9.8 Given the mobility of the population and the clear variation in visitor levels between sites, it is difficult to relate urban impacts to particular locations. There is a considerable range in the amount of houses surrounding heaths, with some sites having over 100,000 houses within 5 km of their boundaries (Map 18). Due to the mobility of the car-driving population, there is, however, no simple relationship between visitor numbers at a given location and the number of houses surrounding that point.

3.9.9 Disturbance is likely to be directly related to visitor numbers, perhaps especially to numbers of visitors with dogs. Fire incidence is well known to be particularly high on the more ‘urban’ heaths (Kirby *et al*., 1999; Woods, 2002), and the recent data from the Urban Heaths Project supports this. Examining data of 3333 fires between 1992 and 1998, Kirkby & Tantrum (1999) revealed a clear link between fire frequency and urban areas. Most fires were in east Dorset, particularly around Bournemouth/Poole, the highest concentrations being around the urban fringes. Fires were more likely to be reported from SSSIs whose boundaries lay within 500m of densely developed areas. Fires appeared more likely to occur on areas whose surrounding 500m was more than

15% developed, presumably due to easier access. Of the 26 SSSIs with the highest number of fires, 70% were in or adjacent to urban areas.

3.9.10 Kirkby & Tantrum's survey of the causes of fires revealed 59% were arson, 17% were camp fires, 8% from management fires getting out of control, and 7% from spreading bonfires. There was a widespread belief that children were responsible for igniting most wild fires: fires were more likely at weekends, during school holidays and in the afternoon and evening. Similar conclusions were noted in the UHP Fire Risk Assessment guide[21].

3.9.11 We have looked at recent fire data. For those 24 urban heaths where at least one fire has been recorded on the Dorset Environmental Records Centre (DERC) Database between 2002 and October 2006, there is no significant correlation with the total number of fires and the area of the site (Table 16), indicating that the bigger sites do not have more fires. However, the total number of fires does significantly correlate with the amount of housing at different distance bands from the edge of the site, indicating that those sites with high amounts of housing round their edge have the most fires.

Table 16: Correlation coefficients (and their statistical test significance, p) for the numbers of fires on heathland patches and the features of the site in terms of its size and the amount of housing at different distance bands from the patch boundary. Fire incidence data supplied by DERC, for the period 2002 – October 2006. Only the 24 patches with at least one fire are included within the analysis. The number of houses within each distance band are all strongly correlated.

Variable	*Correlation co-efficient*	*p*
Area of patch	-0.086	0.689
Number of houses within 500m	0.806	<0.001
Number of houses within 1000m	0.777	<0.001
Number of houses within 1500m	0.741	<0.001
Number of houses within 2000m	0.690	<0.001
Number of houses within 2500m	0.655	<0.001
Number of houses within 3000m	0.656	<0.001
Number of houses within 4000m	0.661	<0.001
Number of houses within 5000m	0.663	<0.001

3.9.12 There is clearly potential to explore the fire occurrence in more detail, especially with the visitor pressure models. Map 17 shows the predicted visitor pressure for the urban heaths in Poole and the reported fires. The fires are clearly concentrated in the particular areas ,and there is scope to do further, detailed analysis with these data.

[21] http://www.dorsetforyou.com/media/pdf/o/c/FireRiskAssessmentBestPracticeGuide_1.pdf

3.10 Evidence on development type and pressure

3.10.1 There is clear evidence that some groups of people tend to visit the countryside more than others (Slee, 2002). It is therefore possible that the occupants of certain types of residential development may be more likely to visit the heaths than others. One of the principal differences between properties is the difference between flats and houses and between properties with gardens and those without. These types of houses would be perhaps expected to house different types of people.

3.10.2 It might be expected that people living in houses with gardens are more likely to keep a dog; for example, RSPCA guidelines for dog ownership recommend a garden and people seeking to rehouse a rescued dog must have a garden[22]. We have not found any evidence describing house type and likelihood of dog ownership. We have found no data describing the proportion of flat owners, compared to house owners, who own a dog. This is an area that warrants further research. It is also important to understand the frequency of visit to the SPA in addition to likelihood of dog ownership. For example, while fewer people in flats may own a dog, it is conceivable that dog owners in flats may well visit the SPA more frequently (to ensure their dog is exercised) than people living in detached houses with gardens, who can allow their dog to run around outside. Nevertheless, it is clear that the evidence for this is limited either way. The more urban, small heaths within the Poole / Bournemouth conurbations will of course attract a very different group of people, and therefore it is important to recognise that housing per se may not necessarily reflect visitor numbers, and that different types of housing may accommodate different types of people, with differing desires to visit heathlands. Further research is clearly needed in this area.

3.10.3 The best data source on pet ownership in the UK comes from the pet food manufacturers association (PFMA, 2006). They estimate that there are around 24 million UK households and, in 2005, the number of households owning dogs was 5.2 million (4.8 million in 2002), with 21% of households with dogs having more than one dog. In 2004 there were an estimated 6.8 million dogs in the UK. Dog ownership varies between different groups, with the highest levels of dog ownership among the 45 to 54 year-old age group - around 30%. Residential accommodation that houses people of this age group might therefore be expected to have the highest levels of dog ownership per property.

3.10.4 Some heathland visitor surveys have determined the type of residential property in which the interviewee lives. Without a knowledge of the relative proportion of different property types within the area it is, of course, impossible to use the interview results to show whether people visiting heaths are more likely to live in a certain property type. However, such surveys can at least provide some indication of whether visitors in particular property types do visit the heaths.

[22] http://www.rspca.org.uk/

3.10.5 The Bourley and Long Valley (Thames Basin Heaths SPA) visitor survey prepared for the QE II appropriate assessment (MORI, 2004) asked respondents whether they came from owned or rented property and whether from a house, flat/maisonette or bungalow/other. A higher percentage of house owners (79%) and those living in houses or bungalows (79%) who visited a heath did so for dog walking than amongst those visitors who rented (63%) or lived in flats/maisonettes (51%). As expected, there are fewer dog walkers from flats and maisonettes than houses, but these data still show a surprisingly large proportion (just over half) of those from flats and maisonettes were accompanied by dogs. In the survey of SPA and non-SPA sites in the Thames Basin Heaths (Liley *et al.*, 2006b), half of all people interviewed lived in detached houses with gardens and only a very small proportion of those people interviewed lived in accommodation without gardens. Of the people interviewed, similar proportions living in detached, semi-detached, terraced houses and bungalows had similar numbers of dogs per household. Only 3% of all visitors came from flats, and some of the visitors living in flats also kept dogs.

4 Evidence to support the effectiveness and limitations of existing mitigations

4.0.1 It is clear that visitor numbers to access points onto the heaths are very variable, with a variety of different factors likely to be influencing visitor numbers. In turn, the numbers arriving at an access point do not necessarily uniquely determine the conservation impact; factors such as where these people go, how the access is managed on the site, and the conservation awareness of the visitors will determine the impact of the visitor pressure on the conservation interest of the site. These factors are summarised in Figure 4, which highlights the variety of ways in which off-site and on-site factors can influence visitor numbers. This figure highlights the range of possible ways in which visitor pressure can be mitigated or impacts avoided.

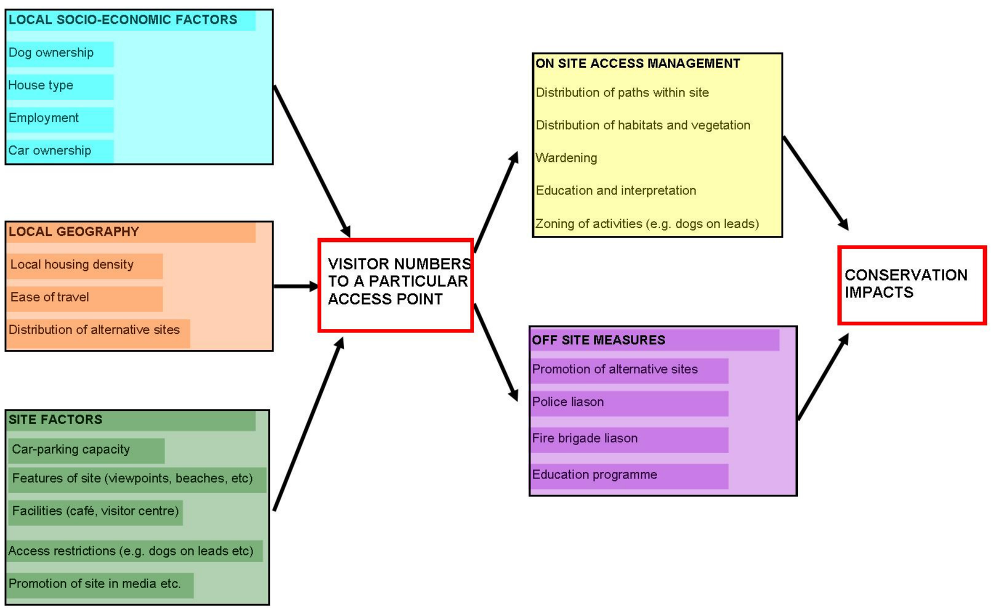

Figure 4: Summary of different factors that influence visitor numbers and conservation impacts on a site

4.0.2 There are a wide variety of potential mechanisms to alleviate the impacts of urban development or to mitigate the impacts of new houses. Examples of these are summarised in Table 17. There are no data available at a county level to show the extent to which these have been implemented within Dorset and which have been successful. There is clear need for further work in this area.

Table 17: Potential mitigation measures for different urban impacts. No attempt has been made to score the effectiveness of these measures and many of the measures are listed despite evidence that they are not necessarily particularly effective (e.g. predator control - see Cote & Sutherland, 1997).

Effect	Description and Impact	Potential mitigation
Fragmentation	Loss of supporting habitats	Creation of suitable habitat (Acid grassland, broadleaved woodland etc) around outside of heathland sites
	Lack of connectivity between sites preventing movement / genetic exchange between sites	Creation of supporting habitats, plus connecting bridges, underpasses and corridors.
	Smaller site size increases edge effects	Buffer smaller sites with heathland creation and supporting habitats; habitat management (removal of non-native species);
Predation and increased mortalities	Access by pet cats, some of which feed on the heath	Fencing and other barriers between housing and sites; pet covenants.
	Different densities of mammalian predators such as foxes present on more urban heaths	Culling; fencing; removal of anthropogenic food sources in area.
	Increase in crows and magpies on sites with greater human activity	Removal of anthropogenic food sources; removal of perches and nest sites for corvids; culling.
Roads	Road kills from traffic	Underpasses, bridges tunnels and other structures to allow wildlife to cross roads; fences and screening along roadsides; roads sunk to ensure birds fly over above car-height.
	Increased levels of noise and light pollution	Screening; quiet road surfaces.
	Roads are barriers to species mobility	Underpasses, bridges tunnels and other structures to allow wildlife to cross roads;
Disturbance to birds	Areas with high visitor pressure not settled by breeding birds, resulting in low densities	Dogs on leads during the breeding season, reduce visitor numbers through reductions in car-park capacity; limit number of new residents around heathland sites; provide alternative sites for people to visit; encourage people to walk in particular areas (e.g. through provision of marked routes); habitat management (e.g. encouraging gorse screens along paths).
	Adults flushed from the nest by people / dogs	Dogs on leads during the breeding season, reduce visitor numbers through reductions in car-park capacity; limit number of new residents around heathland sites; provide alternative sites for people to visit; encourage people to walk in particular areas (e.g. through provision of marked routes), habitat management (e.g. encouraging gorse screens along paths).
	Pairs breed later and fewer times, resulting in reduced breeding success	Reduce visitor numbers in sensitive habitats through reductions in car-park capacity; limit number of new residents around heathland sites; provide alternative sites for people to visit; encourage people to walk in particular areas (e.g. through provision of marked routes), habitat management (e.g. encouraging gorse screens along paths).

Effect	Description and Impact	Potential mitigation
Pollution / Hydrology	Ground and surface water pollution from roads and hard surfaces, spills and dumping.	Protection of water catchments; drainage etc along roadsides.
	Air pollution from industrial uses, fires and vehicles	Reduce or control air pollution sources downwind of heathland sites; habitat management (e.g. burning and grazing)
Trampling	Soil compaction	Reduce visitor numbers (especially horse riders and cyclists) in particular areas; provide boardwalks or similar in sensitive areas;
	Soil erosion from walkers, cyclists and horse riders	Reduce visitor numbers; direct & encourage visitors away from sensitive areas (such as slopes); provide steps etc. to prevent gullying.
	Damage to breeding and wintering sites	Reduce visitor numbers in sensitive areas; access management techniques such as boardwalks to reduce and contain ground disturbance.
	Creation of extensive path network increases spatial disturbance	Contain path network through signs, interpretation, provision of marked routes, wardening.
Vandalism	Damage to signs, fences, gates	Provide funding to replace; use vandal proof infrastructure; wardening; police liaison.
Eutrophication	Enrichment of soils from dog excrement.	Dog bins; education; wardening; enforcement of clearing-up; habitat management.
	Dumping of household and garden rubbish.	Closure of car-parks etc at night; making car-parks etc difficult to access with a trailer; wardening; police liaison.
	Enrichment along road corridors, effects of dust, salt, run-off	Effective roadside drainage to protect heath from run-off; traffic calming; careful road design.
Fires	High fire incidence on urban heaths. Direct mortality of fauna and temporary removal of breeding and foraging habitat	Police and fire service liason; wardening; habitat management (fire breaks etc.), education progammes.
	Long term vegetation change from repeated fires	Habitat management (e.g. grazing); reduction in fires (see above).
Restrictions on management	Stock grazing, gates left open, dogs chasing animals, injury to stock	Careful choice of stock; self-shutting gates; wardening; interpretation and signage; careful implementation of grazing (e.g. ensuring areas without stock are always present where dogs can be run off the lead); community liaison.
	Objections to management e.g. tree clearance	Community liaison; interpretation; education; careful management planning;
	Increased costs of wardening	Additional funding.

4.1 The work of the Urban Heaths Partnership

4.1.1 The Urban Heaths Partnership (UHP) was established to undertake the Urban Heaths LIFE project, and co-ordinates organisations working to implement some of the measures needed to reduce the urban impacts on the heaths. The Partnership comprises local councils, Dorset Wildlife Trust, the Herpetological Conservation Trust, English Nature, Dorset Police and Dorset Fire and Rescue Service (DFRS). The LIFE project, funded under the EU's LIFE-Nature Programme, ran from 2001 – 2005 and targeted the 25% of the Dorset Heathlands which fall within or immediately adjacent to the urban areas of south east Dorset. The project's overarching aim was to strive to change poor public perception towards the heaths and their management, but within this had specific objectives to:

- Improve local organisations' ability to prevent and tackle heathland fires;
- Develop an education programme seeking to prevent abuse of heathlands;
- Deliver a community action programme to build local support for heathlands;
- Provide integrated communication between all partners; and
- Demonstrate effectiveness of actions.

4.1.2 The project was considered to be successful in its objectives of addressing urban pressures on heathlands. Whilst the final report of the LIFE Project has yet to be signed off by the EU (as at January 2007), the Project is recognised by them to have achieved its objectives to the highest standard. Extra wardens were provided on the heaths to discourage unwanted and illegal activities and to engage with visitors to help them understand the importance of the heaths for nature conservation and the need for management. The wardening and education programme concentrated on lessening the effects of the most immediately damaging of the urban pressures – uncontrolled fires and motor vehicle trespass. New fire fighting equipment was purchased and close liaison was established with the fire service.

4.1.3 Progress seems to have been made in reducing the effects of the fires – there was a 60% reduction in the average number of fires per year for the duration of the project when compared to the average number 1992 – 1998 (A. Elliott, *pers. comm.).* Whilst this is not statistically significant given weather-dependent annual variations (Rose *et al.*, 2005), the DFRS recognise a definite reduction in the level of resources used to fight heathland fires (S. Shuck, *pers. comm.*). Those fires which do occur are smaller and extinguished more quickly. Since April 2003 there has been only one heath fire which DFRS classify as a major incident (10 pumps or more). This compares to several per year in the years leading up to the LIFE project (H. Tidball, *pers. comm.*) It is interesting to note that this fire occurred at a time outside the when additional wardens were employed.

4.1.4 Work began on the problems of eutrophication, caused by rubbish dumping and dog faeces, and disturbance from visitors straying from designated routes and unrestrained dogs. The wardens worked closely with local police officers within "Operation Heathland" which was co-ordinated by the Dorset Police Wildlife and Heathland Protection Officer.

4.1.5 An extensive life long education strategy was devised and implemented to improve knowledge, understanding and appreciation of the heaths and their management. The school education packages were designed as a series that children and young people would experience at Key Stages 1-4, from the ages of 6 to 15. The first cohort of young people to have had the whole package will leave school in 2012.

4.1.6 The project has developed a framework for combating the urban pressures on the heaths. The partnership itself is one of the project's biggest successes, facilitating contact, close working relationships and a shared understanding of the issues involved. The project work has been running some years, and is therefore helping to reduce the pressures caused from the current housing levels. These pressures are considerable, and the measures of the success of the LIFE project show that the partnership has been partly successful. However partners believe that this approach can never entirely solve the problems caused by the urban development surrounding the sites without alternative sites to which they can deflect undesirable activities (H. Tidball, *pers. comm.)*(see 4.2.5) . The public perception surveys show a small positive shift in attitudes towards the heaths, indicating that the project is reaching a wide audience (Atlantic Consultants, 2003; 2005), potentially across the population of 450,000. Some of the key findings, comparing 2005 attitude surveys to those in 2003 and 1997, were as follows (data from (Atlantic Consultants, 2003; 2005)):

- The proportion of people who understand that the heathlands are an ancient and man-made landscape is higher than ever and there is a greater understanding as to why the heathlands need to be managed;
- There was a significant increase in people eager to offer help and to learn about the heathlands;
- There was increasing public appreciation of the heathlands as a natural resource and as a valuable place for recreation.

4.1.7. The steps made by the Urban Heaths Partnership, illustrated by the attitude surveys, are small. It would be beneficial (even necessary) for the education programme to be run for long time, or even in perpetuity for the messages to reach its audience, especially as people continue to move into the area from outside. UHP partners consider that it could take a full generation for the required shift in public attitude to take effect: this means that work is judged to need to continue for 15 years at least (H. Tidball *pers. comm.)*.

4.1.8 The consistent decline in conservation status of urban heathlands over the years preceding the project was judged by English Nature in 2005 to have halted.

4.2 Other site & access management measures

4.2.1 There has been access management on the heaths for many years, as part of the routine management of the sites by various nature conservation bodies, agencies, authorities and private owners. Such management work includes the provision of surfaced paths, waymarked routes, hides, screening, interpretation and wardening. While the Urban Heaths Partnership works to tackle the particular problems associated with the more urban heaths, more generic habitat and site management is implemented across sites, often as part of project funding or schemes such as environmental stewardship. The Heritage Lottery funded Hardy's Egdon Heath Project (HEH) ran from 2000 – 2006, and, with a budget of over £3 million, implemented management work on 77 heathland sites. Improvements to pathways were carried out at St Catherine's Hill, Arne, Holton Lee, and Norden. At Holton Lee an electric all-terrain wheelchair was purchased to enable visitors to have better access to the site. Other access works that had been programmed under the Project, such as at Creech Heath and Great Ovens Hill, were funded by Dorset County Council as part of their rights of way improvement under Open Access.

4.2.2 One major improvement to access that was partly funded though, and organised by, the HEH Project, was the Sika Cycle Trail. This was a collaborative project involving Dorset County Council, Purbeck District Council, the Forestry Commission, Greenlink, and the HEH Project. The project saw the development of a nine mile cycle route from the centre of Wareham through to Wareham Forest and back. As well as ensuring that the route had suitable terrain, funding also allowed it to be waymarked and accompanied by a leaflet.

4.2.3 The provision of access infrastructure and site management on heathland sites is constant and on-going, and has been for many years. The work is to some extent mitigation, as site managers will respond to problems as they arise; for example, new steps may be put in where erosion is occurring. Given the wide variety of funding, the different organisations involved and the range of different management works required on different sites, it is difficult to put a per hectare cost on such management. It is clear that where visitor pressure is high, management costs are likely to be higher (Underhill-Day, 2005; Woods, 2002), particularly on smaller, more urban sites. It would be interesting to determine the extent to which funding in recent years for site management has needed to change to account for additional development pressure.

4.2.4 It is clear that there is a wide variety of measures in place to reduce the impacts of high visitor pressure. Little has been done to monitor their effectiveness. The condition of the heathland SSSIs in Dorset provides some indication of the effectiveness of management measures, taken as a whole. The condition assessment data for heathland sites in Dorset shows that over 3000 ha of heathland are currently in 'unfavourable condition' and a further 2600 ha are 'unfavourable recovering' (Table 18). Where notes give reasons for the unfavourable assessment, nearly 300 ha are unfavourable due to definite urban effects such as illicit vehicles, development or disturbance.

Table 18: Summary table of condition of heathland SSSIs in Dorset, raw data (dated October 01 2006) downloaded from the English Nature website[23] and summarised by the authors

Condition	*Area*	*%*
Favourable	2448	29
Unfavourable recovering	2612	31
Unfavourable no change	2383	28
Unfavourable declining	1000	12
Part destroyed	3	0
Destroyed	11	0
Total	8458	100

4.2.5 Comparing the urban heathland sites with the more rural sites it is clear that, despite the amount of work and funding put into the management of the former, more of them are in unfavourable condition than the more rural sites (Table 19). This would suggest that the measures conducted to date are not enough on their own to be successful in solving the management problems created by the sites' urban surroundings.

Table 19: Comparison of condition of urban and rural heathland sites. The table combines data for the more urban heaths (Bourne Valley, Canford Heath, Corfe & Barrow Hills, Ferndown Common, Ham Common, Lions Hill, Parley Common, Slop Bog And Uddens Heath, Town Common, Turbary And Kinson Commons, Upton Heath) and the more rural ones (Arne, Blue Pool and Norden Heaths, Corfe Common, Corfe Meadows, Cranborne Common, Ebblake Bog, Hartland Moor, Holt And West Moors Heaths, Holton And Sandford Heaths, Morden Bog and Hyde Heath, Oakers Bog, Povington And Grange Heaths, Rempstone Heaths, St Leonards And St Ives Heaths, Stoborough & Creech Heaths, Stokeford Heaths, Studland & Godlingston Heaths, The Moors, Thrasher's Heath, Turners Puddle Heath, Winfrith Heath, Worgret Heath). Table gives area in hectares and the percentage in brackets.

	area (%) unfavourable	*area (%) favourable*	*Other (i.e. unfavourable recovering or destroyed)*	*total area*
Urban	906 (63)	62 (4)	479 (33)	1447
Rural	2477 (35)	2386 (34)	2148 (31)	7011

[23] http://www.english-nature.org.uk/special/sssi/report.cfm?category=C,CF

5 Predictions of the effects of development proposed within the RSS

5.1 Review of the 400m exclusion zone

5.1.1 A 400m zone around the heaths, within which a net increase in the number of residential dwellings, is halted, is proposed within the Thames Basin Heaths Delivery Plan and has been widely suggested as a suitable distance at which to totally limit further development around the boundaries of heathland sites. The 400m—as selected by Natural England—is a pragmatic figure based on a number of different impacts and the difficulty of avoiding their occurrence when housing is adjacent to heaths. In particular:

- Residents living very close to the heaths are more likely to visit the heaths than people living further away;
- Cats associated with housing adjacent to the heaths may be more likely to visit the heaths; and
- Other effects, such as garden waste dumping, garden extensions and fly-tipping from gardens, all occur where housing is adjacent or very close to the heaths.

5.1.2 Each of these impacts represents a continuum, with the frequency of occurrence likely to be related to distance from the heaths. For example, the general trend in the proportion of people visiting heaths is that it declines with distance from the heath (Appendix 2, Figure A2.2). With these visitor rate curves there is no clear cut-off point or threshold level at which a neat convenient boundary can be drawn. The 400m figure is therefore a pragmatic attempt to set a sensible boundary, and in reality the difference in the impacts caused by a property at 390m compared to 410m is likely to be negligible. We consider the evidence in detail.

5.1.3 Development within easy walking distance of the SPA is more likely to be of risk to the heaths, as it is unrestricted by accessibility factors such as car park provision. It is highly likely that residents living within easy walking distance would use the heaths and would not be diverted to suitable alternative natural green space for recreation in preference to the heaths. Approximately one-quarter (23%) of all postcodes given by interviewees interviewed in the survey by Clarke *et al.* (2006) were within 400m of the access points where questioned. Grouping people by the mode of transport used to reach the heaths, 400m includes 1% of all the car drivers interviewed in the Clarke *et al.* survey and 56% of people arriving on foot.

5.1.4 Pet cats are known to prey on a variety of wildlife (Woods, McDonald & Harris, 2003), and research on Dartford warblers has revealed high predation rates of chicks by pet cats (Murison *pers. comm.,* unpublished doctoral research). In terms of predation risk from cats, there are few studies that have investigated the hunting ranges of cats (see Underhill-Day, 2005 for a review), and the evidence base is especially limited for studies in the UK and on domestic, rather than feral cats. As with travel distance for people, there is no clear distance at which it is possible to state that any increase in the numbers of cats will not result in an increase in the number of cats visiting the heath. Cats are territorial (see Barratt, 1997; Bateson & Turner, 1990; see Edwards *et al.*, 2001; Langham & Porter, 1991), and, for males especially, home ranges may be exclusive, meaning that the presence of a new male cat in an area is likely to result in a change in territory boundary for other males. This would suggest that the spatial distribution of cat territories, which in turn is likely to be related to the distribution of housing, gardens and prey, will to some extent influence the extent to which individual cats may roam. Underhill-Day provides estimates of home ranges from different studies and shows that some radio-tracked cats have home ranges of over 400 ha. He also provides some figures of the linear distance that individual cats have been shown to travel, and these range from 80m to over 1km apart, mainly in the upper half of that range. Given this, we acknowledge that a 400m exclusion zone may not be sufficient to eliminate the presence of cats on heathland. This area would warrant further research, as there are no specific studies which relate to heaths and surrounding housing.

5.1.5 A range of other urban impacts including garden extensions, garden waste dumping and fly-tipping are likely to be more prevalent when the urban area is adjacent to the heathland boundary. This range of impacts is varied and is likely to be confined to where housing abuts, or is very close to, the heathland sites. Where such impacts have been studied or mapped, the presence of exotic trees, compost heaps, garden extensions etc is usually clearly associated with particular houses and can form a whole line along particular boundaries of heaths (Hall, 1996; Liley, 2004).

5.1.6 Given the range and intensity of the impacts discussed in this section, it is clear that the impact of housing close to the heaths is more severe than housing that is further away. It is also harder to reduce the impact of adjacent housing, due to the difficulties in providing alternative open space and limiting cat numbers. It is also clear that the circumstances may vary between heaths: for example, cat ranging behaviour will be influenced by the amount of existing housing in the surrounding area and the number of other cats. However, the evidence base is not sufficient to specifically identify the instances where an exclusion zone should be increased or decreased in size and to what extent. Where to draw a boundary is therefore a pragmatic decision and it would seem sensible to choose a standard boundary for the zone that is easy to interpret and apply and, given the evidence base, is likely to reduce further impacts on the heaths. The 400 metres selected by Natural England would seem a realistic distance to represent the zone of highest potential impact on the SPA from new residential development.

5.2 Predictions of changes in visitor numbers as a result of development

5.2.1 Annual figures for the proposed level of development were provided by Dorset County Council for the study area. These figures are summarised in Table 20.

Table 20: Proposed annual housing figures by district.

	Scenario 1	*Scenario 2*	*Scenario 3*	*Scenario 4*
	4(4) Advice	*RSS Table 1*	*25k pro-rata scenario*	*28k pro rata scenario*
Bournemouth	680	780	850	950
Poole	445	500	540	610
Christchurch	60	180	195	220
East Dorset	260	260	280	315
Purbeck	75	105	115	130
North Dorset	440	255	280	310
Total	2060	2090	2270	2547

5.2.2 The figures for each scenario in Table 20 were applied, within the GIS, to each district. Potential urban extension sites were first identified through discussion with local authorities. Each urban extension site with the allocated amount of housing, and assigning the remaining housing to each postcode within each district by the necessary percentage (calculated on a pro rata basis). No increase in housing was allocated to any postcodes within 400m of the SPA boundary.

5.2.3 The predicted increase in visitor pressure as a result of these scenarios are shown in Table 21, and mapped in Maps 19–21.

Table 21: Predicted increases in visitor pressure to the heaths as a result of different housing allocations. Scenario 0 is the "current" prediction. Visitors by car component based on Model C3 or C5.

Scenario	*Model C3*		*Model C5*	
	Predicted total visitor numbers	% increase	Predicted total visitor numbers	% increase
0 (current)	20,211	0	17,450	0
1	20,488	1.4	19,164	9.8
2	20,445	1.2	19,144	9.7
3	20,538	1.6	19,515	11.8
4	20,571	1.8	19,727	13.0

5.2.4 There is clearly a difference between the two estimates based on car visitor models C3 and C5. Model C3 only accounts for people walking to the heath, as the car-drivers are predicted by car-park size alone, which is assumed in the predictions to stay the same in the future. As we have included the 400m exclusion zone (i.e. no development within 400m), the increase in foot visitors is small. This would support the effectiveness of a 400m exclusion zone. Model C5 involves housing density in its prediction for car-drivers, and therefore the difference between the two models is due solely to differences in the predicted number of visitors by car.

5.2.5 It is clearly crucial to understand the extent to which car-parks might limit the numbers of people visiting the sites, as this will help determine whether estimates are reasonable for a given car park size. There is no evidence from our work that car-park capacity is limiting or could limit visitor numbers: the model equation does not predict that car-parks are always full, but that car-park capacity acts as a surrogate measure for places people tend to visit. This is clearly an area for more research. A detailed examination of the equation for Model C3 shows that, where there are few spaces there is the highest expected number of visitors per parking space (see Table A2.4 in Appendix 2). An access point with just one parking space is predicted by model C3 to receive 7 visitors per 16 hours. Given that the mean visitor group size in the visitor survey data for Dorset (see Clarke *et al.* 2006) was 1.5, this would equate to a predicted 5 car-visits during the 16 hours, or one car per 3 hours per space. The typical dog walk is likely to take much less than one hour to walk, and therefore the model C3 predictions of current visitor rates would suggest that car-parks within the area are not currently being used to their full capacity most of the time.

5.2.6 It is of course possible to apply a similar approach to the model C5 estimates. We took the predicted visitor numbers to each access point, calculated for scenario 4, using Model C5 and checked to see whether, for any access point, these exceeded the potential capacity based on car-park spaces. We assumed each visit to last three hours (this is likely to be an over estimate) and each car to contain 1.5 people: an access point can therefore hold five cars and 7.5 visitors per car-park space in a 16hr period. The predictions (using Model C5 for scenario 4) for all access points with parking were below this capacity, suggesting that car-park size is unlikely to be limiting, at least most of the time. We therefore tentatively suggest that the percentage increase in visitor numbers as a result of scenario 4 could be up to a maximum of 13% across the entire SPA (Table 20), with local increases on particular parts of the heaths much higher (see Map 19).

5.3 Mitigation

5.3.1 There is a wide range of potential mitigation measures available, as summarised in Table 17. The evidence base for the effectiveness of many of the measures is limited. It is clearly impossible for us to state the amount of development that could be accommodated in the study area by using avoidance and mitigation measures to achieve no adverse impact on the heaths. In this section we discuss only the principal measures with which it is possible to mitigate for urban development, or avoid further impacts arising from it. We attempt to discuss the potential for each measure, drawing on the evidence-base in the literature and the results of the visitor modelling shown above.

5.3.2 We recommend that further work is needed to address which mitigation and avoidance measures should be implemented where. This work should be done strategically, bringing together landowners and site managers from the necessary organisations and using the models of visitor pressure produced in this report. In the near future, analysis of bird distributions in relation to visitor pressure and habitat will be available and this may indicate areas where the Annex 1 birds are thought to be absent because of high disturbance levels. These will be the areas where it would be ideal to reduce visitor pressure and, similarly, it will be possible to identify areas where an increase in visitor levels would result in a reduction in the number or density of key bird species present. With a knowledge of visitor distribution and pressure, a knowledge of the site, and an understanding of access management measures, it will be possible to look across all sites and identify areas where measures to reduce or contain visitor pressure should be targeted. Different options will be available depending on circumstance and geography, and it will be possible to target the appropriate measures to the right locations. For example, a reduction in car-parking capacity and provision of a marked route at one site might be effective but not necessarily appropriate or possible at a different site. Similarly, car-parking controls (e.g. closures of some car parks, wardening, permit systems with registration of dog users using car parks) may be a feasible mitigation strategy in certain locations, but we stress that there is no evidence from our work that car-park capacity is limiting or could limit visitor numbers (see paragraphs 5.2.5 and 5.3.34).

5.3.3 For many types of mitigation to be successful, heath users will need to change their behaviour, patterns of access and how they visit the heaths. Such changes are likely to be slow to occur and potentially difficult to implement.

Alternative greenspace, forestry and the River Stour

5.3.4 There is little evidence to guide the design of new greenspace, or management of existing greenspace, to ensure it attracts the people who would otherwise be likely to visit the heaths. The only study looking at people's preferences and using these to explore the "quality" of greenspace is Liley *et al.* (2006b). This study, through the use of photographs, highlighted that people visiting SPA heathland sites, when compared to those people visiting more urban parks and other sites outside the SPA, preferred sites with semi-natural vegetation and some tree cover. People visiting SPA sites stayed for longer, perhaps suggesting that they walked further. For dog walkers, convenient car-access, the ability to let the dog off the lead and the absence of livestock are important. Specific studies of dog walkers show that they select sites where they perceive their dog will have fun (Edwards *et al.*, 2006).

5.3.5 These results would suggest that alternative sites, if intended to attract people away from the heaths, should be relatively large and have a relatively 'wild' feel, containing a mix of semi-natural habitats and certainly some tree cover. There should be convenient car-parking. Following the results from Edwards (2006), for dog walkers specifically, sites should be perceived as "fun" for dogs, i.e. the dogs are able to run loose, there is a range of habitats (water, scrub, etc) and a regular community of dog walkers.

5.3.6 The Dorset visitor surveys suggest that the distance people walk on the heath is related to the size of the site, with dog walkers walking further on larger heaths. There was no difference in the length of the walk on the heath for those dog walkers who travelled by car and those who walked to the site, suggesting that the length of dog walk on the heath was the same for both groups. Across all sites, the average distance walked was 2.2 km, penetrating (at the mid point of their route) 700 m onto the heath. Taking these averages, the typical dog walk can be considered as a circle with a circumference of 2200 m and a radius of 350 m. Such a circuit requires an area of c.38 ha. It could therefore be suggested that sites suitable for an average dog walk (for those people who tend to visit heaths) need to be at least 38 ha. These recommendations clearly describe sites which are beyond the normal PPG17 provision for open space, informal recreation and sport facilities.

5.3.7 It is difficult to suggest a total area of greenspace that might accommodate the increase in visitors as a result of further housing. The simplest means of estimating the area would be to take the percentage increase in visitor numbers and apply that to the area of heath and associated land. We have mapped 10,718 ha of 'visitable' land within or associated with the Dorset Heaths SPA. Taking the percentage increases in visitor numbers described in Table 21 and applying these to the area of visitable land gives a crude estimate of the land that might be necessary to ensure that overall average visitor numbers across the whole visitable area remains the same (Table 22). An increase of just under 1400 ha (13% of 10,718 ha) is suggested for the housing allocation within scenario 4 over the 20 year period to 2026. This is equivalent to c.70 ha per year.

Table 22: Estimates (derived from model C5 predictions) of total additional greenspace necessary over the next 20 years to 2026 for the housing allocations in each scenario

Scenario	*Predicted total visitor numbers*	*% increase*	*Additional land (ha) needed to maintain current visitor levels*
0 (current)	17,450	0	0
1	19,164	9.8	1050
2	19,144	9.7	1039
3	19,515	11.8	1265
4	19,727	13.0	1393

5.3.8 The figures in Table 22 provide a guide to levels of greenspace allocation. They give the area of additional land needed to maintain the same overall average visitor levels, calculated with no consideration of other mitigation measures that could be implemented and based on our visitable patches. Our calculation relies on two assumptions:

- additional greenspace would be provided to maintain the current mean visitor pressure
- mean visitor pressure is calculated across our visitable patches rather than all access land (i.e. including alternative sites too) or simply the designated sites

5.3.9 We use the current visitor pressure as a baseline because of a lack of more detailed information of 'acceptable' access levels. If, for example, it was possible to identify a level of visitor pressure at which urban effects might occur it would be possible to use such a threshold to provide a more robust estimate.

5.3.10 We have used the total area of visitable patches (rather than the area of SPA land within the patches) as it is difficult to isolate the SPA. Access points and car-parks are often located outside the SPA and where people walk does not necessarily bear any relation to where the SPA boundary lies. The visitable patches therefore represent a network of sites providing recreational greenspace to the current population. We do recognise that it might be useful to provide similar figures for the area of greenspace based simply on the SPA designated land within our patches. Taking all the cells within our patches that are alse within the SPA, we calculated the mean percentage change between the current level of visitor pressure (from Model C5) and that from scenario 4 (as in Table 22). This value is 11.9%, and applying this to the area of our patches that are designated as SPA (5441 ha) we obtain a figure of 647ha.

5.3.11 This figure of some 650ha assumes that the land within our visitable patches, yet outside the SPA, is able to absorb additional visitor pressure, without any impact on the SPA. This is clearly likely to be unfounded, as it will be impossible to stop people at the SPA boundary and the right of access extends over all the sites. On some sites, however, it may be possible to guide visitors in such a way. This is especially likely to be the case within certain large forestry blocks (see 5.3.16).

5.3.12 The success of the provision of additional greenspace as mitigation is dependent upon the ability of a site to attract people away from the heaths, and ultimately the ability of additional land to achieve this is much more important than the actual total area of land provided. Sites must meet the quality criteria outlined above (5.3.4) and crucially be in a location that will work to divert visitors away from more sensitive sites.

5.3.13 The western edge of the Bournemouth / Poole conurbation around the Lytchett Matravers area is an area where alternative sites for recreation might relieve pressure on Canford Heath, Upton and the Corfe Hills area. Securing alternative greenspace in this area is clearly crucial. Obvious potential sites are the farmland around Lytchett Matravers and also Henbury Plantation. In order to attract people away from the heaths, any site here would need to be large and easily accessible with good parking facilities, in order to draw people the crucial extra distance.

5.3.14 The flood plain of the River Stour between Wimborne and Christchurch is clearly visible on maps as it acts as a northern boundary to the spread of the urban conurbation of Bournemouth and Poole. There are footpaths along much of the valley and it is a large area of green space. Few parts of the flood plain are important for nature conservation. The valley has the potential to play a key role in providing green space. In terms of location, it acts as a natural barrier to people traveling north from Bournemouth, as there are relatively few bridges. The crossing points, such as at Longham, are therefore located on busy roads and would provide ideal locations to 'intercept' people that might otherwise travel to the heaths. The valley has the potential to attract people that might otherwise visit Canford, Parley, Ferndown, St. Catherine's or possibly even the heaths slightly further a field, such as Avon Heath. Some of the sites within the valley are already used by dog walkers. In order to function as an alternative site, there must be convenient parking and road access, and a network of suitable walks, plus habitat that would attract people that would otherwise be visiting large blocks of heathland and woodland. Paths would therefore need to be relatively dry and there would need to be a variety of circular routes possible from car-parks. Being a linear strip of habitat, the provision of different routes and circular walks is likely to be difficult to implement and would need careful planning.

5.3.15 It is likely that forestry areas could have a considerable role to play as mitigation sites. The large pine plantations are included in our visitor model as they are associated with the SPA and have existing access, so forestry sites would not count as additional greenspace. It may however be possible for some of these sites to accommodate more visitors. As most forestry areas have the potential to be restored to heathland and do currently support the Annex 1 bird species, caution is needed in increasing visitor numbers to commercial forestry in the general area of the SPA. The cyclical nature of commercial forestry means that the habitat for the key bird species (clearfell and very young planting) changes in space and time. Given that access points, such as car-parks, are likely to be relatively fixed, it is important to recognize that locations that do not support the key bird species at present may well do so in the future.

5.3.16 There is scope for further research on access patterns within commercial forestry, as access patterns in forestry areas are likely to be different to open heathland. Within plantations the routes used by those visiting for recreation tend to be graveled tracks designed to move machinery and timber. These wide tracks act as clear, robust routes for visitors. Clearfell and young plantations, the areas used by woodlarks and nightjars, are difficult to walk through and tend to have no paths through them. It is therefore possible that forestry areas may be able to support higher densities of visitors with little conservation impact, but more work is needed to confirm this. Forest areas can be made more attractive to visitors through the provision of better parking facilities, landscaping / careful planting and by providing a network of routes that encompass landmarks and features within the forest.

5.3.17 Forestry sites of particular relevance to the study area are

- Cannon Hill & Uddens Plantation
- Puddletown Forest
- Hurn Forest
- Whitesheet Plantation
- Ringwood Forest
- Wareham Forest

5.3.18 Cannon Hill, Uddens Plantation and Whitesheet Plantation are all located to the east of Wimborne and to the south of Holt Heath. Cannon Hill is close to the A31 which provides fast access from the direction of both Wimborne and St. Leonard's. The area does support nightjars, but at present has very limited car-parking. There are viewpoints and the potential for a variety of circular walks. At present there is little infrastructure for walkers. The area is included within our visitor modeling, and the model predictions highlight the relatively low numbers of car-visitors. With better facilities for people with cars, this area may attract visitors that otherwise might visit Ferndown, Parley (e.g. Lone Pine Drive) and Uddens / Slop Bog. Measures may be needed at these sites to dissuade visitors (livestock grazing, presence of wardens, enforcing dogs on leads) as well as more welcoming features at Cannon Hill.

5.3.19 Puddletown Forest is to the west of the SPA area and is not close to European designated heathland areas. It is close to Dorchester, and therefore is likely to receive visitors from outside the study area. In terms of attracting people away from the heaths, it is likely that this site could only reduce pressure by attracting people happy to travel some distance – such as those involved in specialist activities such as orienteering or mountain biking. There is already a mountain bike circuit being developed here.

5.3.20 Hurn Forest is a reasonably large patch with only a small proportion of its area (in the south) designated as SPA. There are nightjars and woodlarks distributed throughout the patch. It is directly linked to Barnsfield which holds good numbers of woodlarks, Dartford warblers and nightjars and which has no public access. Hurn Forest is strategically placed between Parley Common, Avon Heath and Sopley, and therefore there is a clear area of non-SPA designated forestry that could perhaps accommodate more visitors . The car-park at the northern part of the forest block is easily accessible from the A31 and is therefore easy and quick to access from both the west and the east. This car-park has ten spaces and could potentially be enlarged and designed better to attract people away from Avon Heath South Park and Parley. It is likely that Hurn Forest could receive some increase in visitors without impacting on the bird numbers present there (although analysis would be necessary to verify this). The long, thin shape of the Forest also provides the potential to provide a long route / circuit for cyclists and horse riders.

5.3.21 Both Ringwood Forest and Wareham Forest are large blocks of conifer plantation with small patches of designated sites within them. Both these sites support populations of all three Annex 1 bird species. Within Ringwood Forest the visitor models highlight the high numbers of visitors to Moors Valley Country Park, which has a large car-park and a wide range of facilities. This site is likely to attract people from a considerable radius, while the smaller, more informal parking locations will attract local dog walkers from Ringwood, Ashley Heath and Verwood. European sites, such as Noon Hill and Stephen's Castle, are small and located on the edge of the Forest, accessible on foot by Verwood residents. These sites will benefit from on-site access management. Were more parking locations provided along the B3081 it may be possible to draw some visitors away from the forest areas directly adjacent to Verwood and reduce pressure here.

5.3.22 Wareham Forest lacks any large focal car-park and centre such as Moors Valley, and has much fewer people living around it. It is a large site and visitor pressure is relatively dispersed, with the main focus being Cold Harbour and Lawson's Clump. It is unlikely that changing the infrastructure here would reduce visitor pressure on the adjacent heaths.

5.3.23 The whole issue of alternative sites must be addressed strategically, ensuring that a network of small and larger sites, providing for a range of recreational users, is in place. This network must dovetail with the heathland sites and the management of them, ensuring that people wishing to visit the countryside are aware of where they can visit and which sites are best suited for different activities.

5.3.24 Alternative sites clearly need to be promoted to ensure that they are used, and it is likely to take some time for communities to find out about them and learn to use them.

Heathland support areas

5.3.25 Heathland support areas are areas adjacent to existing heaths that reduce visitor pressure within the heath by allowing access onto them. This additional land does therefore not serve to attract visitors away from heathland sites, nor requires any chance in general access patterns, in terms of where people travel to etc. A good case study is that of Sunnyside Farm. This farmland, adjacent to Stoborough NNR, was purchased by English Nature as it provided the opportunity to provide lie-back land for livestock, to enhance the integrity of the site and to enhance access. When not used for livestock grazing (the summer, which coincides with the time when dog walkers are asked to keep their dogs on the lead while on the heath), dog walkers are able to let their dogs run off the lead across the fields. Interviews were conducted at the site as part of the Dorset Heath Visitor survey (Clarke *et al.*, 2006) and 13 out of the fifteen dog walkers interviewed at the site were using the new land to exercise their dogs.

5.3.26 We predicted the likely impact of adding a heathland support area by using the model developed in section 3 and Appendix 2 above. We explored a hypothetical example of the addition of 217 ha of land with public access to the east of the heathland at Parley (Map 22), an example suggested by Natural England. This new block of access land would essentially link two existing patches, those of Parley and Merritown. The addition of this access land would serve to reduce pressure on Parley, as there would be no net increase in local housing and the model 'spreads out' the visitors away from the access points (Map 23). Some parts of the Merritown patch would increase marginally in visitor pressure as a result of people being able to walk between the two patches. This hypothetical scenario is useful as it demonstrates:

- Visitor pressure will change as a result of the addition of heathland support areas;
- Visitor numbers in particular areas may go up as well as down; and
- The location of the new land, in relation to the distribution of access points, parking and housing is crucial: where the land is close to access points, it will generate the biggest reduction in visitor pressure.

Pet covenants

5.3.27 There is clearly room for concern regarding the use of restrictions on the keeping of pets as a way of avoiding harm to the heathlands arising from:

- predation and disturbance from domestic pets accessing the SPA unaccompanied (e.g. hunting cats); or
- disturbance caused by dogs being taken for a walk on the SPA, and the people taking them for a walk, who might not otherwise disturb the SPA birds.

The reliance that can reasonably be placed on the effectiveness of such restrictions, in terms of long term compliance and enforcement, is uncertain and the avoidance of disturbance effects would not be achieved by such restrictions. It should be emphasised that, if the conditions or obligations about pet restrictions reliably led to there being no further pets within the relevant dwellings, then self-evidently they would avoid the effects of predation and disturbance arising from the keeping of the pets. This alone, however, may not remove the potential effects of disturbance.

5.3.28 Concerning the issue of avoiding disturbance, there is currently insufficient evidence to determine that walkers on their own do not have a disturbance effect on the Annex 1 birds to be satisfied that restrictions on pets would overcome the disturbance effects on the SPA. Whilst research does suggest that dogs have a different impact to people alone (Lord *et al.*, 2001; Taylor, in press), this should not be interpreted as evidence that walkers alone do not cause disturbance. Most studies have not attempted to separate out the impacts of walkers alone from walkers with dogs; whilst providing clear evidence for an impact from increased urbanisation and increased recreational use on heathlands, they do not attempt to differentiate between user groups. Visitor surveys (Clarke *et al.*, 2006; MORI, 2004) have shown that a substantial proportion of visitors to heathlands do leave the main tracks, suggesting that disturbance from walkers alone is not likely to be limited to the major linear routes across sites.

5.3.29 Even assuming that a restriction on pet ownership might be effective it would not therefore remove all the likely impacts from a residential development on the SPA alone or in combination. It does not in itself remove the requirement for mitigation of those impacts.

5.3.30 Turning to the issue of enforceability, restrictions on the keeping of pets relying on enforcement by the planning authority, via a condition or a S.106 planning obligation, are generally unlikely to provide an effective avoidance measure. This is because their successful enforcement cannot be relied upon to the extent necessary to ascertain that there would be no adverse effect on the integrity of the SPA. The success of these planning measures is reliant on two issues; detection and/or reporting of breaches of the restriction, and action to enforce against an offending party by the local authority. We are not aware of any evidence to suggest that such a self-policing system is successful; rather, the temptation might be to follow suit, if one owner breached the covenant and kept a cat or a dog. There is no prospect of any planning authority being able to enforce such a condition or obligation on the large numbers of dwellings that are expected in the area, as discussed in section 6 above. Informal discussions with the Local Planning Authorities have also indicated that this would be the case. We therefore consider that the use of conditions prohibiting the keeping of cats and dogs would fail the tests of reasonableness and enforceability. No such condition has ever been imposed by the Secretary of State or an Inspector as far as we are aware.

5.3.31 The use of a S.106 obligation whereby the developer covenants to impose a restriction on the conveyance of the property would similarly be unenforceable by the planning authority and unreliable as an avoidance measure.

5.3.32 An alternative form of restriction that could be potentially more successful, is where the accommodation would be in flats or apartments, on leasehold, with communal areas and other communal management administered by a management company where it would be for the management company to monitor and enforce the restriction. In these cases the developer would covenant to establish the management company and impose the restrictions on the leases. The planning authority would not be the enforcing authority. However, the extent to which such a restriction (in the form of a S.106 obligation) would be enforced would depend, firstly, on the detection of such breaches, relying largely again on self-policing, and, secondly, on the willingness of that company to enforce. Historically, Inspectors have noted that in the event of a breach of a prohibition on keeping pets, enforcement could give rise to difficulties.

5.3.33 A current research project (Hoskin, R. and Tyldesley, D. (in prep.) *The Thames Basin Heaths Special Protection Area: a review of planning appeal decisions 2005 - 2006*. Natural England Research Project 2006) has found that covenants prohibiting the keeping of cats and / or dogs have been accepted as potential mitigation measures in a number of cases, particularly relating to flats where a management company could enforce the restriction, and also where there was no restriction on the current dwelling(s) on the site. However, seven further cases rejected the use covenants as ineffective and / or unenforceable and in ten appeal decisions such covenants were found to be insufficient to avoid harm to the SPA because they would not deter other recreational visits not related to dog walking.

5.3.34 There is therefore clearly concern about the reliance on restrictions in respect of keeping pets. Where restrictive covenants are concerned, evidence is needed to demonstrate to decision makers that such covenants are effective. That evidence, presented in a rigorously systematic way or underpinned by statistical analysis, is not available. If such covenants are shown to be effective in almost all cases (one could reasonably expect an occasional non-compliance that would not diminish the overall efficacy of the covenants generally), then they could make a useful contribution to reducing the effects of disturbance (and predation by cats). They cannot, however, be relied upon as avoidance measures on their own, because they do nothing to reduce the effects of people using the heaths for recreation without dogs and, of course, they would not apply to freehold properties or leasehold properties with no management company. At best they would reduce rather than eliminate recreational pressures.

Improvement and changes to access and habitat management on the heaths

5.3.35 Whilst an option may appear to be for Natural England and the landowners to close access to the heaths, this would not be possible or desirable. Much of the patches we have mapped are 'open access land' under the provisions of the *Countryside and Rights of Way Act*[24]. Much of the boundaries are open and there are many access points and established rights of way across the sites. Some of the area is also common land. It would not be practicable to close off or significantly reduce access on these sites. Restrictive access management is notoriously difficult to establish and sustain where there is a significant current level of public access. Measures to do so would need to be disproportionately complex and expensive to be effective. Even in the exceptional circumstances where the landowners or managers intend to deter or contain visitors, they tend not to be fully successful.

5.3.36 Natural England aims to ensure responsible access to the heaths so that people may enjoy their landscapes and wildlife; closing the heaths would be contrary to current policy and would not help to improve the public's understanding of the value of the heaths to the natural and historic environment. What is required is a sustainable level of managed access to the heaths that does not affect the bird populations for which they are classified.

5.3.37 Access management measures are already in place on many heathland sites, for example interpretation, wardening, boardwalks etc. It is anticipated that these measures alone, in the absence of alternative green space provision, would not enable permissions to be granted for residential development within the study area. This is because without alternative green space provision for the existing and potential new users of the heathland sites, access management measures may simply have the effect of displacing visitors from one part of the heaths to another.

5.3.38 It should also be born in mind that visitors visit the heathland sites from well beyond 5 km away (in Dorset an estimated 29% of all visitors by car and 20% of all visitors came from more than 5km from the heath access points (Table A2.1 in Appendix 2)). While the percentage of residents visiting from this distance is small, it is possible that there could be an increase in visitor pressure arising from well beyond 5 km, and this is why the predictive model C5 incorporates visiting rates from residents living up to 10 km away. Access management measures on the heathland sites would be the most effective means of absorbing such visitor pressure as these visitors are likely to be infrequent (rather than, for example dog walkers on their daily dog walk). They would therefore be expected to visit the well-known 'honey-pot' sites, where such access management measures are likely to be in place.

5.3.39 Our analysis of visitor numbers shows that car-park size is the best predictor of the number of visitors driving to an access point. This might suggest that limiting car-park

[24] Countryside and Rights of Way Act 2000. Section 1(1)

size would reduce visitor pressure by reducing the number of visitors by people coming by car. If a car-park is full and there is no room for additional cars, then it does seem logical that there will be a ceiling on the number of cars and therefore visitors. However, there is no actual evidence that this might be the case. It is possible that the pattern of distribution and size of car-parks has arisen as a response to visitor numbers at particular locations. This would suggest that car-park size merely reflects a feature of a site – its attractiveness, the views, the range of walks possible etc. It is interesting to note that the number of car-parks per kilometre of patch edge is the same for Dorset and the Thames Basin Heaths (see the figures in Table 10), and this might suggest that there is particular spacing that relates to the edge of sites. There is evidence that even when there is no parking at an access point people still find somewhere to park nearby (e.g. at the St Catherine's access point included in the survey by Clarke *et al.* 2006). In addition, visitors displaced by the closure of one car-park may simply go elsewhere, reducing visitor pressure around the closed car-parks, but increasing visitor numbers at other parts of the SPA.

5.3.40 Car-park closure is not likely to be a simple measure to implement as there is likely to be opposition from local people. Given the likely practical difficulties and the lack of evidence of its effectiveness, we are cautious in recommending car-park control as a means of reducing visitor pressure. However, we suggest that there may be merit in exploring this approach further. The measure is likely to be most successful where the number of spaces is simply reduced, rather than the car-park closed completely, and in addition where there is a range of alternative sites in the vicinity, or where the number of spaces at alternative sites can be increased. Double yellow lines may be effective where nearby street parking is currently used. Parking locations where limiting the number of spaces or even closure could be tested include Avon Heath South Park, Canford Heath (Gravel Hill), Upton Heath (e. & n. side of the heath), Parley (Lone pine drive).

5.3.41 There would need to be very careful monitoring of visitor numbers and car-park use, both at the sites where the restriction or closure of car parks was introduced and at surrounding sites. To assess the effectiveness of such measures, comparable data on visitor pressure is needed both before and after the changes were implemented

5.3.42 The condition of sites will have an influence on the distribution and abundance of the key species. Through positive habitat management it should therefore be possible to increase the numbers of key species within the sites, therefore mitigating for any loss as a result of urban impacts. Natural England has a Public Service Agreement Target to restore 95% of the area of SSSIs to favourable condition by 2010, and therefore such habitat management should be assumed to be likely to happen regardless of changes in access levels, and therefore such management is not mitigation. On the whole, habitat management also encounters the obstacle of reliance on third party agreement, when it is considered as possible mitigation for the potential impacts from development outside the SPA.

6 Recommendations for further work

6.1 There are some clear gaps in the knowledge base and a need for further work. Where relevant we have highlighted particular gaps within the report. Here we summarise particular areas that warrant further research (in no particular order):

- Potential alternative sites should be sought, mapped and the network looked at strategically. The GIS layers developed in this contract will provide a starting point, allowing gaps and key locations to be identified. A network of alternative sites will be necessary that provides sites large enough to attract dog walkers and in locations that will ensure they attract people that would otherwise visit the heaths.

- There is a paucity of information comparing the recreational use of heathlands and green space by people living in flats compared to houses and also whether people living in properties with gardens are more or less likely to visit green space. Rather than interview people on heathland / green space sites, one way of achieving these details would be a postal, or door-to-door type survey. A web-based approach may even be appropriate. The crucial need is for knowledge of house type, house location and the range of sites visited (and frequency of visit) in the surrounding area. This information would help determine whether different types of development have different levels of impact.

- There is a need for specific information on the recreational use of green space within the study area, and the extent to which people using these sites are people that also visit heathland sites. The large parks within Bournemouth and the beach areas are of particular interest.

- The evidence-base to demonstrate the effectiveness of mitigation measures to reduce urban effects. We recommend that measures such as car-park closure / reduction of spaces, modification of vegetation (such as allowing thick gorse screens to develop along certain routes), the provision of new heathland support areas and the creation of alternative sites are implemented in a way in which their effectiveness can be monitored and determined. Each of these would make a small study in their own right, but resources (time and money) need to be planned to assess visitor pressure pre- and post- implementation of any mitigation measures.

- Visitor monitoring should be co-ordinated in a strategic fashion across the European sites. We recommend that a series of automated visitor counters be established. The use of trailmasters or treadle counters, all located in a standard fashion across different sites would provide a baseline data set of visitor numbers and the variation between sites. Actual counts and questionnaires could be dovetailed with the electronic devices to allow calibration. Such a data set would allow further development of the visitor model and the potential to accurately record the effect of development and mitigation measures.

- The visitor model we have developed as part of this contract could be improved through an exploration and incorporation of factors quantifying the attractiveness of sites. We suggest further questionnaire data and interviews with site managers could be used to identify features of sites (viewpoints, pools, landmarks, beaches etc) which attract people, and this knowledge could be used to develop and add a weighting “attractiveness index” within the model to adjust predictions for access points of sites and/or pixels which contain these features. It may also be possible to include the path network within sites, and adjust the model predictions according to path density. The model could be tested through spot-counts within the heaths or through the use of counters (see above).

- The visitor model could be applied to spatial data sets to explore the extent to which visitor pressure across the heath patch might determine the distribution of key wildlife, fire incidence etc. It should be possible with such analyses to identify particular levels of visitor pressure at which a particular effect (such as a specific high probability of fire occurrence, or the absence of a particular bird species due to disturbance) might occur. Management measures could then be targeted accordingly. In addition, this work would provide guidance as to which areas could accommodate an increase in visitor pressure and where visitor pressure should be reduced.

- There is currently little information on the extent to which nutrification resulting from dog fouling is a problem; quantifying this impact would be useful. Soil sampling at set locations and repeated over time would provide indications of the rate of change and total input of nutrients. Aerial photographs, fixed point photography and vegetation monitoring would be useful to supplement the soil data.

- There is a need to further our understanding of the impact of pet cats. Research should focus on hunting ranges, habitat selection, prey choice and should look across a range of housing types and urban habitats. Such research could use radio collars, were willing owners to be found, allowing routes to be tracked and, with a suitable sample size of cats, it should be possible to determine the variation in ranging behaviour and factors which influence how far a cat may roam.

- Detailed monitoring of urban impacts and particular species is recommended on key sites. We suggest recording a number of key attributes on different sites and collecting these data at regular intervals. Key attributes could include fixed point photographs (e.g. of paths), measurements of path widths, counts of dog faeces, counts of visitor numbers through particular access points, number of fires, area of fires, bird numbers and distribution.

- Access patterns in forestry compared to heathlands. This research would be seeking to identify whether commercial plantations are able to support higher densities of visitors than open heathland without any conservation impact.

- There is little information on predator abundance and behaviour on urban heaths – foxes and crows are likely to occur at different densities and possibly behave differently where housing is present. We recommend applied research comparing rural and urban heaths and determining whether there are differences and mitigation that might be effective.

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Appendix 1

Visitor data from visitor surveys

SiteName	*CPType*	*CPCapacity*	*SPA*	*Foot visitors*	*Car visitors*	*Other visitors*
Avon Heath South Park, Boundary Lane	Official	16	Dorset	1	118	0
Belben road	Unofficial	2	Dorset	0	23	0
Black Hill	No parking	0	Dorset	0	11	0
Canford Gravel Hill	Official	12	Dorset	0	61	3
Ferndown	Unofficial	3	Dorset	22	1	1
Godlingston	Unofficial	2	Dorset	10	15	12
Great Ovens (Sandford)	Unofficial	2	Dorset	29	0	2
Hartland tramway	Unofficial	15	Dorset	1	51	2
Holt (Whitesheet Hill)	Official	20	Dorset	0	80	7
Lions Hill	Unofficial	1	Dorset	28	3	0
Morden	Official	7	Dorset	1	36	11
Parley (Lone Pine Drive)	Unofficial	6	Dorset	21	37	5
Sopley (Ramsdown Car Park)	Official	22	Dorset	3	63	0
St Catherine's	No parking	0	Dorset	22	52	0
Stoborough New Road	Unofficial	4	Dorset	28	5	1
Tadnoll	Official	6	Dorset	4	45	0
Talbot Heath	Unofficial	3	Dorset	14	8	2
Turbary Common	Unofficial	2	Dorset	44	4	8
Upton	Unofficial	2	Dorset	41	8	7
Winfrith	Unofficial	1	Dorset	7	19	2
B3011 opposite Arrow Lane	Unofficial	4	TBH	5	12	0
Black Bushes Road	Unofficial	2	TBH	1	29	0
Bourley Road	Official	36	TBH	1	100	12
Burdenshott Road	Official	25	TBH	3	36	0
Car Park off Cricket Hill Lane	Official	8	TBH	14	60	9
Car Park off the A30	Official	22	TBH	18	10	11
Chobham Road, chobham common	Official	35	TBH	2	77	0
Chobham Road, Horsell	Official	18	TBH	9	122	9
Currie’s Clump (Boldermere CP)	Official	65	TBH	2	112	1
E of Aberconway House (Wrens Nest CP)	Official	12	TBH	4	36	0

Lightwater Country Park entrance	Official	120	TBH	24	92	0
Mytchett Place Road	Unofficial	10	TBH	12	62	0
N entrance to Warren Heath	Official	7	TBH	2	49	9
Nightingale Road / A325	Unofficial	4	TBH	15	4	0
Off Crowthorn Road	Official	12	TBH	7	70	1
Play area, Springfield Avenue	Unofficial	2	TBH	22	0	3
Queens Road, Cowshot Common	Unofficial	3	TBH	29	19	3
S entrance to Bramshill Plantation	Unofficial	1	TBH	0	2	0
Salt Box Road	Official	18	TBH	3	167	3
Sandpit Hill	Official	8	TBH	14	29	1
Shore's Road	Official	40	TBH	1	211	18
South Road	Unofficial	5	TBH	18	4	22
Staple Hill	Official	15	TBH	27	3	0
The Lookout	Official	200	TBH	3	309	5
Top of Bracknell Road	Unofficial	3	TBH	31	2	5
Top of Kings Ride	Unofficial	1	TBH	25	53	9

Appendix 2

Detailed methods and results of modelling

Definition of "visitable" patches

The designated boundaries of the European Sites do not necessarily follow boundaries that match where people might visit. Some sites, such as the MOD areas of Bovington and Lulworth have no public access. In other areas public access extends beyond the SPA, sometimes linking different patches. We therefore defined "visitable" patches of heath and forestry, based primarily on the Dorset Heaths SPA. The SPA boundary file was provided in digital format by English Nature. We then created a second file within the GIS in which we modified the SPA boundary to reflect areas of open access, as defined by the CRoW Act (2000)[25] and detailed on the web (see http://www.countrysideaccess.gov.uk/). We also added additional areas with extensive expanses of visitable countryside, for example areas of land adjacent to heaths such as forestry or on nature reserves where public access is permitted. Farmland criss-crossed with rights of way, or golf courses crossed by footpaths were not included. The final map therefore contained a series of polygons representing areas where relatively unrestricted access occurs to the SPA and surrounding land. Each patch was given a name and a unique code, allowing cross-reference with other files.

Mapping of access points

All access points onto each visitable patch were mapped onto the GIS as point data. For most of those sites within the Urban Heaths Project, maps of access points were provided by the site wardens. All other sites were visited specifically for this project. The following data was collected on each access point:

Access point type	Either 0: no parking possible in the immediate vicinity 1: Official car park with designated off-road parking 2: Unofficial parking, such as lay-by, verge, street parking or similiar
Car-park spaces	An estimate of the number of parking spaces available. This was simple to collect for official car-parks, but where there was street parking or similar an attempt was made to quantify how many cars could be parked adjacent to the access point.
Patch number	The patch to which the access point is associated, allowing cross reference with the other files
Name	If present (most car-parks tend to have a name)
Organisation	Organisation responsible for managing the access point, where clear
Interpretation	1: interpretation present or 0: no interpretation present
Notes	Recording the presence of any features which may attract or deter visitors using the access point, for example the presence of a café, visitor facilities or the fact that parking might be difficult or dangerous.

Each point was also given a unique code to allow cross reference with other data files.

Predictive modelling of visitor numbers

Two separate broad studies of visitor behaviour and access patterns to heathlands in southern England have been undertaken Clarke *et al.* (2005) and Liley *et al.* (2006). These two studies

[25] Countryside and Rights of Way Act 2000.

used similar methods, with the amount of time (16 hours) spent at each access point and the interviewing protocol identical, allowing the two datasets to be merged. The data are based on interviewing people as they leave a heath and describe the distances people travel to visit heathlands, the number of people in their visiting group, why they visit, where they went on the heath and thus the length of their route, etc.

These two studies were merged and used to develop predictive models of visitor numbers and distribution within the heaths. Such models are intended to be used on both the Dorset and Thames Basin Heaths SPAs to explore and inform English Nature and planners about:

- the variation in visitor density and people pressure within the SPA;
- the area of heathland which is visited;
- the total number of visits per year; and
- the effect of new housing development on the numbers of visitors to the SPA.

Our approach to the modelling has four stages/components:

(i) A statistical method to predict visitor numbers to a specific access point from visitor survey data at a selected sample of access points, separately for visitors arriving on foot and by car;
(ii) A map of all the access points within the SPA;
(iii) The application of (i) to all access points to predict the total numbers of visitors to each access point, and when summed, to each heath patch and to the whole SPA; and
(iv) Using visitor survey data on the distances people travel once on the heath to plot the predicted spatial distribution of visitor pressure within each heath patch.

Factors which may influence visitor numbers at a specific access point are discussed in Liley *et al.* (2006) and include: the size of the human population living near the access point, the ease of access (e.g. a river or motorway may make reaching the site difficult), ease of parking / number of parking spaces, the number of other visitors (some people want to avoid too many other people when walking), facilities (toilets, cafés etc), the inherent quality of the site (e.g. the presence of viewpoints and wildlife) and the presence of alternative sites nearby. Many of these features are difficult to measure for all access points and not appropriate to a simple model of visitor numbers.

Using the combined visitor surveys data from the Dorset and Thames Basin Heaths, visitor numbers for 46 different sites were available. These data are presented in Appendix 1, which provides descriptions of each access point and presents the raw data from the visitor survey work. The questionnaire used in the Thames Basin Heaths survey is given in Appendix 3.

Our first approach was to extract, using a GIS with spatially-referenced postcode data, the total number of people[26] living at different distance bands extending away from each access point. In the questionnaire, visitors were asked for the postcode from where they had travelled (usually their home). From this we can derive the statistical distribution of the distances people travel to visit heaths; this varies depending on whether they arrived on foot or by car (Table A2.1, Figure A2.1). In Dorset, 75% of interviewed people arriving on foot ('foot visitors') came from within 500 m; in contrast, only 2% arriving by car ('car visitors') lived within 500 m and 29% lived over 5 km

[26] The postcode data provides details of the number of houses (residential properties) associated with each postcode, with each postcode stored within the GIS as point data spatially referenced by the centre of gravity of the postcode's map area. We extracted the postcodes within a given distance of each access point, and we convert these data to actual people by multiplying the number of houses by 2.36, the average number of occupants per UK residential property.

away. From this we concluded that the number of foot visitors and car visitors needed to be modelled and predicted separately.

Table A2.1 Distances (m) travelled from home to Dorset heath access points, overall and separately for people who came by car/van and on foot.

Mode of transport to heath access point	Maximum distance travelled (m) by percentage of visitors				
	25%	50%	75%	90%	95%
car/van	1760	3700	5300	8800	>10000
foot	200	330	500	1100	3000
All	420	1800	4400	7300	>10000

	Percentage of people travelling less than critical distances					
	300m	500m	1000m	2000m	3000m	5000m
car/van (n = 263)	0%	2%	8%	31%	43%	71%
foot (n = 146)	44%	75%	89%	92%	95%	96%
All (n = 427)	16%	28%	37%	52%	62%	80%

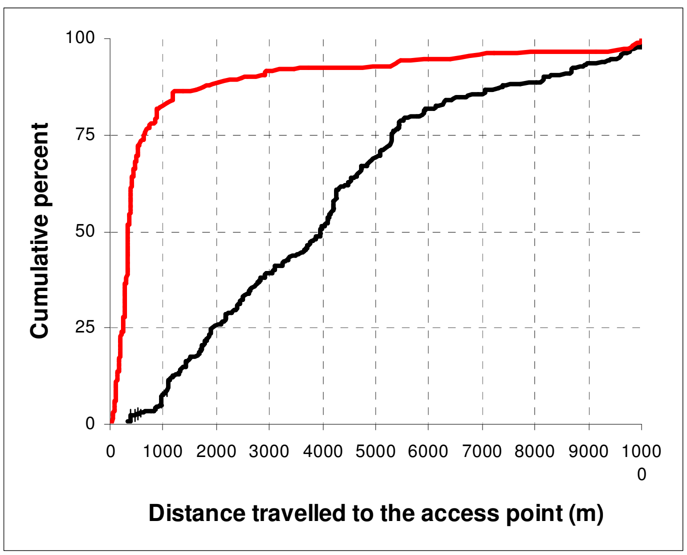

Figure A2.1. Distribution of the distances travelled to Dorset heath access points by car/van (black) and on foot (red).

Models based on visitor rates within distance bands

We calculated the number of visitors coming from each selected distance band. The number of visitors to an access point from each distance band could then be expressed as the proportion of residents within the distance band that visit the access point (and heath within a 16hr period). This can be calculated separately for each access point but due to the small numbers of visitors involved these proportions are usually subject to high levels of sampling variability. Moreover, individual characteristics and attractiveness of each access point (and patch) and its 'catchment' lead to large real variability in visitor rates between access points and patches. As an example of an outlier high visitor rate, 20 interviewed people visited Stoborough heath on foot from the

47 houses (110.92 people) whose postcode was within 200-400m of the New Road access point, which equates to an visitor rate of 0.1803, whereas the overall average visitor rate from this distance on foot across all surveyed access points in Dorset was only 0.0149 (see below).

However, we need estimates of such visitor rates to apply to the vast majority of other non-surveyed access points within the SPAs. Therefore, as a simple first step, more robust estimates of ‘average’ visitor rates (P_k) with distance band *k* were obtained by dividing the total number of visitors within a distance band (summed over access points) by the total number of residents within the distance band (summed over access points) (Tables A2.2-A2.3 and Figure A2.2).

The foot visitor rates to the Dorset and Thames Basin heaths show similar patterns, rates are not consistently higher in one SPA; foot visitor rates for the TBH were slightly higher from distances of <200m but lower from distances of 200-400m. Car visitor rates for people living up to 3km tend to be higher for the TBH, although in the shortest distance band of 0-400m, rates were highest in Dorset.

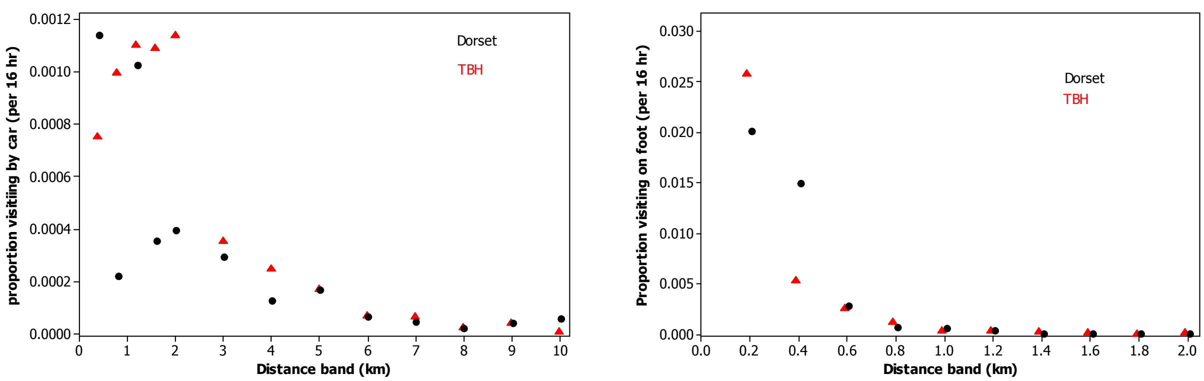

Figure A2.2. Proportion of residents visiting the site during the 16 hour survey period by car (left) and on foot (right), in relation to distance from the access point. These graphs are plotted by dividing the number of visitors interviewed that came from a distance band by the total number of people living within that distance band. Each point is calculated from the total residents and total visitors within that distance band summed over all access points within each SPA (Dorset (●), TBH (▲)).

Table A2.2 Overall numbers and proportions (P_k) of residents in distance bands from surveyed access points on the Dorset and Thames basin Heaths (TBH) SPAs who visited on foot (per 16 hr period).

Distance (km)	Total visitors on foot		Total residents		Proportion visiting (P_k)		
	Dorset	TBH	Dorset	TBH	Dorset	TBH	Overall
<0.2	43	34	2145	1317	0.020044	0.025819	0.022241
0.2-0.4	86	35	5763	6662	0.014923	0.005254	0.009738
0.4-0.6	27	33	9676	13126	0.002790	0.002514	0.002631
0.6-0.8	9	22	13355	17969	0.000674	0.001224	0.000990
0.8-1.0	10	9	17473	25686	0.000572	0.000350	0.000440
1.0-1.2	8	10	21547	28818	0.000371	0.000347	0.000357
1.2-1.4	1	8	29085	33694	0.000034	0.000237	0.000143
1.4-1.6	0	4	33604	38874	0.000000	0.000103	0.000055
1.6-1.8	2	0	40236	44727	0.000050	0.000000	0.000024
1.8-2.0	1	5	46350	51148	0.000022	0.000098	0.000062
2.0-2.2	2	0	47691	54905	0.000042	0.000000	0.000019
2.2-2.4	0	1	51453	61546	0.000000	0.000016	0.000009
2.4-2.6	3	1	57140	66271	0.000053	0.000015	0.000032
2.6-2.8	0	0	60064	69894	0.000000	0.000000	0.000000
2.8-3.0	3	1	62568	74989	0.000048	0.000013	0.000029
3-4	2	1	398210	472614	0.000005	0.000002	0.000003
4-5	0	2	467153	701371	0.000000	0.000003	0.000002
5-6	4	0	522605	814863	0.000008	0.000000	0.000003
6-7	1	0	457507	910974	0.000002	0.000000	0.000001
7-8	3	0	524892	989583	0.000006	0.000000	0.000002
8-9	0	0	635659	1176517	0.000000	0.000000	0.000000
9-10	4	0	699339	1263051	0.000006	0.000000	0.000002
>3km	14	3	3705365	6328973	0.000004	0.000000	0.000002

Table A2.3 Overall numbers and proportions (P_k) of residents in distance bands from surveyed access points on the Dorset and Thames basin Heaths (TBH) SPAs who visited by car (per 16 hr period).

Distance (km)	Total visitors by car		Total residents		Proportion visiting (P_k)		
	Dorset	TBH	Dorset	TBH	Dorset	TBH	Overall
<0.4	9	6	7908	7979	0.001138	0.000752	0.000944
0.4 - 0.8	5	31	23031	31095	0.000217	0.000997	0.000665
0.8 - 1.2	40	60	39020	54504	0.001025	0.001101	0.001069
1.2 - 1.6	22	79	62689	72568	0.000351	0.001089	0.000747
1.6 – 2.0	34	109	86586	95875	0.000393	0.001137	0.000784
2 - 3	81	116	278917	327606	0.000290	0.000354	0.000325
3 - 4	50	117	398210	472614	0.000126	0.000248	0.000192
4 - 5	78	118	467153	701371	0.000167	0.000168	0.000168
5 - 6	33	54	522605	814863	0.000063	0.000066	0.000065
6 - 7	19	59	457507	910974	0.000042	0.000065	0.000057
7 - 8	9	22	524892	989583	0.000017	0.000022	0.000020
8 - 9	24	46	635659	1176517	0.000038	0.000039	0.000039
9 - 10	39	6	699339	1263051	0.000056	0.000005	0.000023

Overall, given the large variability in visitor rates between individual access points, we concluded that it was best to combine the survey data for the two SPAs and use a single model of visitor rate with distance for both SPAs, but with separate models for visitors arriving by car and on foot.

These relationships between visitor rates and distance provide a potential method for predicting visitor numbers. For any particular access point in the SPA (not just those involved in the visitor survey questionnaire), we can use the GIS postcode database to determine the total number of people living within each distance band from the access point, multiply this by the estimated proportion predicted to visit from that distance and then sum across all distance bands to predict the expected number of visitors passing through that access point (within a similar 16 hour period). This predictive 'model', denoted model F1 and C1 for foot and car visitors respectively, can be expressed mathematically by:

Predicted numbers = sum over all distance bands k of (P_k x Res_k) (F1 and C1)

where P_k = visitor rate from distance band k (right-hand column of Table A2.2)
and Res_k = number of residents in distance band k from the access point

We tested the effectiveness of this approach by comparing the predicted number of visitors at each of the 46 surveyed access points with the actual number recorded at each access point during the survey questionnaire (Figure A2.3).

The predictions were not accurate. The amount of variation (R^2) in observed numbers explained (R^2 = 1 – (residual sum of squares) / (total sum of squares of observed values about their mean)) was 22% for foot visitors and less than zero for car visitors. There is so much variation between access points in visiting rates amongst those that come by car, that this simple, but intuitive, approach is not effective for predicting car visitor numbers. While the overall rates shown in Figure A2.2 provide an indication of the likelihood of visitors at different distance bands to visit sites, many sites do not seem to fit this pattern. There are probably a range of other unmeasured (or un-measurable) factors influencing how many people visit a particular heath via particular access points.

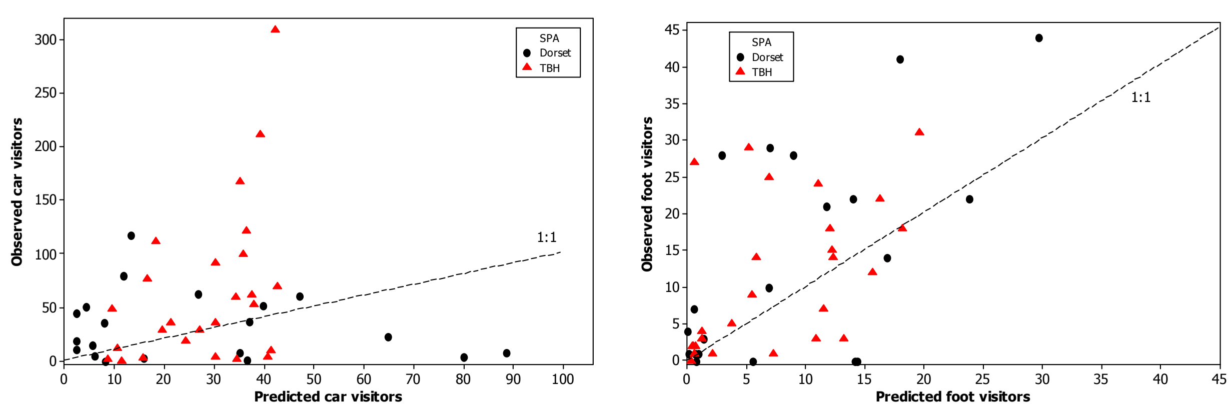

Figure A2.3 Observed (from the visitor surveys) versus predicted (using the overall visitor rate by distance data in Table A2.2) number of visitors arriving by car (left) and on foot (right) for each site surveyed (20 sites in Dorset and 26 sites in the Thames Basin Heaths).

Regression-based predictive models

As an alternative to this approach, we used multiple regression statistical models to predict visitor numbers using variables concerning the access point (e.g. parking capacity, the number of residents living at specific distance bands and the number of alternative car-parks within 1km (the latter data available for Thames Basin Heaths sites only). The observed numbers of visitors recorded at the access points which are expected (i.e. predicted) to be most popular are likely to vary more in absolute terms than the observed visitor numbers for heath access points expected to be attracting fewer visitors. In statistical terms this implies that the unexplained residual variance in recorded visitor numbers from any predictive regression model is likely to increase with the predicted value. Therefore using simple (i.e. unweighted) multiple regression to assess the relationship between visitor numbers and environmental factors is not appropriate, or at least not optimal. The relationship between visitor numbers and factors may also be non-linear. Statistical models based on (square root or logarithmic) transformed values, which can often make relationships linear and with more homogeneous residual variance, were therefore assessed. Generalised Linear Models (GLM) (McCullagh and Nelder, 1989) were also assessed by treating the count of visitor numbers at an access point as a Poisson distribution with mean equal to the model prediction for the site. To allow for the residual variability being greater than that expected for a standard Poisson error distribution, the standard errors of the regression model coefficients obtained by fitting a Poisson likelihood were automatically increased by the appropriate factor ($\sqrt{k}$), where k is the fitted model residual mean deviance (McCullagh & Nelder 1989, p199-200).

These statistical modeling approaches were conducted separately for visitors arriving on foot and for those arriving by car as they are influenced by different factors. The observed counts used in the analyses were the total number of visitors recorded over the 16 hour survey period at each access point. (These can be converted to estimated daily rates later.)

Predicting number of visitors arriving on foot

It was found that the number of foot visitors was related to the number of people living within a range of relatively short distance bands, especially 0-400 m (R^2 = 37%), 400-800 m (R^2 = 34%) and maximally for 0-800 (R^2 = 40%) (all test $p < 0.001$); moreover the percentage of variance explained (R^2) was less than 12% for all combinations of distance bands within the range 800m to 10km.

Although splitting the residents within 800m into two variables—the number of people residing with 0-400m and the number living between 400 and 800m (denoted 'NRes0-400' and 'NRes400-800' respectively)—did not give a statistically significant improvement in model fit (least squares regression R^2 = 41%), the resulting model had more intuitive sense as the predictive Poisson GLM equation was (standard errors (S.E.) of regression coefficients given in brackets):

Foot visitors (per 16hr) = 4.09 + 0.00631 'NRes0-400' + 0.00394 'NRes400-800' (F2)
(1.43) (0.00783) (0.00206)

The intercept term of 4.09 was statically significant and represents the base average number of visitors on foot which cannot be attributed to the density of nearby housing. It was initially tempting to interpret the coefficients as implying that, on average, an additional 0.631% of people living within 400m and a smaller 0.394% of people living 400-800m away will visit a heath on foot within a typical 16hour visiting period. However, these rates differ from the observed foot visitor rates from these distance bands of 1.246% ((43+34+86+35) / (2145+1317+5763+6662)) and 0.168% (91/54126) respectively (Table A2.2). Although over 80% of foot visitors do living within 800 m, using model equation (F2) to predict foot visitors numbers for other access points would imply no effect of increased housing beyond 800 m on foot visitor numbers, which is not true.

Therefore, our recommended model for predicting number of visitors arriving on foot is model F1 based on the observed overall visitor rates by distance band approach, given by equation (1) and the observed overall foot visitors rates in Table A2.2.

Predicting number of visitors arriving by car

For people arriving by car ('car visitors'), the number of car-park spaces at each access point was a highly significant predictor of visitor numbers (Figure A2.4, test $p < 0.001$), and in no model could the simple regression prediction be improved through the inclusion of the number of residents at any particular distance bands, or the number of alternative car parking spaces within 500m or 1000m. Due to the inherent considerable variability between access points, there is no definitive method to determine the optimum form of the statistical relationship between car visitor numbers and the number of car parking spaces. Liley & Clarke (2006) derived a predictive Poisson GLM equation, whereby the numbers visiting by car was related to the square root of the number of car parking spaces (denoted '√CarParkSpaces') at the heath access point, as follows (standard errors (S.E.) of regression coefficients given in brackets):

$$\text{Car visitors (per 16hr)} = \underset{(1.61)}{15.31}\ \sqrt{\text{CarParkSpaces}} \qquad \text{(C2)}$$

Various other forms of the relationship between these two variables were also assessed. However, the form of equation eventually selected for use in predicting car visitors to other access points in the Dorset and TBH SPAs was the following simple log-log relationship (R^2=41%):

$$\text{Log}_e(\text{Car visitors} + 1) = \underset{(0.338)}{1.551} + \underset{(0.1397)}{0.7703}\ \text{Log}_e(\text{CarParkSpaces} + 1) \qquad \text{(C3a)}$$

The relationship on these log-log transformed scales appear to be approximately linear, although there is now some suggestion that the (proportional) residual variance in visitor numbers is slightly greater when there are relatively few car park spaces (Figure A2.4).

Equation C3a can be re-written as:

$$\text{Car visitors (per 16hr)} = 4.716\ (\text{CarParkSpaces})^{0.7703} - 1 \qquad \text{(C3b)}$$

This implies that the number of car visitors increases with the number of car park spaces raised to the power of 0.77, rather than to the power 0.5 implied in model C2; a power coefficient of 1 would imply visitor numbers are directly proportional to the number of car park spaces; model C3 implies a moderate tendency for increases in visitors numbers with increases in car parking spaces to be less for larger car parks. Because this predictive equation was derived by back-transforming a regression relationship derived on the log-log scale, the estimates for a given number of car park spaces will for the geometric mean number of car visitors, rather than the higher arithmetic mean numbers (which can be strongly influenced by one or more observations of unusually high visitor numbers). For this study, the geometric mean, which should also approximate the median for a given level of parking space, is considered to be most appropriate for the majority of access points.

Table A2.4 shows the practical effect of predictive equation (C3) for a range of car parking spaces; one space implies on average 7 visitors arriving by car, two spaces give a predicted average visitor rate of 10 people, while a large car park with 50 spaces is predicted to lead to, on average, nearly 100 (96) visitors per 16 hour visiting period. Access points with no immediately adjacent parking spaces are still predicted to attract, on average, 4 visitors per 16 hr period who drove from home by car; this is not unreasonable as there are often places to park short distances away from some access points, such as on residential roads in nearby housing estates. As an extreme example, 52 people interviewed at the St Catherine's access point north of Christchurch said they drove from home to visit the SPA and parked away from the access point which has no space to park. This also highlights the problem of characterising the features and facilities of access points. The prediction from model C3 was always within the observed range of car visitors to the surveyed access points with the same or similar level of car park spaces, apart from for the two access points with no spaces for which the observed visitors by car (11 and 52) was greater than the 4 predicted (Table A2.4).

Car park spaces		0	1	2	4	6	10	20	50	100	200	400	800
Predicted visitors arriving by car based on model C3		4	7	10	15	20	29	48	96	164	279	476	812
Observed car visitors	spaces	0	1	2	3-4	5-8	10-15	16-25	35-65	120	200		
	n	2	4	7	7	7	6	7	4	1	1		
	mean	31	19	11	7	37	47	85	125	92	309		
	min	11	2	0	1	4	3	10	77				
	max	52	53	29	19	60	70	167	211				

Table A2.4: Observed and predicted number of visitors arriving by car (per 16hour visiting period) in relation to the number of car parking spaces at a heath access point; predictions based on log-log model equation C3. Observed visitor numbers based on the 46 Dorset and TBH access points.

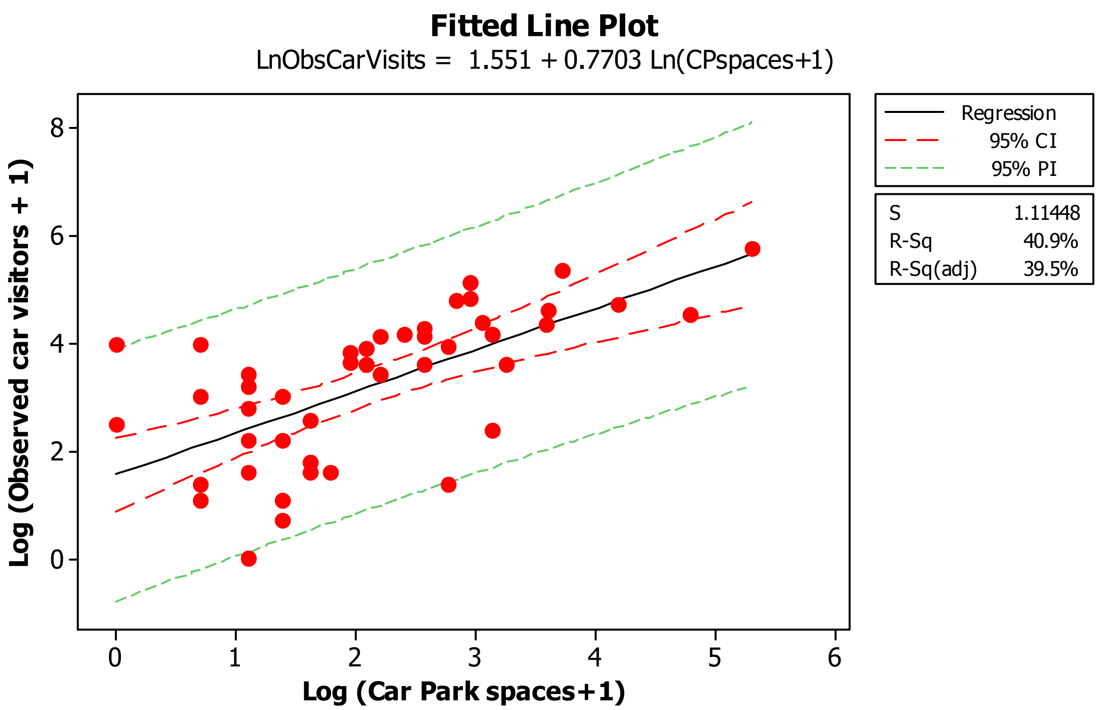

Figure A2.4: Linear regression relationship (model equation C3) between the logarithm (to base e) of the observed number of visitors arriving by car ($\log_e(y+1)$) and the logarithm of the number of car parking spaces at each access point ($\log_e(x+1)$) for the 46 Dorset and THB access points.

There was no statistically significant difference in the estimated model C3 log-log relationship between the Dorset and Thames Basin Heath SPAs (Figure A2.5). Therefore this single model based on the combined survey data was assumed to be valid for both SPAs.

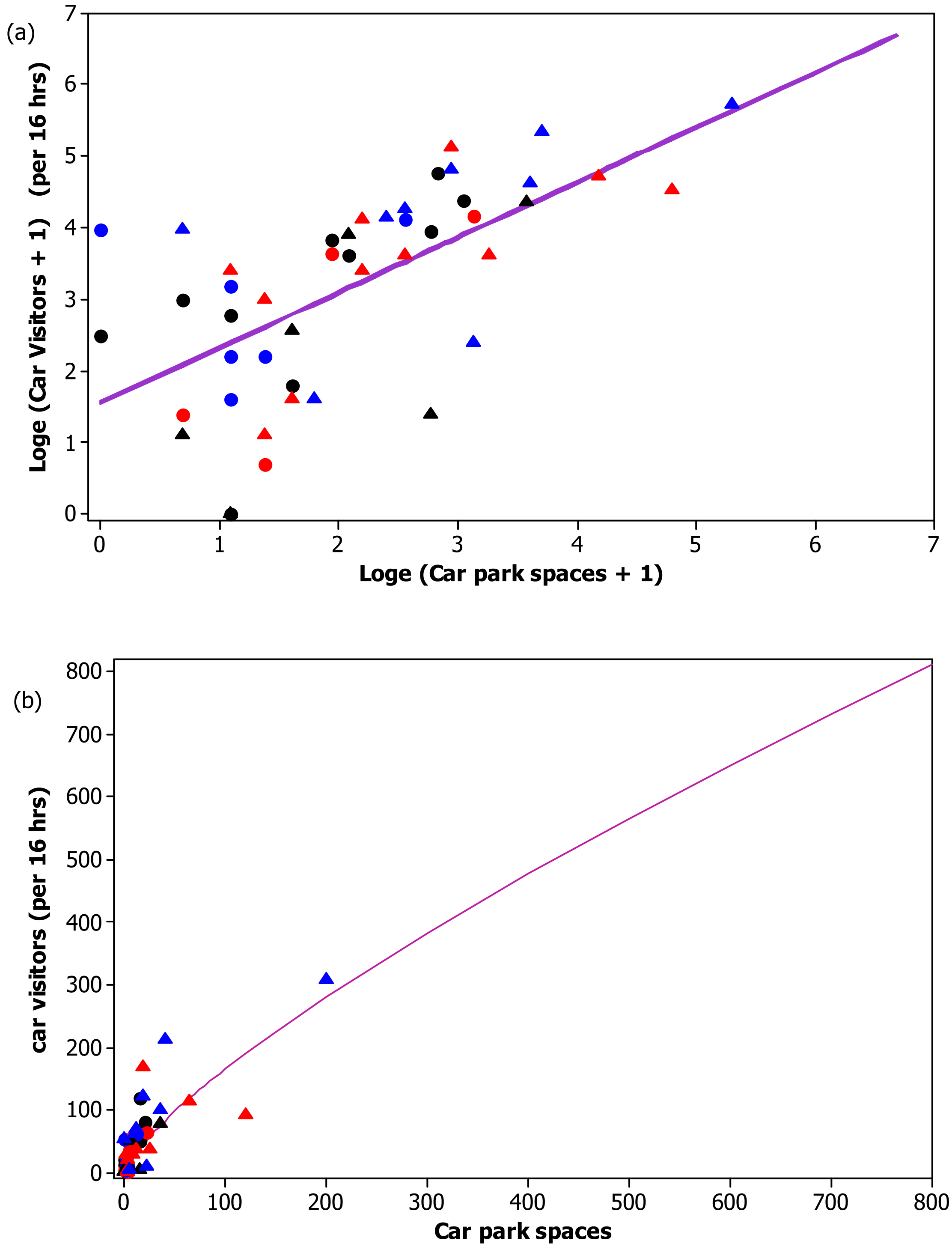

Figure A2.6: Observed and model C3 fitted relationship between number of visitors arriving by car and the number of car parking spaces at each access point (Dorset (circle), TBH (triangle); residents within 5km (black = <45000, red = 45000-150000, blue = >150000); (a) log-log model C3a, (b) back transformed model C3b plotted up to the maximum of 800 car park spaces estimated for any access point in either SPA.

Models based on visitor rates in relation to distance and car park spaces

Having established that: (a) car visitor rates vary and generally decline with distance from the access point and separately, and (b) the overall number of visitors by car is related to the number of car park spaces available at the access point, we then tried to combine these features into the following models which assumes the car visitor rate versus distance curve is dependent on the amount of car parking spaces.

The 46 surveyed access points were divided into three roughly equal-sized groups based on their number of car park spaces (13 (28%) with 0-2 spaces, 20 (44%) with 3-15 spaces, and 13 (28%) with 16-200 spaces and the observed rates of visiting by car from each distance band calculated independently for each of the three groups (Table A2.5, Figure A2.7).

Distance (km)	Total visitors by car			Total residents			Proportion visiting		
	0-2	3-15	15-200	0-2	3-15	15-200	0-2	3-15	15-200
<0.4	4	9	2	6936	6898	2053	0.000577	0.001305	0.000974
0.4 - 0.8	2	20	14	15283	25861	12982	0.000131	0.000773	0.001078
0.8 - 1.2	20	41	39	24747	41925	26852	0.000808	0.000978	0.001452
1.2 - 1.6	14	44	43	31931	69004	34321	0.000438	0.000638	0.001253
1.6 – 2.0	18	46	79	45149	86772	50539	0.000399	0.000530	0.001563
2 - 3	34	71	92	176908	240840	188774	0.000192	0.000295	0.000487
3 - 4	11	25	131	253511	337815	279497	0.000043	0.000074	0.000469
4 - 5	17	56	123	312551	476482	379490	0.000054	0.000118	0.000324
5 - 6	4	37	46	343087	580678	413703	0.000012	0.000064	0.000111
6 - 7	2	32	44	291840	655804	420838	0.000007	0.000049	0.000105
7 - 8	2	7	22	290950	781408	442118	0.000007	0.000009	0.000050
8 - 9	6	9	55	408131	889430	514615	0.000015	0.000010	0.000107
9 - 10	0	15	30	434754	921504	606131	0.000000	0.000016	0.000050

Table A2.5: Observed overall car visitor rates from distance bands, separately for access points with 0-2, 3-15 and 16-200car parking spaces; these rates form the basis of model C4.

The overall car visitor rate to access points with 3-15 car parking spaces is higher than to access points with two or fewer car park spaces at all distances (except 8-9 km). Moreover, at all distances, the visitor rate to access points with the largest class of car park spaces (16-200 spaces) is at least twice as high as, and up to six times higher than, the rate for access points with fewer spaces (the only exception is for within 400 m of the access points for which car visitor rates were slightly higher at intermediate levels of car park spaces (Table A2.5, Figure A2.7).

For any specific access point, the appropriate group's car visitor rate curve for the number of car park spaces at the access point can be used to derive a prediction of the expected number of visitors by car to that point (termed model C4), as follows:

Predicted car visitors at an access point with car park spaces in group *i* (C4)
= sum over all bands *k* of (P_{jk} x Res_k)
where P_k = visitor rate from band *k* amongst access points in car park group *j*
and Res_k = number of residents in distance band *k* from the access point

This model is an improvement of the single car visitor rate curve of model C1 and the amount of variation (R^2) in observed car visitor numbers explained (R^2 = 1 – (residual sum of squares) / (total sum of squares of observed values about their mean)) by model C4 was 18% (Figure A2.8).

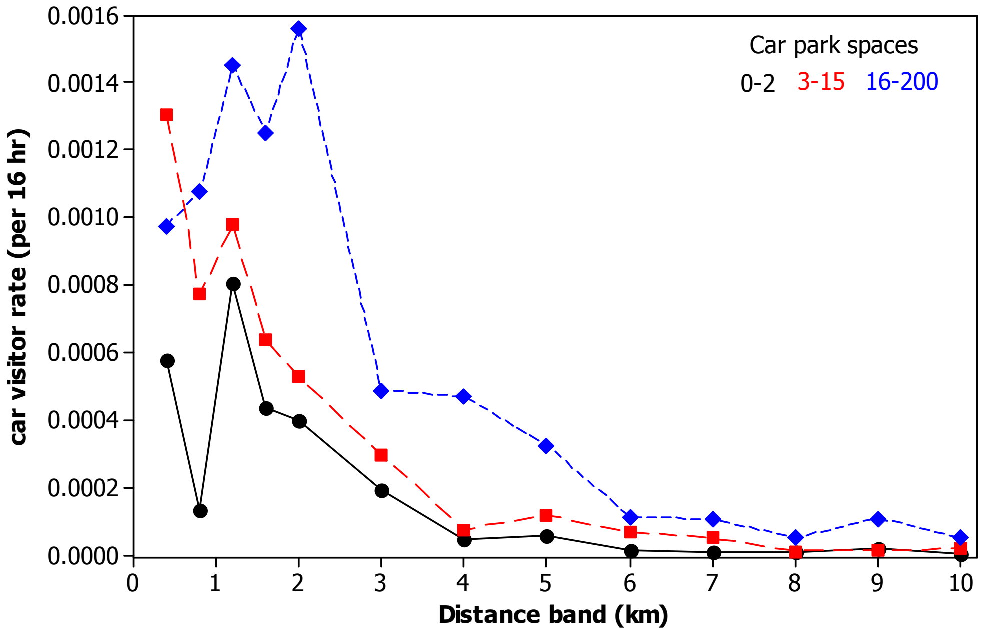

Figure A2.7: Observed overall car visitor rates from distance bands, separately for access points with 0-2 (●), 3-15 (■) and 16-200 (♦)car parking spaces; these curves form the basis of model C4.

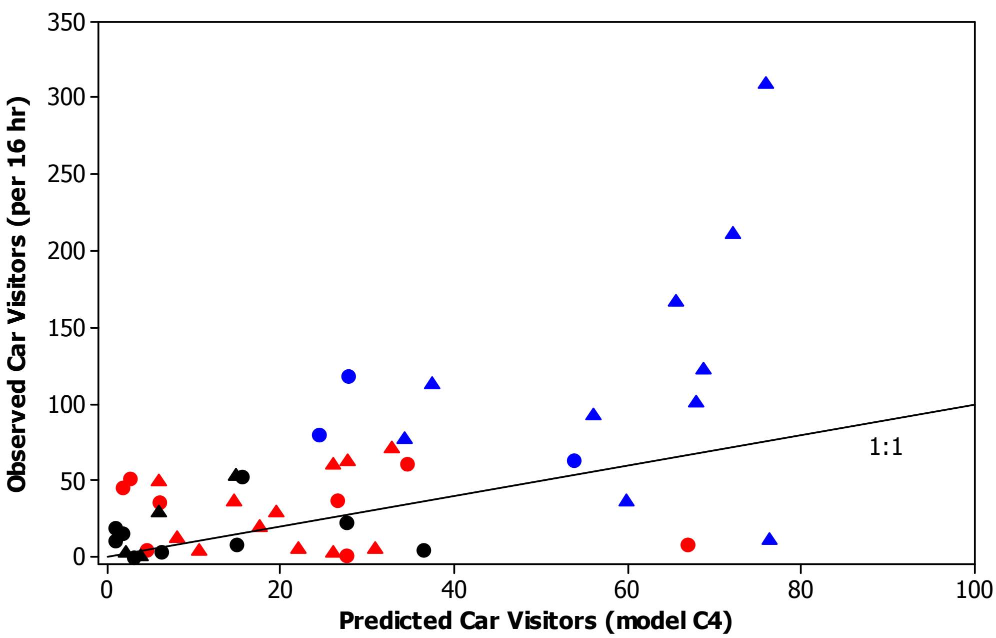

Figure A2.8: Observed and predicted number of visitors arriving by car to each access point (Dorset (circle), TBH (triangle); car park spaces (black = 0-2, red = 3-15, blue = 16-200); prediction is based on model equation C4.

Although model C4 is an improvement in fit over the single visitor rate versus distance curve of model C1, it still tends to under-predict car visitor numbers at access points with high numbers of car parking spaces. We could have tried to sub-divide the surveyed access points into more groups based on their car park spaces, but instead chose to try to fit models which related the visitor rate from any distance band to any particular access point to continuous mathematical functions of both distance and the number of car park spaces at the access point.

The relationships was fitted using Generalised Linear Models (GLM) (McCullagh & Nelder, 1989), treating the observed car visitor rate from a distance band to any particular access point as having a binomial distribution (i.e. *r* visitors out of *n* residents) and log-link model. To allow for the residual variability being greater than that expected for a simple Binomial error distribution, the standard errors of the regression model coefficients obtained by fitting a Binomial likelihood were automatically increased by the appropriate factor ($\sqrt{k}$), where *k* is the fitted model residual mean deviance (McCullagh & Nelder, 1989, p199-200).

Several forms of model were assessed but the best overall model (C5), with all coefficients highly significant ($p < 0.001$) was (standard errors (S.E.) of regression coefficients given in brackets):

$$\text{Log}_e(\text{Car visitor rate}) = \underset{(0.130)}{-6.293} - \underset{(0.0458)}{0.7780}\,\text{Distance}_k + \underset{(0.00965)}{0.10125}\,\text{Distance}_k.\text{Log}_e(\text{CarParkSpaces}) \quad \text{(C5a)}$$

where Distance_k = distance band *k* from the access point. As observed car visitor rates from distances up to 1 or even 2 km show no consistent trends (Figure A2.7), and some rates were based on low numbers of visitors, the data were combined prior to model fitting so that all distances up to 1.2 km were treated as 1.2 km and all distances of 1.2-2.0 km were treated as 2.0 km.

Table A2.6 and Figure A2.9 show the predicted car visitor rates based on model C5 for a range of distance bands and number of car park spaces. Under model C5, for a given number of car park spaces, the visitor rate is assumed to be constant for distances up to 1.2 km as suggested by the observed survey data, and thereafter declines exponentially by a constant proportion per kilometre.

Equation (C5a) can be re-expressed as:

$$\text{Log}_e(\text{Car visitor rate}) = -6.293 - (0.7780 - 0.10125\,\text{Log}_e(\text{CarParkSpaces}))\text{Distance}_k \quad \text{(C5b)}$$

This indicates how the exponential rate of decline in visiting rate with distance decreases with the number of car park spaces. This suggests that people may tend to drive further to an access point which they know has lots of car-parking spaces.

Model C5 gives an improvement in fit over model C4 with the amount of variation (R^2) in observed car visitor numbers explained (R^2 = 1 – (residual sum of squares) / (total sum of squares of observed values about their mean)) increasing from18% to 29% (Figure A2.10).

Distance (km)	Number of car parking spaces								
	0	2	5	10	20	50	100	200	800
0.0 - 1.2	0.0007270	0.0008308	0.0009038	0.0009729	0.0010524	0.0011722	0.0012737	0.0013847	0.0016380
1.2 – 2.0	0.0003901	0.0004873	0.0005608	0.0006340	0.0007227	0.0008650	0.0009933	0.0011419	0.0015108
2 - 3	0.0001792	0.0002502	0.0003088	0.0003712	0.0004518	0.0005916	0.0007280	0.0008973	0.0013656
3 - 4	0.0000823	0.0001284	0.0001701	0.0002174	0.0002825	0.0004046	0.0005336	0.0007051	0.0012343
4 - 5	0.0000378	0.0000659	0.0000937	0.0001273	0.0001766	0.0002767	0.0003911	0.0005541	0.0011157
5 - 6	0.0000174	0.0000338	0.0000516	0.0000745	0.0001104	0.0001893	0.0002866	0.0004354	0.0010085
6 - 7	0.0000080	0.0000174	0.0000284	0.0000436	0.0000690	0.0001294	0.0002101	0.0003421	0.0009115
7 - 8	0.0000037	0.0000089	0.0000156	0.0000256	0.0000431	0.0000885	0.0001540	0.0002689	0.0008239
8 - 9	0.0000017	0.0000046	0.0000086	0.0000150	0.0000270	0.0000605	0.0001128	0.0002113	0.0007447
9 - 10	0.0000008	0.0000024	0.0000047	0.0000088	0.0000169	0.0000414	0.0000827	0.0001660	0.0006731

Table A2.6: Predicted car visitor rates based on model C5 in relation to distance band from access point and number of car parking spaces at the access point

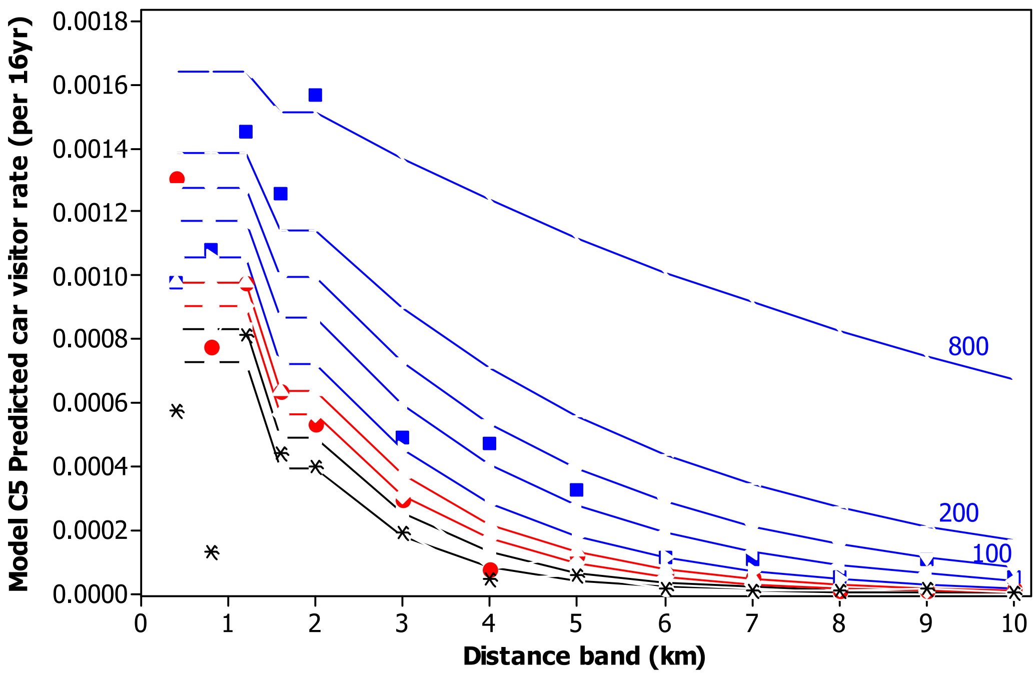

Figure A2.9: Car visitor rates predicted from model C5 in relation to distance bands and car park spaces (0, 2, 5, 10, 20, 50, 100, 200, 800), together with overall observed car visitor rates (as in Figure A2.7) for access points with 0-2 (●), 3-15 (■) and 16-200 (♦)car parking spaces.

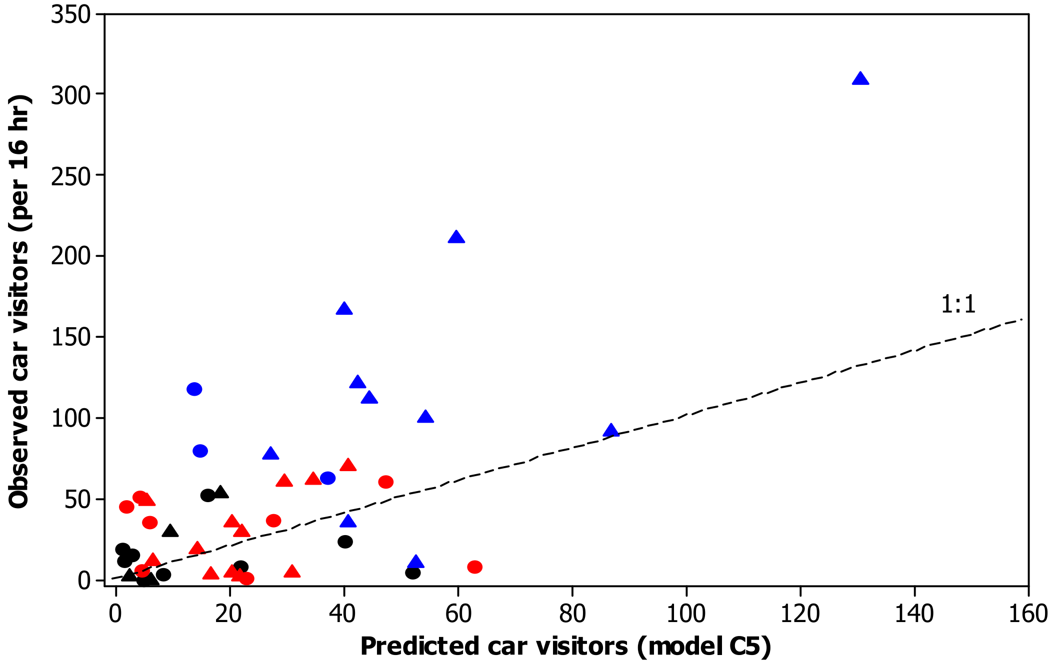

Figure A2.10: Observed and predicted number of visitors arriving by car to each access point (Dorset (circle), TBH (triangle); car park spaces (black = 0-2, red = 3-15, blue = 16-200); prediction is based on model equation C5.

Predicting total numbers of visitors

Model F1 is the recommended equation for predicting the number of visitors who walk to an access point. The number of visitors who travel by car can be predicted from either model equation C3 (based on the number of car park spaces only) or model equation C5 (whereby visitor rates of surrounding residents depend on both their distance away and the number of car park spaces at the access point.

The combination of the two predictions, namely for foot visitors (PREDFOOT) and for car visitors (PREDCAR), provides a means of determining the total number of visitors arriving at an access point by car or by foot. A small number of people also arrived by other means (e.g. bike, horse, public transport). To incorporate these additional people, we then assumed their numbers would be related to the total numbers arriving by car and foot and so we calculated the observed number of 'Others' as a percentage of those arriving by foot and car combined for each access point. We took the median percentage value of 3% across all access points as our adjustment factor.

A further adjustment was required as the equations above have been derived using the data on the number of people interviewed. Not all people leaving the site were interviewed – for example some declined, and therefore the count of people actually leaving (and thus visiting) the site was higher. Specifically, the relationship between the number interviewed and the total number of visitors was accurately described (r^2 = 95%) by the simple regression (Figure A2.11):

Total numbers of visitors leaving = 1.423 * Number of people interviewed

Combining these two factors (i.e. for 'Others' and non-interviewees) gives a correction factor of approximately 1.45 to apply to the predicted overall numbers of interviewees arriving by car and by foot.

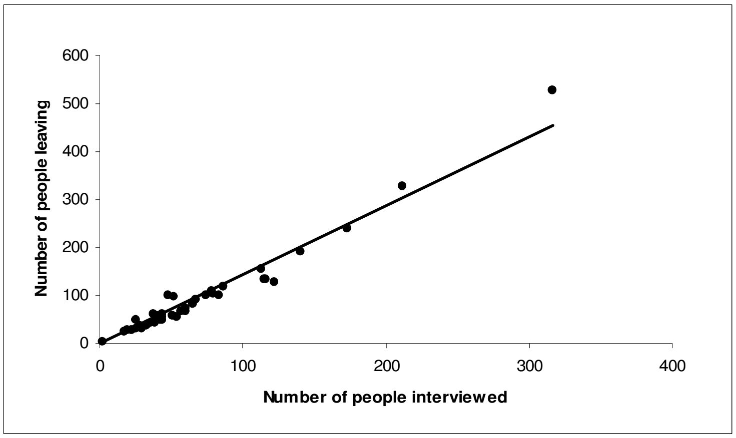

Figure A2.11: Relationship between the number of people interviewed at each site and the number of people leaving. Regression equation: y = 1.423x, r2 = 0.95.

The predicted total number of visitors at a given access point was therefore calculated as follows:

Predicted total visitors (PREDTVISIT) = 1.45 * (PREDFOOT + PREDCAR) (T1)

These overall estimates (PREDTVISIT) are for the total of the number of people predicted to visit over 16 hours of surveying, during a weekend and week-day in the summer.

Plotting the spatial distribution of visitors

Having derived predictions of the expected number of visitors to each access point, the next step was to derive estimates of the expected spatial distribution of visitors within each heathland patch on the Dorset Heaths SPA. This was done as follows.

<u>50m grid of pixels within the SPA, grouped in heathland access patches</u>

- (i) A grid of 50m x 50m squares was drawn to cover the land area of the Dorset Heaths SPA. Any grid squares not within the SPA boundary were deleted.
- (ii) Each column on the grid was identified with a letter and each row with a number, allowing each cell ("pixel") within the grid to have a unique identifier. They were also identified by their Nation Grid Reference (NGR) Easting and Northing in metres.
- (iii) As the SPA is comprised of component SSSIs, the SSSI name was recorded for each pixel.
- (iv) Some SSSIs are fragmented by roads, railways etc which act as barriers to access. Therefore the SPA was also divided into patches. A patch was defined as any discrete, contiguous group of pixels, not split by a motorway or railway line with no means of crossing.
- (v) Visitors passing through an access point are assumed to only visit pixels on the same patch.

(vi) Where an access point to a heath patch was outside the formal SPA boundary the patch was extended in a realistic manner, for the purpose of spatial modelling only, up to the access point so that the spatial penetration model algorithm of the distances visitors travelled away from the access points could still be applied appropriately.

(vii) Pixels covering areas where visitors either cannot (e.g. MOD land) or obviously do not walk (e.g. valley mires) were identified and excluded ("exclusion pixels") from the statistical prediction of the spatial distribution of visitor pressure within the patches.

<u>Heathland patch penetration distance</u>

(viii) It was not possible to obtain or derive the precise distance that an interviewed person had penetrated into the heath. However, Clarke *et al.* (2005) and Liley *et al.* (2005) both recorded the route of paths on the patch that each visitor claimed they had followed. After inputting all of the routes into a GIS, the distance from the access point to the mid-point of a route was taken as the penetration distance. The frequency distribution of distances that visitors travelled on the Dorset and Thames Basin heaths were generally similar (although penetration distance was naturally less on some of the smaller Dorset heath patch). The data from the two visitor surveys were combined to give a single overall probability distribution of penetration distances (Figure A2.12). This distribution was intentionally based on 50m intervals of penetration distances. Using this single distribution for all patches, regardless of size, is not unreasonable, as most people will walk around most of a very small patch and this will be predicted in the spatial model using the overall distribution based on penetration distances onto all patches (For example, on a patch only 300m wide most people will tend to walk all across and around it and using the overall penetration distribution in Figure A2.12 predicts that about 90% of people will walk 300m from an access point.)

<u>Visitor pressure in each 50m cell</u>

(ix) Given the predicted number of visitors (V_i) passing through an access point i, we can use this cumulative penetration distribution to estimate the proportion (Pi_d) of visitors who penetrate at least d metres onto the heath from this access point.

(x) In terms of mapping visitor pressure in this study, we assume that all parts (i.e. pixels) on a patch can potentially be reached and/or impacted by visitors, apart from those already identified as "exclusion pixels". (Obviously this is not strictly true as, for example, stands of dense scrub are much less easily accessed.)

(xi) Each visitor who penetrated a distance d on the heath is assumed to travel over K pixels at each of the 50m distance classes up to a distance d from the access point. In our estimates we set K equal to 2 (but 3 might also be a reasonable number if a circular route is assumed)

(xii) For each access point i we determine the number of pixels (M_{id}) on the same patch within each distance class d from the access point.

(xiii) Then the estimated number of people N_{id} travelling from a particular access point i across a particular pixel at a distance class d from the access point is estimated by:

$$N_{id} = V_i * P_{id} * K / M_{id}$$

(xiv) The total number of people visiting a particular pixel from all access points on the same patch is estimated by summing the estimates of the number of visitors to the cell from the individual access points.

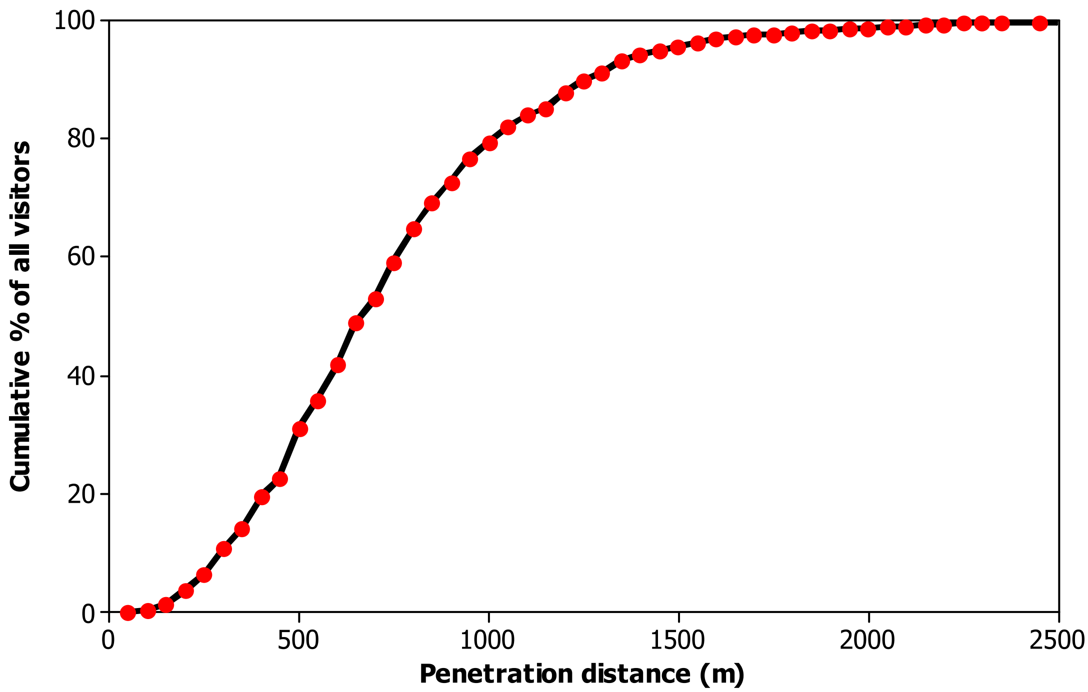

Figure A2.12 Cumulative frequency distribution of the penetration distance onto heaths by all visitors combined.

Places (i.e. pixels) on the heath which are either not near any access points or only near access points with very low expected numbers of visitors will, as might be expected, have low predicted visitor pressure. However, our detailed modelling, predictions and spatial analysis has allowed us to derive quantitative estimates of the absolute and relative density of visitors throughout each part of each SPA heathland patch.

Appendix 3
Questionnaire used in the Thames Basin Heaths Visitor Survey

INSTRUCTIONS TO INTERVIEWERS:
Use this sheet to read out the questions (IN BLACK INK, BOLD & BLOCK CAPITALS) and enter the answers on the summary sheet. Questions should be read out exactly as written. The red text shows the answers that people may give, and these answers should be read out after the question.

HELLO, COULD YOU SPARE ME A COUPLE OF MINUTES TO ANSWER SOME BRIEF QUESTIONS REGARDING YOUR VISIT TO THIS HEATH TODAY. THIS IS PART OF A STUDY OF VISITOR ACCESS PATTERNS COMMISSIONED BY ENGLISH NATURE.

1) **HOW MANY ADULTS IN TOTAL, INCLUDING YOURSELF, ARE THERE WITH YOU HERE TODAY FOR THIS VISIT ?** if more than one: **HOW MANY ADULTS AND HOW MANY CHILDREN** (UNDER 16) **?**

---

2) **CAN I JUST CHECK, HOW MANY DOGS DO YOU HAVE WITH YOU TODAY?**

---

3) **HOW FREQUENTLY DO YOU TEND TO VISIT THIS SITE ?**

DAILY,
ONCE A WEEK,
ONCE A MONTH,
SPORADICALLY (VARIES THROUGH THE YEAR)
DON'T KNOW / FIRST VISIT

---

4) **DO YOU TEND TO VISIT THIS SITE AT A CERTAIN TIME OF DAY ?**

BEFORE 9AM
BETWEEN 9AM AND 12
BETWEEN 12 AND 2
BETWEEN 2 AND 4
AFTER 4PM
DON'T KNOW / FIRST VISIT

---

5) **FROM WHICH POSTCODE DID YOU TRAVEL TO REACH THIS SITE ?**

---

6) **HOW DID YOU GET HERE ?** single answer only. Add if necessary: **WHAT FORM OF TRANSPORT DID YOU USE ?**

CAR
VAN
BUS / COACH
MOTORCYCLE
BICYCLE
HORSE
ON FOOT
OTHER (WRITE IN)

---

7) **DID YOU ENTER THE HEATH FROM HERE OR FROM SOMEWHERE ELSE ?**

ENTERERED FROM THIS ACCESS POINT
ENTERED FROM A DIFFERENT ACCESS POINT
DON'T KNOW

---

8) **WHERE HAVE YOU WALKED DURING YOUR VISIT TO THIS AREA TODAY?** show visitor aerial photograph and annotate copy. if necessary ask for landmarks.

---

9) **WHAT WAS THE MAIN PURPOSE OF YOUR VISIT TODAY ?** multiple answers ok.

DOG WALKING
WALKING
JOGGING / RUNNING
MOTOR-CYCLING
BICYCLING
HORSE-RIDING
PICNIC
OTHER (WRITE IN)

---

10) **DO YOU VISIT ANY OTHER PLACES, EITHER HEATHLAND OR NON-HEATHLAND, FOR THIS SAME PURPOSE ?**

YES: **GO TO QUESTION 10**
NO: **END OF QUESTIONNAIRE**
DON'T KNOW: **END OF QUESTIONNAIRE**

---

11) **HOW FAR DO YOU TYPICALLY TRAVEL FROM YOUR HOME TO REACH THESE ALTERNATE SITES ?**

<1 MILE
1 – 5 MILES
>5 MILES

---

12) **AND HOW DO YOU TRAVEL FROM YOUR HOME TO REACH THESE OTHER SITES?**

BY CAR OR OTHER MOTOR VEHICLE
ON FOOT
OTHER

THANK YOU VERY MUCH FOR YOUR TIME

References

Alexander, I. & Cresswell, B. (1990) Foraging by Nightjars *Caprimulgus europaeus* away from their nesting areas. *Ibis*, **132**, 568-574.

Angold, P.G. (1997) The impact of a road upon adjacent heathland vegetation: effects on plant species composition. *Journal of Applied Ecology*, **34**, 409-417.

Armitage, P., D., Blackburn, J.H., & Symes, K.L. (1994). The environmental quality of a small urban water course, the Bourne Stream (Dorset), assessed with macroinvertebrate density. Institute of Freshwater Ecology, Wareham, Dorset.

Atlantic Consultants (2003). Public perceptions of heathlands in Dorset. Urban Heaths Partnership.

Atlantic Consultants (2005). Public perceptions of heathland in Dorset. Urban Heaths Life Project.

Barratt, D.G. (1995) *Prey habits and movement patterns of house cats in Canberra, Australia*, University of Canberra, Canberra, Australia.

Barratt, D.G. (1997) Home range size, habitat utilisation and movement patterns of suburban and farm cats Felis catus. *Ecography*, **20**, 271-280.

Bateson, P. & Turner, D.C. (1990) *The Domestic Cat: the biology of its behaviour* Cambridge University Press, Cambridge.

Bibby, C.J. (1979a) Breeding biology of the Dartford warbler *Sylvia undata* in England. *Ibis*, **121**, 41-52.

Bibby, C.J. (1979b) Conservation of the Dartford Warbler on English Lowland heaths: a review. *Biological Conservation*, **13**, 299 - 307.

Bibby, C.J. (1979c) Mortality and movements of Dartford warblers in England. *British Birds*, **72**, 10-22.

Bibby, C.J. & Tubbs, C.R. (1975) Status, habitats and conservation of the Dartford warbler in England. . *British Birds*, **5**, 177-195.

Bobbink, R., Hornung, M., & Roelofs, J.G.M. (1998) The effects of air-borne nitrogen pollutants on species diversity in natural and semi-natural European vegetation. *Journal of Ecology*, **86**, 717-738.

Bonner, C. & Agnew, A.D.Q. (1983) Soil phosphorous as an indicator of canine faecal pollution in urban recreation areas. *Environmental Pollution (Series B)*, **6**, 145-156.

Bowden, C. & Hoblyn, R. (1990) The increasing importance of re-stocked coniferous plantations for woodlarks in Britain: implications and consequences. *RSPB Conservation Review*, **4**, 26-31.

Bowden, C.G.R. (1990a) Nightjar habitat requirements - preliminary results from radio tracking in Thetford Forest. . In Heathlands Conference II: History and management of southern lowland heaths. (eds M.H.D. Auld, B.P. Pickess & N.D. Burgess). RSPB Harrow House, Dorset.

Bowden, C.G.R. (1990b) Selection of foraging habitats by Woodlarks (*Lullula arborea*) nesting in pine plantations. *Journal of Applied Ecology*, **27**, 410-419.

Bullock, J.M. & Webb, N.R. (1994) Responses to severe fires in heathland mosacis in southern England. *Biological Conservation*, **73**, 207-214.

Burgess, N.D., Evans, C.E., & Sorensen, J. (1989). Management Case Study: The management of heathland for Nightjars at Minsmere, Suffolk. RSPB Reserves Ecology Department.

Buro Happold (2003). Purbeck Transportation Study: Existing conditions and consultations. Buro Happold, Bath.

Catchpole, C.K. (1991). The Dartford warbler on lowland heath. . RSPB.

Catchpole, C.K. & Phillips, J.F. (1992) Territory quality and reproductive success in the Dartford Warbler *Sylvia undata* in Dorset, England. *Biological Conservation*, **61**, 209 - 215.

Clarke, R.T., Liley, D., Underhill-Day, J.C., & Rose, R.J. (2006). Visitor access patterns on the Dorset Heaths, Rep. No. 683. English Nature

Conway, G., Wotton, S., Henderson, I., Langston, R., Drewitt, A., & Currie, F. ((in prep)) The status and distribution of breeding European Nightjars Caprimulgus europaeus in the UK in 2004. . *Bird Study*.

Cote, I.M. & Sutherland, W.J. (1997) The Effectiveness of Removing Predators to Protect Bird Populations. . *Conservation Biology*, **11**, 395-405.

Cramp, S. & Simmons, K. (1977 - 1995) *Birds of the Western Palearctic* Oxford University Press, Oxford.

Dickinson, J.E.R., D. (2006, in press.) Using the car in a fragile rural tourist destination: a social representations perspective. *Journal of Transport Geography*.

Dunnett, N., Swanwick, C., & Woolley, H. (2002). Improving urban parks, play areas and green spaces. DTLR, HMSO, Norwich.

Edwards, G.P., De Preu, N., Shakeshaft, B.J., Crealy, I.V., & Paltridge, R.M. (2001) Home range and movements of male feral cats (Felis catus) in a semiarid woodland environment in central Australia. *Austral Ecology*, **26**, 93-101.

Edwards, V. & Knight, S. (2006). Understanding the pyschology of walkers with dogs: new approaches to better management. University of Portsmouth, Portsmouth.

Gibbons, D.W., Reid, J.B., & Chapman, R.A. (1993) *The New Atlas of Breeding Birds in Britain and Ireland: 1988-1991.* T & AD Poyser, London.

Gibbons, D.W. & Wotton S. (1996) The Dartford warbler in the United Kingdom in 1994. *British Birds*, **89**, 203-212.

Gimingham, C.H. (1992) *The lowland heathland management book* English Nature, Peterborough.

Green, G. (2004) *The Birds of Dorset* Christopher Helm Ltd., London.

Gregory, R.D., Wilkinson, N.I., Noble, D.G., Robinson, J.A., Brown, A.F., Hughes, J., Procter, D., Gibbons, D.W., & Galbraith, C. (2002) The population status of birds in the United Kingdom, Channel Islands and Isle of Man: an analysis of conservation concern 2002 - 2007. *British Birds*, **95**, 410 – 448.

Griffiths, E. (2004). Hengistbury Head Visitor Survey, 2004. Bournemouth Borough Council.

Hall, C. (1996). An assessment of human impacts on the Castle bottom to Yateley Common SSSI, Hampshire. English Nature, Lyndhurst, Hampshire.

Holloway, S. (1996) *The Historical Atlas of Breeding Birds in Britain and Ireland 1875-1900.* T&AD Poyser, London.

Kirby, J.S. & Tantrum, D.A.S. (1999). Monitoring heathland fires in Dorset: Phase 1. Report to DETR. . Terra Environmental Consultancy, Northampton.

Lack, P., (ed) (1986) *The Atlas of Wintering Birds in Britain and Ireland.* T&AD Poyser, Calton, Staffs.

Lake, S. (2004). Dorset Nightjar Survey 2004. RSPB, Wareham, Dorset.

Langham, N.P.E. & Porter, R.E.R. (1991) Feral Cats (Felis Catus L.) On New Zealand Farmland. I. Home Range. *Wildlife Research*, **18**, 20.

Langston, R., Liley, D., Murison, G., Woodfield, E., & Clarke, R.T. (2005) What effects do walkers and dogs have on the distribution and productivity of breeding Nightjar Caprimulgus europaeus? In Birds and Recreational Disturbance (ed A. Drewitt). On line special edition of Ibis, Peterborough.

Liley, D. (2004). Human impacts on the Castle Bottom to Yateley Common and Hawley Commons SSSI, Hampshire. . RSPB.

Liley, D. & Clarke, R.T. (2002). Urban development adjacent to heathland sites in Dorset: the effect on the density and settlement patterns of Annex 1 bird species. English Nature, Peterbrough.

Liley, D. & Clarke, R.T. (2003) The impact of urban development and human disturbance on the numbers of nightjar Caprimulgus europaeus on heathlands in Dorset, England. *Biological Conservation*, **114**, 219 - 230.

Liley, D., Jackson, D.B., & Underhill-Day, J.C. (2006a). Visitor Access Patterns on the Thames Basin Heaths, Rep. No. ENRR 682. English Nature, Peterborough.

Liley, D., Mallord, J.W., & Lobley, M. (2006b). The "quality" of green space: features that attract people to open spaces in the Thames Basin Heaths area. English Nature, Peterborough.

Liley, D. & Underhill-Day, J.C. (2006c). Dog walkers on the Dorset Heaths, Analysis of questionnaire data collected by wardens on Dorset's Urban Heaths. Footprint Ecology / Urban Heaths Partnership / English Nature.

Lord, A., Waas, J.R., Innes, J., & Whittingham, M.J. (2001) Effects of human approaches to nests of northern New Zealand dotterels. *Biological Conservation*, **98**, 233-240.

Mader, H.J., Schell, C., & Kornacker, P. (1990) Linear barriers to arthropod movements in the landscape. . *Biological Conservation*, **54**, 209-222.

Mallord, J.W. (2005) *Predicting the consequences of human disturbance, urbanisation and fragmentation for a woodlark Lullula arborea population*. Doctorate, UEA, Norwich.

Marzluff, J.M. & Neatherlin, E. (2006) Corvid responses to human settlements and campgrounds: causes, consequences and challenges for conservation. *Biological Conservation*, **130**, 301-314.

Moore, N.W. (1962) The heaths of Dorset and their conservation. *Journal of Ecology*, **60**, 369-91.

MORI (2004). Bourley and Long Valley Users Survey, research study conducted for Taylor Woodrow. MORI.

Morris, A., Burgess, D., Fuller, R.J., Evans, A.D., & Smith, K.W. (1994) The status and distribution of Nightjars *Caprimulgus europaeus* in Britain in 1992. *Bird Study*, **41**, 181-191.

Murison, G. (2002). The impact of human disturbance on the breeding success of nightjar *Caprimulgus europaeus* on heathlands in south Dorset, England, Rep. No. English Nature Research Report 483. English Nature, Peterborough.

Murison, G., Bullock, J.M., Underhill-Day, J.C., Langston, R., Brown, A., & Sutherland, W.J. (in press,) Habitat type determines the effects of disturbance on the breeding productivity of the Dartford Warbler Sylvia undata. *Ibis*.

Office of the Deputy Prime Minister (2005) Biodiversity and Geological Conservation, - Statutory obligations and their impact within the planning system Part III A. (ed D.f.E.F.a.R. Affairs), Vol. Circular 06/2005.

PFMA (2006) Pet Food Manufacturer's Association Website.

Purbeck Heritage Committee (2002). Making Purbeck More Special, A strategy for the Purbeck Heritage Area 2002-2007. Purbeck District council, Wareham, Dorset.

Reijnen, R., Foppen, R., & Veenbaas, G. (1997) Disturbance by traffic of breeding birds: evaluation of the effect and considerations in planning and managing road corridors *Biodiversity and Conservation*, **6**, 567-581.

Robins, M. & Bibby, C.J. (1985) Dartford warblers in 1984 Britain. *British Birds*, **78**, 269-280.

Rose, R.J. & Clarke, R.T. (2005). Urban impacts on Dorset Heathlands: Analysis of the heathland visitor questionnaire survey and heathland fires incidence data sets, Rep. No. 624. English Nature, Peterborough.

Rose, R.J., Webb, N.R., Clarke, R.T., & Traynor, C.H. (2000) Changes on the heathlands in Dorset, England, between 1987 and 1996. *Biological Conservation*, **93**, 117-125.

Sharrock, J.T.R., (ed) (1976) *The Atlas of Breeding Birds in Britain and Ireland.* BTO., Tring.

Sitters, H.P. (1986) WoodLarks in Britain 1968-83. . *British Birds*, **79**, 105-116.

Sitters, H.P., Fuller, R.J., Hoblyn, R.A., Wright, M.T., Cowie, N., & Bowden, C.G.R. (1996) The woodlark *Lullula arborea* in Britain: population trends, distribution and habitat occupancy. . *Bird Study*, **43**, 172-187.

Slee, B. (2002) Social exclusion in the countryside. *Countryside Recreation*, **10**, 2-7.

Taylor, E. (2002) *Predation risk in woodlark Lullula arborea habitat: the influence of recreational disturbance, predator abundance, nest site characteristics and temporal factors.* , University of East Anglia.

Taylor, E.J. (in press) Effects of disturbance on Stone Curlews. *Ibis*.

Taylor, K., Anderson, P., Liley, D., & Underhill-Day, J.C. (2006) *Promoting Positive Access Management to Sites of Nature Conservation Value: A Guide to Good Practice* English Nature / Countryside Agency, Peterborogh and Cheltenham.

Tubbs, C.R. (1963) The significance of the New Forest to the status of the Dartford warbler in England. *British Birds*, **56**, 41-49.

Underhill-Day, J.C. (2005). A literature review of urban effects on lowland heaths and their wildlife, Rep. No. 624. English Nature, Peterborough.

Webb, N.R. (1989) Studies on the invertebrate fauna of fragmented heathland in Dorset, UK, and the implications for conservation. *Biological Conservation*, **47**, 153-165.

Webb, N.R. (1990) Changes in the heathlands of Dorset, England, between 1978 and 1987. *Biological Conservation*, **51**, 273-286.

Webb, N.R. & Thomas, J.A. (1994). Conserving insect habitats in heathland biotopes: a question of scale. In *Large-scale processes and conservation biology* (eds P.J. Edwards, R.M. May & N.R. Webb), pp. 129-151. Blackwell Scientific Publications, Oxford.

Webb, N.R. & Vermaat, A.H. (1990) Changes in vegetational diversity on remnant heathland fragments. *Biological Conservation*, **53**, 253-264.

Wernham, C.V., Toms, M.P., Marchant, J.H., Clark, J.A., Siriwardena, G.M., & Baillie, S.R. (2002) *The Migration Atlas: movements of the birds of Britain and Ireland.* T. & A. D. Poyser, London.

Westerhoff, D. & Tubbs, C.R. (1991) Dartford warblers Sylvia undata, their habitat and conservation in the New Forest, Hampshire, England in 1988. . *Biological Conservation*, **56**, 89-100.

Witherby, H.F., Jourdain, F.C.R., Ticehurst, N.F., & Tucker, B.W. (1938) *The handbook of British Birds* Witherby, London.

Woodfield, E. & Langston, R.H. (2004). A study of the effects on breeding nightjars of access on foot to heathland. English Nature Peterborough.

Woods, M., McDonald, R.A., & Harris, S. (2003) Predation of wildlife by domestic cats Felis catus in Great Britain. *Mammal review*, **33**, 174-188.

Woods, N.I.E.P.o.t. (2002) Do Dorset's heaths have a future? . In Sixth National Heathland Conference (eds J.C. Underhill-Day & D. Liley). RSPB, Sandy, Beds. , Bournemouth.

Wotton, S.R. & Gillings, S. (2000) The status of breeding Woodlarks *Lullula arborea* in Britain in 1997. *Bird Study*, **47**, 212-224.

Wright, L., Hoblyn, R.A., Atkinson, P.W., Sutherland, W.J., & Dolman, P. (2005) A threatened species benefits from climate change ? . In British Ecological Society Meeting, pp. Conference poster. British Ecological Society.