Access Patterns in South-east Dorset.
The Dorset Household Survey 2008:
Consequences for Future Housing and Greenspace Provision

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Summary

This report considers how different factors influence visitor rates to heathlands in south-east Dorset. We focus on the extent to which the presence or extent of different types of habitat and existing greenspace in the vicinity of where people lives determines the amounts of visits people make to heaths. The data we use comes from the household survey of south-east Dorset residents conducted in 2008 (full details of which are presented in a separate report).

We highlight the following factors that influence the number (or likelihood) of visits made to heaths by individual households

Characteristics of the household
Dog owners visit greenspaces, and particularly heaths, more than non dog owners. Dog owners make an average of 289.5 visits per year to any type of greenspace compared to an average of 119.5 annual visits by households without a dog (i.e. dog walkers make 2.4 times as many visits to green space as non dog walkers). The ratio of dog owners to non dog-owners is greatest for heaths, to which dog-owning households make over four times as many visits both on foot (ratio 4.03) and by car (ratio 4.34). People in flats tended to visit heaths less frequently (but there were significant differences in visit rates only for those people living in flats well away from heaths, who tended to make less visit heaths).

Mode of transport
Similar numbers of visits are made by people travelling to heaths by car as those travelling on foot: 43% of all visits to heaths are made by people walking from home and similarly 43% of all heath visits were made by car. A clear majority of the surveyed Dorset households tended to travel by car when visiting the coast (54%), Hengistbury (60%) and the New Forest (91%), while most visits (53%) to 'Other' types of greenspace (all greenspaces which were not heath, coast, Hengistbury or the New Forest, were grouped together as 'Other' and this grouping included parks, gardens, woods and rivers) were made by people travelling on foot.

Proximity to heathland
The annual number of visits made per household to heaths correlated with the amount of heathland surrounding the home postcode, i.e. those people living in locations surrounded by lots of heathland visit heaths more often than those surrounded by less heathland. For those travelling to heaths on foot, the highest correlations were found with the area of heath within a distance of 1500m. For car-borne visitors the highest correlation occurred using the area of heath within 5000m and especially within 1500m-5000m.

Availability of non heathland green space sites
There was an indication that people living close to the coast visit heaths less. When there is no heath within 500m of a household, the presence of coastal greenspace within any distance limit from 500m outwards up to 15km has a statistically significant reduction on both the likelihood of visiting any heath and the number of heath visits made in a year.

When there is some heath within 500m of a household, there is no statistically significant effect of the presence of coastal greenspace within any distance limit on either the likelihood or rate of visiting heaths.

There is also evidence that the rate of visiting heaths, per household, declines with the amount (rather than just presence) of nearby coast, with relatively strong negative correlations up to 3km from the coast; however, this was only statistically significant when there is no heath within 1500m. This suggests that if there is some heath nearby (i.e. within 1500m) then the presence of coast within 3km does not generally reduce the household's total visitor rates to heaths.

Almost all responding households had some 'Other' greenspace within 1500m. There was no apparent effect of the presence of 'Other' greenspace (within either 0.5km or 1km of respondents' home postcodes) on reducing either the likelihood or frequency of visiting heaths regardless of whether heath was present or not

within either 500m or 1500m of the household. Correlations with the number of visits to heaths and the amount of 'Other' greenspace within a range of distances were weak or even positive (i.e. suggesting that people with more greenspace surrounding their homes may actually visit heaths more).

There were no consistent significant differences in the number of annual heath visits per household in relation to the amount of 'Other' greenspace within 3000m for any level of the amount of heath within 1500m of the household. This lack of effect was also found when all non heath sites (coast, new forest, Hengistbury and Others) were grouped together into a single category.

However, there was a significant effect of the number (rather than total area) of greenspaces surrounding a home postcode with households with more 'Other' greenspace sites nearby tending to visit heaths less. The strongest effect of 'Other' greenspaces on heath visits per household was found with the number of 'Other' greenspaces within 3km (or perhaps 5km) of the household. Thus, with a choice of several nearby 'Other' greenspaces, it seems that some sites may attract visitors away from heaths.

Due to their unique character, we treated Hengistbury Head and the New Forest as two different special types of site. The presence of Hengistbury Head within 1.5km and within 3km reduces both the likelihood and rate of visiting heaths regardless of whether or not there is any heath within 500m or 1500m respectively.

Predictive modelling

Following on from our preliminary statistical analyses, we explored the extent to which different variables could be combined to generate a predictive model of the number heath visits per household. We tried different combinations of variables relating to the presence of, area of, or distance to the different types of greenspace.

Models were also developed that included whether or not a household owned a dog. The best fitting parsimonious model for predicting the annual number of heath visits by a household involved the following variables. Each variable was significant both on its own and in combination with all the others:

- area of heath within 500m of the household
- area of heath within the distance band 500-5000m of the household
- straight-line distance to the nearest coast
- straight-line distance to Hengistbury
- number of 'Other' greenspaces within 3km (i.e. all non- heath, non-coast greenspaces except Hengistbury and the New Forest)

Interpretation of the regression coefficients (i.e. the "effect" of each variable) in the best model suggests that on average:

- Dog-owning households visits heaths roughly three times more often than households without dogs
- For households within 500m of a heath, a doubling of the area of heath within 500m results in an increase of 41% more visits to heaths.
- For households that are lie between 500m and 5000m of a heath, a doubling of the area of heath results in an increase of 17% more visits to heaths.
- Each 1km nearer to coastal greenspace is associated with an reduction in the number of heath visits per household of approximately 5%
- Each 1km nearer to Hengistbury Head is associated with an approximate reduction in the number of heath visits per household of 2%
- Every additional 'Other' greenspaces within 3km of a household is associated with an average reduction in the number of heath visits of 0.75% (per greenspace).

Actual current distribution of greenspace in relation to current and future housing

We also summarise the current distribution of different greenspace within the sub region, in relation to current and future housing. Greenspace sites are widely distributed throughout south-east Dorset, with sites tending to be smaller in urban areas than those in rural areas. Heathland sites tend to be larger than all other types of greenspace site, but this is amplified in urban areas, such that heathlands are virtually the only large areas of open space. The current distribution of housing is largely concentrated around the southern part of each district/unitary authority, with the largest centres being predominantly away from heathland sites. A large proportion of the planned housebuilding across the five districts/unitary authorities is in areas with no current local greenspace provision. There is relatively little future housing planned for areas directly adjacent to heathland or where heathland is the only local greenspace, for example 10% of future housing in Poole will be close to heathland (within 500m) and not close to any other type of greenspace – this is the highest figure for any of the local authorities within the sub-region.

Implications for strategic planning

The provision of alternative greenspace ('SANGS' – suitable alternative natural greenspace) is a potential mechanism with which to reduce visitor pressure on the heaths, thereby accommodating additional development and population growth without negative impacts on the heaths. Our results suggest that existing greenspace (away from the coast) does not deflect people from visiting heaths and that simply increasing the area of existing greenspace is not likely to be effective as a means of reducing the numbers of visitors to heaths. We have shown that the area of the existing network of farmland, parks, gardens and other types of greenspace surrounding a postcode makes no significant difference to the amount of visits people make to heaths. We have not, however, implicitly tested SANGS as we have only looked at visitor rates in relation to the current types and availability of greenspace, sites which are not designed to necessarily attract people that would otherwise visit heaths (i.e. sites that are neither suitable nor provided as alternatives).

A clear implication is therefore that new greenspace, if intended to deflect people from visiting heaths, must be different to the existing greenspace, carefully designed and targeted to provide a similar experience to heaths. The quality of the experience offered by new sites is likely to be critical. In our models we found a significant effect of the number of green spaces (but not area of greenspace), suggesting that quality (and possibly variety) of greenspace is important. New sites that are similar to the heaths or are coastal would seem to have the biggest potential to deflect visitors away from the heaths.

As many people walk to heaths as travel to them by car. For foot visitors, the strongest correlation with the number of visits per household per year and area of heathland was using a distance band of 1500m. For car-visitors the strongest correlation was using pooled bands from 1500-5000m. These results lend support to the current zoning (no new residential development within 400m of SPA / SAC and developer contributions per dwelling within 400m – 5000m). The high numbers of foot visitors supports the use of a zone directly adjacent to the heaths and the use of a 5km zone is clearly appropriate as a broad catchment for car-borne visits.

This study focuses on current patterns of access, patterns potentially established over decades. Change, in terms of the use of new sites and the choices people make as to where to go to undertake particular activities, will take many years. The provision of alternative sites is part of a package of measures that could be used to influence people's behaviour and choice of site (examples of other measures include education initiatives, wardening on the heaths and the enforcement of dogs on leads on the heaths). As such measures are new or yet to be implemented across the sub-region, this report cannot not test their effectiveness, nor might it be necessarily be expected that change might have occurred to date. It would therefore be useful to repeat this survey at a later date (say ten years), to determine the effectiveness of the introduction of new sites and management measures on the heaths.

There is also clearly a need for further work to actually test the effectiveness of SANGS (i.e. with before and after monitoring of the SANGS and the adjacent heathland sites). Further work is need to study people's perception of the quality and attractiveness of sites, and perhaps to try to develop greenspace attractiveness indices to help improve understanding and predictive modelling of visitor rates. Very careful implementation of new greenspace sites, in combination with other mitigation measures, and with detailed monitoring and further research is recommended.

Contents

Acknowledgements

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1 Introduction

This work was initiated following increasing awareness of the potential adverse effect of recreational pressure on South-east Dorset Natura 2000 sites, particularly the Dorset Heathlands SPA (see Clarke et al., 2008; Liley and Clarke, 2003; Liley et al., 2006a; Mallord, 2005; Mallord et al., 2007; Mallord et al., 2006; Murison, 2002, 2007; Murison et al., 2007). A strategy is currently being progressed to prevent the occurrence of adverse effects upon Natura 2000 sites in South-east Dorset, focusing upon the impacts of recreational pressure. The project has come about through the close partnership of the South-east Dorset local authorities and Natural England. This strategy is currently in the form of An Interim Planning Framework (IPF), running from 2006 – 2009, then to be succeeded by a joint Development Plan Document.

The IPF seeks to ensure no new dwellings are consented within the critical zone of 400m from any part of the SPA; and to secure developer contributions, based on a standard tariff, from all further development within the 400m to 5km zone around the Dorset Heaths SPA. The key elements of the approach are the use of the tariff to fund a continuation of the promising educational work, particularly relating to the awareness of fire risks and fire control/prevention measures developed by the EU-funded Urban Heaths LIFE project; and the concept of the provision of additional areas of access land, both around the heaths (referred to as 'heath support areas') or new suitable alternative natural greenspace (SANGs), intended to attract people to use alternative sites rather than the designated heathland.

Alternative sites provide an attractive and relatively straightforward solution to a potentially complex problem. Their effectiveness remains untested. While it is perhaps intuitive that, if provided with a suitably attractive alternative, people will change their access patterns or new residents will go to the SANGS, this is by no means proven. Creation of new places to visit and encouraging access to these places may in fact simply increase the amount of recreational visits people make – allowing people greater opportunities and thereby encouraging people to go out more. New homes surrounded by lots of attractive green space may attract the type of people that spend more time outside. It may simply be that the heaths are too difficult to replicate and too attractive in their own right, attracting people who seek relatively wild spaces with extensive semi-natural habitats that are essentially unique in their appeal.

With the scale and location of development anticipated in the draft RSS, it is clearly important that the IPF and the joint DPD are based on a sound evidence base. We use the household survey data to explore the extent to which people visit heathland in relation to the other types of site surrounding where they live, i.e. the extent to which other sites may serve to "deflect" people that would otherwise visit heaths.

The full details of the household survey are presented in a separate report (Liley et al., 2008), which provides an overview of the methods and results. A questionnaire was sent to 5000 residents of south-east Dorset, selected at random. The questionnaire asked about patterns of access. Rather than directly ask whether people would visit alternative sites, it instead asked people to name sites that they visited and prompted respondents to consider which coastal, woodland, heathland and other types of green space they visited. Respondents were asked to name which sites, and how often, they visited.

In this report we aim to analyse these data with the aim of determining how visit rates to heathland (i.e. the likelihood of visiting heaths, or the number of annual visits to heaths) are influenced by the amount of other greenspace surrounding the heath. The original intention was to build predictive models allowing us to test the effectiveness of different scenarios of new housing and new greenspace provision.

2 Our Approach

GIS

A GIS database of greenspace sites within 15 km of the household survey area (approximately 15km beyond the three districts, Purbeck, East Dorset and Christchurch, and two unitary authorities, Poole and Bournemouth) was constructed. This relied heavily on data supplied by the relevant local authorities, supplemented by information from Natural England (SSSIs, Open Access land etc), play areas from Dorset Children's Information Service (http://www.dorsetcis.org.uk/main.aspx) and local knowledge of the authors. This database was then cross-referenced with the original site GIS database from the original household survey report to ensure no sites had been missed. The database was then filtered and manually checked and the following (which were present in some of the local authority data) removed:

- roadside verges
- land with no public access
- allotments
- sites less than 1 ha were also then removed.

This database was different to that used in the original report, where we built a GIS layer from the named sites actually visited. For this analysis we have built a GIS layer describing all sites, and then from these have selected the sites actually visited. There are 1,919 sites within 15 km of the household survey area, constituting 55,075 ha. Of this, the respondents to the survey only visited 10 % of the sites, although those sites made up 79 % of the area. This therefore suggests that the greenspace sites identified above that were not visited by the respondents tended to be small sites.

All the sites were then classified into one of the following greenspace types: Heath (wholly or partly within the Dorset Heaths SPA or SAC), Coast, New Forest, Hengistbury Head and Other.

GIS data on the postcodes within southeast Dorset in 2007, gave the centroid of each postcode to the nearest 10 m and the number of residential delivery points for each postcode. This was used to spatially locate, as close as possible, the home address of each respondent. This information was also used to quantify the current amount and distribution of housing within the five districts/unitary authorities and also, with information from each of the local authorities, the possible spatial distribution of planned future housing.

The postcodes from which the original survey data was obtained, were used to calculate the number and distance travelled by each household to each greenspace category. They were then also used with the GIS database on greenspace sites to calculate the area and number of greenspaces of each category surrounding each postcode. Linear buffers were drawn around each postcode at the following intervals: 500 m, 1 km, 1.5 km, 2 km, 2.5 km, 3 km, 4 km, 5km, 6 km, 7 km, 8 km, 9 km, 10 km, 12.5 km and 15 km. Both the area and number of sites within each category within each distance band was calculated for all residential postcodes.

Additionally the local available greenspace was calculated. This was completed by constructing a grid of 250 m square cells. Buffers of 500 m (taken to be local) were drawn around heath, coast and 'other' greenspace sites. Then all grid cells for which the centroid fell within the 500 m buffer were classified as being within 500 m of that greenspace category. Information on the current and planned housing, displayed spatially according to postcode, was also summed within the 250 m grid cells to provide information on local greenspace availability, both currently and for planned housing.

Visitor rate modelling from Household questionnaire data

The annual number of visits made by a household to a particular type of greenspace was estimated for each respondent. The questionnaire asked how often the household visited a particular site they had named, and respondents were given the choices such as "most days", "most weeks" etc. We assumed these categories of frequency of visit were equivalent to:

- 1 visit per year if frequency was left blank
- visits for 'a few times per year',
- 12 visits for 'roughly every month',
- 40 visits for 'most weeks'
- 250 visits for 'most days'.

The total number of visits made by the household to a particular type of greenspace was then estimated by summing the estimated visits made to up to four most frequently visited sites of that type. As a test to check that the use of different totals for each frequency of visit would not have a marked effect on the analysis, different combinations of different scorings were also derived and correlated with each other (these results are presented in Appendix 1).

The average number of visits made to heaths per household is 32.1, but 36% of households do not visit any heaths, while just over half (52%) visit a heath "a few times a year or less" (scored as four visits) or not at all. At the other extreme, 10% of households make over 60 visits to heaths per year and 5% make over 250 visits, with the maximum visits in a year by a whole household estimated to be 830.

A range of features attract or detract individuals and households to particular types of greenspace. Therefore, although having a greater area of greenspace within a certain distance is likely to attract more visits, the overall visitor rate to a particular type of greenspace may be greater if there are a number of different spaces rather than just one large greenspace. Alternatively the attraction may be of having one large open area which provides a feeling of openness or wildness. Therefore we used both area and number of sites within given distance bands in our modelling.

Special cases of Hengistbury Head and the New Forest

Hengistbury Head is a coastal Greenspace site which also contains heath. Thirty seven percent of the respondents analysed visited Hengistbury Head each year and 17% visited roughly monthly or more frequently. As it attracts such a large number of visitors each year, for the purpose of analysis and model building, it was treated as a separate, unique type of greenspace.

Thirty one percent of all households visited the New Forest at least once each year. Respondents often did not specify where in the New Forest they visited and therefore it was hard to determine the distance many people travelled so, for analysis, we treated the whole New Forest National Park as one large Greenspace and merely measured the area of New Forest within distance bands of each household.

For each postcode, we calculated the area of Hengistbury Head and the area of the New Forest NP within each distance band, as this may influence and maybe reduce the rate of use of nearby heath, coast and other greenspaces.

Statistical tests and graphics

In Appendix 2 we provide additional background to the approaches used and rationale behind statistical testing. We refer the lay reader who requires additional information to this section.

We rely on non-parametic tests for much of the analysis in order to account for the skewed distributions in visitor rates (i.e. typically lots of households that visit heaths infrequently and a small number that visit repeatedly. We use Spearman Rank correlations to test for significant correlations between the area of land and heath visitor rates and Kruskal-Wallis tests to test for differences in the level of heath visits between households grouped according to the presence and amount of heath, coast and other types of greenspace within selected distance bands.

We use box plots frequently throughout the report. These plots describe the data for particular groupings, and typically include the following:

- Horizontal line: indicating the median value for that group
- Box: indicating the 25th and 75th percentiles (i.e. the range that encompasses middle 50% of the values)
- Vertical lines: "whiskers" indicating the upper and lower limits of the data
- Asterisks: indicating outlier values (i.e. any data points that fall outside the 95th and 5th percentiles.

These attributes are described in Figure 1.

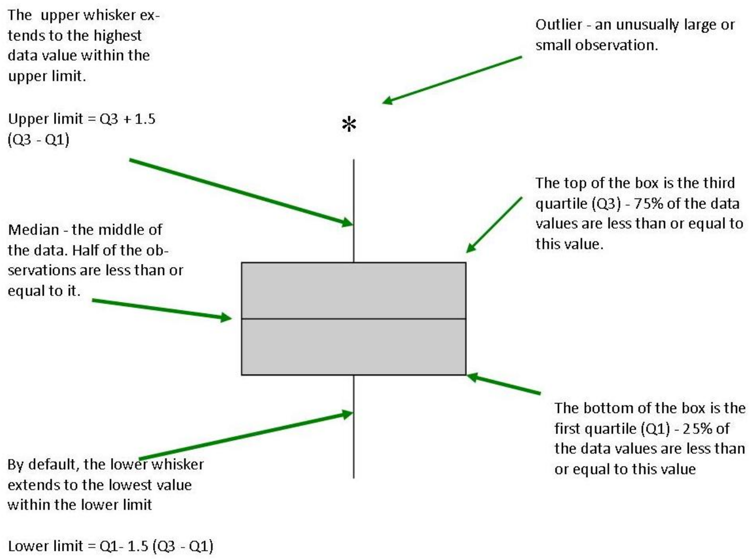

Figure 1: Box plot attributes

Our regression models fit the best multiple linear relationship between the annual total number of heath visits by a household and a selected set of variables measuring characteristics of the household (e.g. dog-owning or not) and distance to, or amounts of each type of greenspace within selected distance bands of the household. The overall fit of model is measured by the cross-validation R^2, denoted R^2_{cv}, which measures the percentage of total variation in the observed heath visitor rates per household which is explained by the regression predicted values, where the prediction for each household is based on fitting the model excluding the data for that household (Minitab 15, 2007).

Our regressions involve the prediction of the logarithm (to base 10, $\log_{10}(X+1)$) of the annual heath visits, rather than the raw untransformed number of visits. This is done for two reasons, firstly because the effect of a particular greenspace area variable is likely to depend on the values of the other predictor variables and is more likely to have a multiplicative proportional effect rather than a linear constant effect, secondly because the regression residuals (errors in prediction) are more likely to be of roughly constant size on a log scale (and homogeneity of residuals is an assumption of least squares multiple regression). In general the more visits occur on average for a given set of nearby greenspace conditions, the more variable will be the actual number of visits between individual households.

For the area variables (area of different habitats surrounding postcodes), which we refer to as Log(Area) we actually used $\text{Log}_{10}(\text{Area} + 1)$ to overcome the problem of zero areas within distance bands for some households.

All tests were performed using Minitab (Version 15, 2007).

3 Effect of household characteristics on heath visitor rates

Dog owners

The frequency of heath visits tends to be higher for households owning a dog that for those without a dog across all bands of area of heath within 1500m (Figure 2).

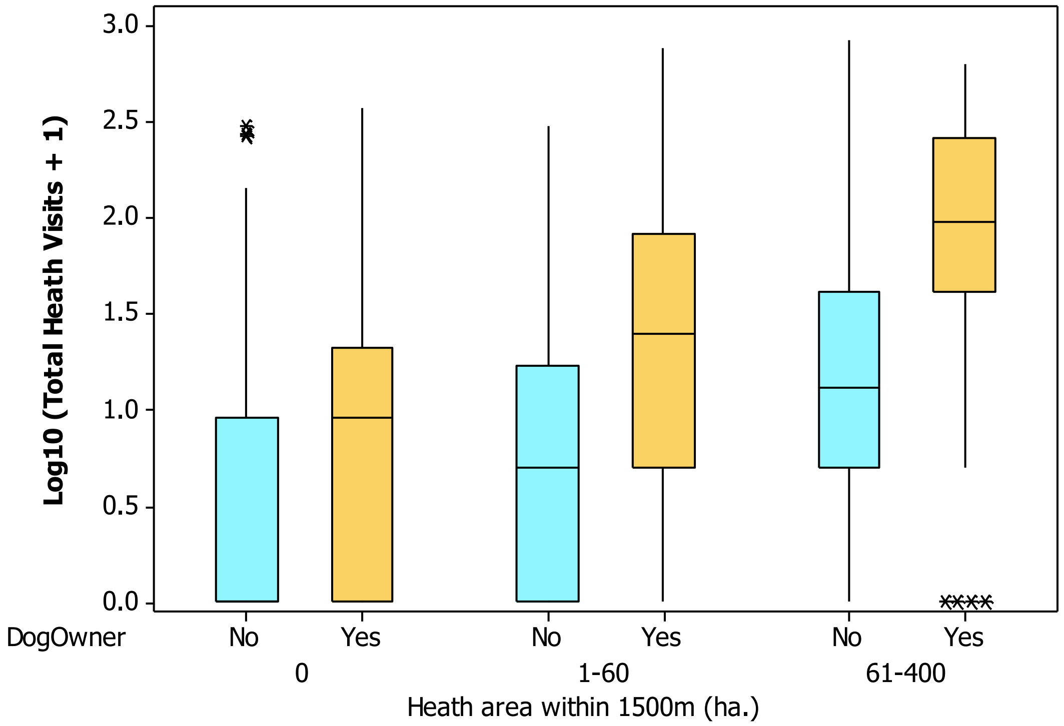

Figure 2: Boxplot of Log10 (Annual Heath visits per household + 1) in relation to area of heath (ha) within 1500m, subdivided by whether or not the household owns a dog

Dwelling type

Dwellings were grouped into flats and non-flats (terraced/semi/detached houses and bungalows). For each level of area of heath within 1500m, the median annual heath visits was less for people living in flats than for non-flats. However, the difference in medians was only statistically significant amongst the very large group of respondents who had no heath within 1500m and hence had to travel further to visit any heaths (Figure 3).

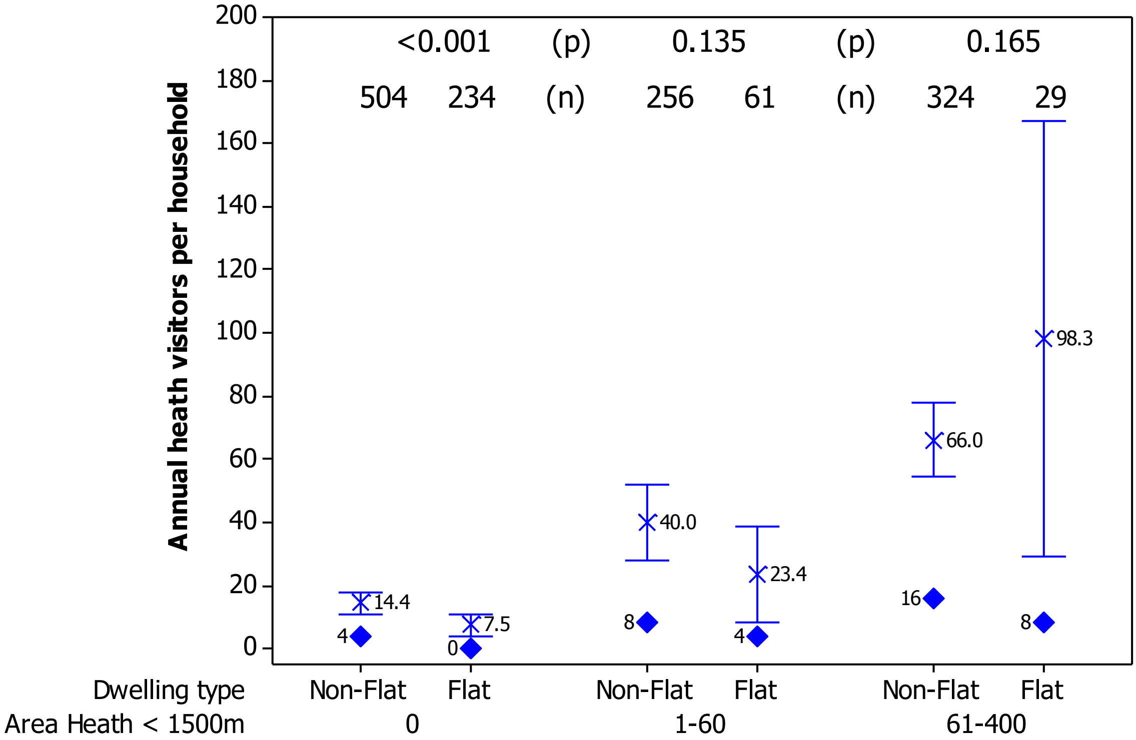

Figure 3 Means (labelled X) and their 95% confidence limits and medians (♦) of annual number of heath visits per household grouped by dwelling type (flat/non-flat) and area of heath (ha.) within 1500m (n = households per group); p = Kruskal- Wallis test probability for effect of dwelling type within each heath area group

As might be expected, a flat typically houses fewer people (mean 1.77) compared to non-flats (mean 2.51), with single person occupancy in 43% of flats compared to only 15% of houses/bungalows (Table 1).

Table 1 Percentage of households with 1, 2 or 3+ people in relation to dwelling type (flat versus house/bungalow)

	People in household			
	1	**2**	**3+**	**N**
Flat	43%	44%	13%	324
House/Bungalow	15%	49%	36%	1084
Overall	21%	48%	31%	

Number of people in household (household size)

As the household questionnaire asked people to respond on behalf of the whole household on their combined use of greenspaces, it might be expected that more visits would be made by larger households. Families with small children would tend to visit greenspaces together (or at least the children would be with one or more parents), while in contrast, households with grown-up independent children might be more likely to make more independent and thus greater overall visits to greenspace, although this may not be to heaths.

Analysis of the overall annual number of heath visits per household in relation to household size, shows that although the median number of heath visits is less for single occupancy households than for those with three or more people for each category of the amount of nearby heath, the difference is only statistically significant in the situation with no heath within 1500m when overall levels of heath visits are low (Figure 4).

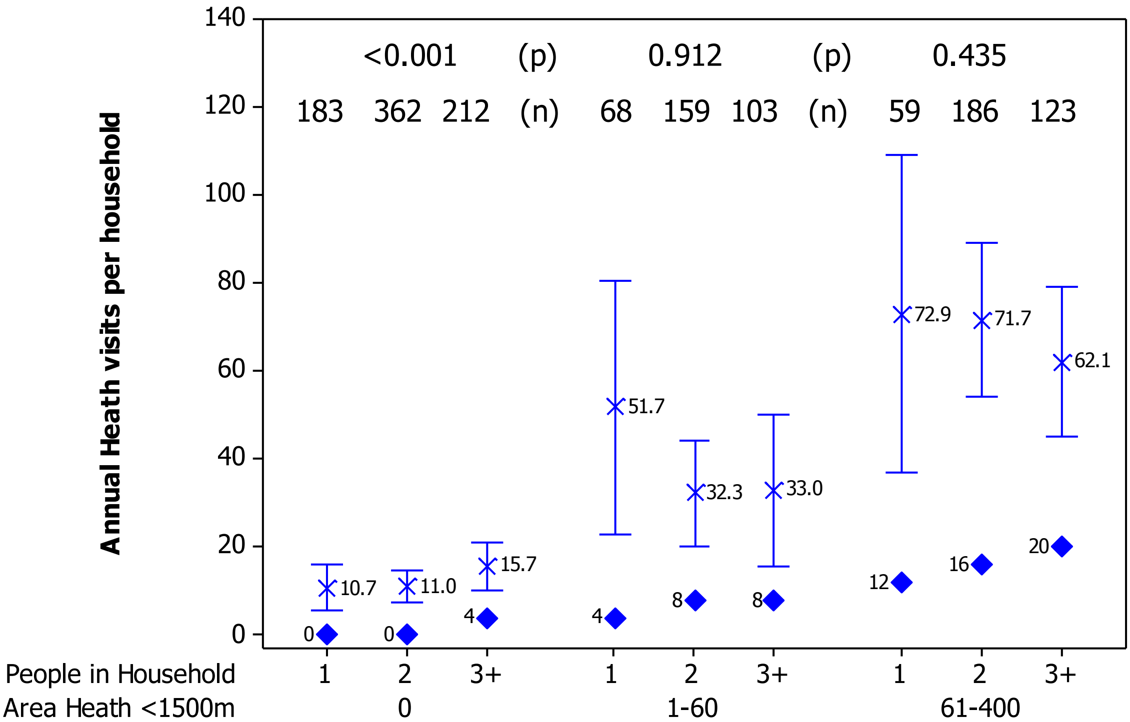

Figure 4: Means (labelled X) and their 95% confidence limits and medians (♦) of annual number of heath visits per household in relation to number of people living there and the area of heath (ha.) within 1500m (n = households per group); p = Kruskal- Wallis test probability for influence of household size within each heath area group

Dog ownership, dwelling type and heath visits

There is some suggestion that slightly fewer heath visits may be made by households living in flats than houses/bungalows, but this may be due to the fact that only 10% of people living in flats own a dog compared to 23% in houses/bungalows.

However, amongst all households with a dog, there is still a statistically significant lower mean (ANOVA on log scale, p=0.042) and median (p=0.041) heath visit rate from flats; amongst households without dogs, there is also a statistically significant lower visiting rate from flats compared to houses/bungalows (Figure 5).

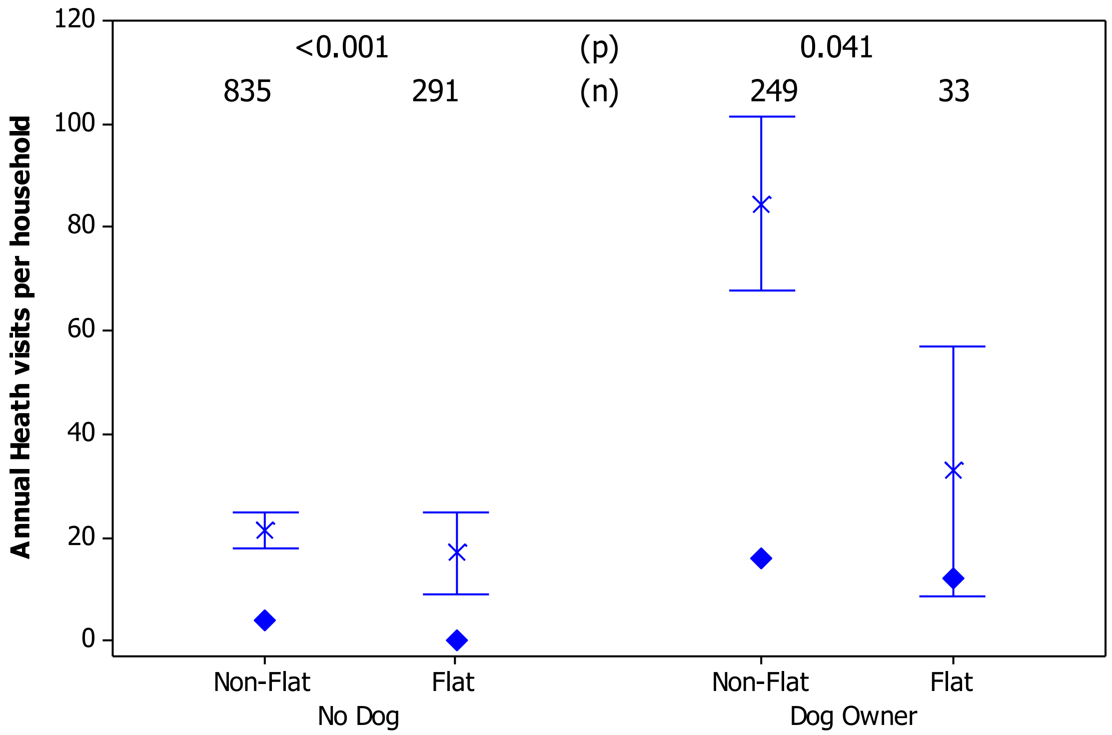

Figure 5: Means (labelled X) and their 95% confidence limits and medians (♦) of annual number of heath visits per household grouped by dwelling type (flat/non-flat) separately for households with and without a dog (n = households per group); p = Kruskal-Wallis test probability for effect of dwelling type within dog ownership group

Summary of household characteristics & implications

There is some evidence that the annual number of visits per household to heaths is higher from non-flats and for households with dogs.

In the subsequent regression modelling, we will make allowance for whether or not each dwelling owns a dog and whether it is a flat.

4 Mode of transport

The distance people travel to each type of greenspace is likely to depend on their mode of travel; if walking they are more likely to visit relatively close greenspaces. The modes of transport were grouped as follows ‘Foot’, ‘Car’ (car or motorcycle) and ‘Other’ (bicycle, public transport, other or unspecified). Table 2 shows the number and percentage of all visits to each type of greenspace mode using each mode of transport.

Table 2: Mean annual visits per household to each type of greenspace arriving by foot, car or Other means (% of total visits to that type given in brackets)

Transport mode	Heath	Coast	Other	Hengistbury	New Forest	Total
on Foot	13.9 (43%)	18.5 (34%)	29.4 (53%)	2.2 (31%)	0.1 (1%)	64.1 (42%)
by Car	13.7(43%)	29.1 (54%)	18.6 (34%)	4.3 (60%)	4.0 (91%)	69.7 (45%)
Other	4.5 (14%)	6.6 (12%)	7.4 (13%)	0.6 (9%)	0.3 (8%)	19.4 (13%)
Total	32.1 (100%)	54.3 (100%)	55.4 (100%)	7.1 (100%)	4.4 (100%)	153.3 (100%)

Based on this stratified random survey of households, we estimate that 43% of all visits to heaths are made by people walking from home, while the same percentage of all heath visits was made by car.

This finding of equal numbers of visits being made on foot as by car differs from the results of the survey of 20 heath access points of Clarke *et al* (2006) who recorded 59% of those questioned arrived by car and only 36% walked to the site. The reason for the difference is that the study of Clarke *et al* (2006) consciously selected a mix of urban and rural heaths and with roughly half of all surveyed access points having car parking spaces. The majority of Dorset heath access points do not have parking spaces. Thus the study of Clarke *et al* (2006) may have over-estimated the true proportion of all visits to all heaths made by car and under-estimated the proportion made on foot.

The finding of the current household questionnaire survey that as many visits are made to heaths by walking from home as by driving has implications for further analyses. Because heath visits made on foot tend to be from much shorter distances than visits by car (Clarke et al (2006), it is likely that the amount of heath and other greenspaces within walking distance is the most important.

Slightly more than half (54%) of all visits to the coast are made by car and a further 34% on foot; thus relative more people drive to the coast than drive to a heath (only 43% of all heath visits) (Table 2).

Although the estimated average annual visits per household to Other greenspaces (55.4 per year) is about the same as to the coast (54.3 per year), a much higher percentage of visits to Other greenspaces (such as parks and woodland) is made on foot (53%) compared to the percentage for coastal sites (34%).

Amongst the average 7.1 annual visits per household to Hengistbury Head, 60% of people come by car and a further 31% walk from home (Table 2).

Amongst our Dorset household survey responses, the vast majority (estimated 91%) of all visits to the New Forest were made by car with only 1% arriving on foot.

Summary of results relating to mode of transport used to visit different types of sites
There are as many visits made on foot to heaths as those made by people who drive. A higher proportion of people travelling to other greenspaces walk, whereas a higher proportion of visits to the coast, New Forest and Hengistbury are made by people who drive rather than walk.

5 Dog ownership, mode of transport and greenspace visitor rates

It may be important to know whether owning a dog affects not only the type of greenspace visited but also the mode of transport used to get there; for example do dog owners prefer to walk their dog to open spaces such as heaths?

Table 3 is an expansion of Table 2 to consider the estimated average annual visits made to each type of greenspace on foot, by car or other means, separately for households which own and do not own a dog. Overall, dog owners make an average of 289.5 visits per year to any type of greenspace compared to an average of 119.5 annual visits by households with a dog; this is a ratio of 2.38 (Table 3).The rate of visiting each type of greenspace by each mode of transport is higher for dog-owning households in every case (except for the relatively small number of visits to Hengistbury Head by 'Other' means which is probably by public transport which is awkward for dog owners) (Table 3(c)).

The ratio of greenspace visits by dog owners to visits by non dog-owners is greatest for heaths to which dog-owning households make over four times as many visits both on foot (ratio 4.03) and by car (ratio 4.34). In contrast, for coastal greenspace visits, although dog-owners make more visits than non-dog-owning households, they only make an estimated 28% more visits on foot and 55% more visits by car than households without a dog (Table 3).

Table 3 Mean annual visits per household to each type of greenspace arriving by foot, car or Other means (% of total visits to that type given in brackets), for households (a) without and (b) with a dog; (c) ratio of mean visits by households with a dog to mean visits by households without a dog

(a) Households without a dog (n=1173)

Transport mode	Heath	Coast	Other	Hengistbury	New Forest	Total
on Foot	8.7 (43%)	17.6 (35%)	19.7 (49%)	1.6 (32%)	0.1 (1%)	47.7 (40%)
by Car	8.2 (40%)	26.2 (52%)	13.4 (32%)	2.8 (55%)	3.2 (90%)	53.8 (45%)
Other	3.4 (17%)	6.4 (13%)	7.2 (18%)	0.7 (14%)	0.3 (9%)	18.0 (15%)
Total	20.4 (100%)	50.2 (100%)	40.3 (100%)	5.1 (100%)	3.5 (100%)	119.5 (100%)

(b) Households with dogs (n=291)

Transport mode	Heath	Coast	Other	Hengistbury	New Forest	Total
on Foot	35.0 (44%)	22.5 (35%)	68.5 (59%)	4.5 (30%)	0.1 (1%)	130.5 (45%)
by Car	35.7 (45%)	40.7 (58%)	39.6 (34%)	10.3 (68%)	7.6 (94%)	133.8 (46%)
Other	8.7 (11%)	7.6 (11%)	8.2 (7%)	0.3 (2%)	0.4 (5%)	25.2 (9%)
Total	79.4 (100%)	70.7 (100%)	116.2 (100%)	15.0 (100%)	8.2 (100%)	289.5 (100%)

(c) Ratio of mean visits of households with dogs to mean visits of households without dogs

Transport mode	Heath	Coast	Other	Hengistbury	New Forest	Total
on Foot	4.03	1.28	3.47	2.73	1.24	2.74
by Car	4.34	1.55	2.95	3.67	2.41	2.49
Other	2.54	1.18	1.14	0.41	1.40	1.40
Total	3.90	1.41	2.88	2.92	2.30	2.38

Summary of results relating to dog ownership and implications for visit rates

Dog owning households visit sites more frequently than those households without a dog. Other greenspace, the coast and heaths attract dog walkers. Other greenspace sites are the most heavily visited by dog walkers, especially those walking to sites. Heaths appear to disproportionally attract dog walkers compared to other kinds of site; there are four times as many dog walkers as non dog walkers visiting heaths.

6 Heath visitor rates in relation to area of heath within selected distance bands

As a preliminary analysis, we calculated the Spearman rank correlations between the annual number of visits to heath by a household and the total area of heath within selected distance bands (Table 4)[1].

The total number of heath visits per household is statistically significantly positively correlated (p<0.05) with the area of heath in all 500m or 1000m distance bands up to 8000m (Table 3), however the correlations are weaker above 4000m (we highlight correlations above 0.3 in the table). Amalgamating bands gives the highest correlation of total heath visits with heath area within the band up to 1500m (r_S = 0.379), but the correlation is almost as high with heath area within 3000m (r_S = 0.369) and within 5000m (r_S = 0.378) of the household.

Table 4 Spearman rank correlations between annual number of visits to any heath by a household (total, on foot, by car, other means) and the total area of heaths within selected distance bands of the household (correlations >0.3 highlighted in bold, correlations >0.051, >0.067 and >0.086 are statistically significant at probability p < 0.05, <0.01 and 0.001 respectively)

Distance band (m) for area of heath	Annual household visits to any heath Total	on Foot	by Car	Other
<500	**0.328**	**0.409**	0.116	0.085
500-1000	**0.357**	**0.440**	0.126	0.112
1000-1500	**0.371**	**0.452**	0.126	0.158
1500-2000	**0.337**	**0.422**	0.113	0.137
2000-2500	**0.317**	**0.375**	0.111	0.126
2000-3000	**0.316**	**0.307**	0.148	0.123
3000-4000	**0.304**	0.207	0.197	0.130
4000-5000	0.229	0.098	0.200	0.076
5000-6000	0.127	0.006	0.119	0.061
6000-7000	0.077	0.022	0.062	0.046
7000-8000	0.059	0.065	0.055	-0.003
8000-9000	0.050	0.045	0.060	0.020
9000-10000	0.062	0.053	0.066	0.024
10000-12500	0.043	0.073	0.029	0.013
12500-15000	-0.066	-0.037	-0.018	-0.034
<1000	**0.362**	**0.448**	0.127	0.113
1000-2000	**0.350**	**0.436**	0.117	0.144
<2000	**0.358**	**0.450**	0.146	0.142
<3000	**0.369**	**0.419**	0.148	0.141
500-1500	**0.375**	**0.461**	0.125	0.152
<1500	**0.379**	**0.466**	0.125	0.151
1500-3000	**0.347**	**0.383**	0.143	0.133
3000-5000	0.290	0.163	0.217	0.110
1500-5000	**0.366**	0.295	0.219	0.141
<5000	**0.378**	**0.316**	0.220	0.141
5000-10000	0.080	0.054	0.076	0.028
10000-15000	-0.005	0.028	0.009	-0.011

[1] Rank correlations (r_S) were used in preference to Pearson correlations as they are much less susceptible to the influence of one or a few very high outlier values of one or both variables and are unaffected by whether the correlation is calculated on the raw data values or log-transformed values

The annual number of heath visits per household made by walking from home to the site ("on foot") correlated most highly with the area of heath within 500m distance bands up to 2000m with the highest detected rank correlation being 0.466 for total heath area within 1500m of the household (Table 4).

Correlations of the estimated annual number of visits to heaths per household, made by car with heath area within specific distance bands are generally weaker than for visits on foot (Table 4), with rank correlations only greater than 0.2 for amalgamated distance bands in the range 1500-5000m.

Figure 6 shows the log-log relationship between the annual total heath visits per household and the area of heaths within 1500m. The fitted linear and locally-weighted (Lowess) regression lines (Minitab 15, 2007) highlight how average visitor rates increase with the amount of nearby heath, albeit with enormous variability between individual households (as might be expected).

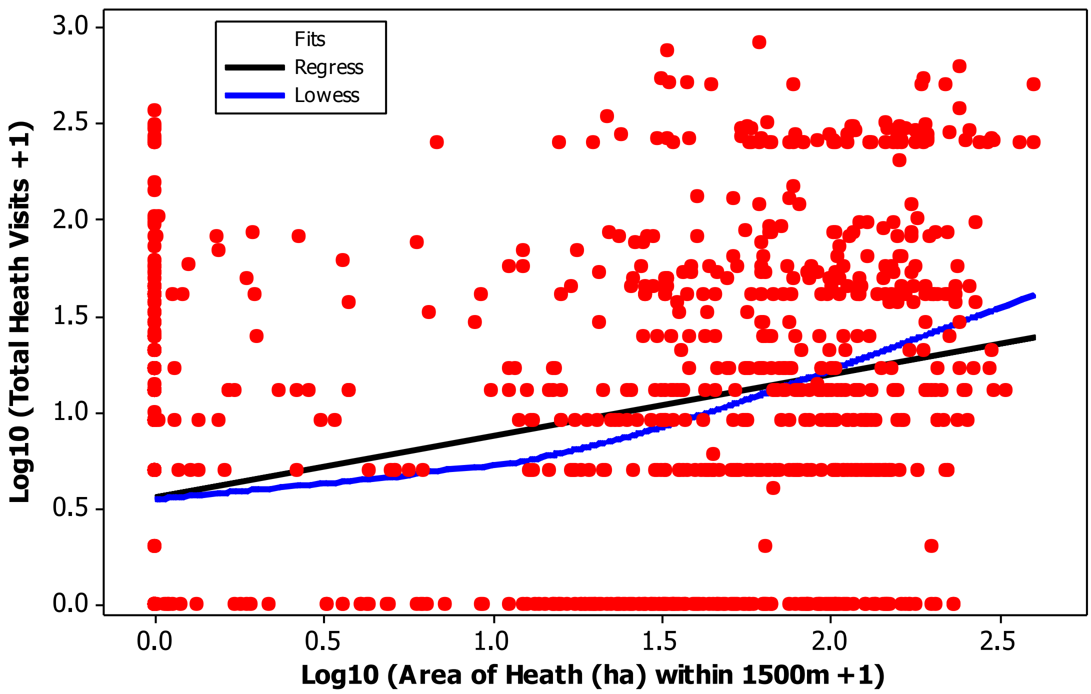

Figure 6 Relationship between annual heath visits per household and area of heath within 1500m of the household (both axes on Log10 (X+1) scale); together with the fitted linear (black) and lowess (blue) regression lines

The log-log linear regression relationship for the relationship in Figure 6 ((adjusted R^2 = 15.1%, test p<0.001) is (SE in brackets) :

$$\text{Log}_{10}\,(\text{Heath visits} + 1) = \underset{(0.024)}{0.564} + \underset{(0.020)}{0.318}\ \text{Log}_{10}\,(\text{Heath area within 1500m} + 1\text{ha})$$

This can be re-written as:

$$\text{Heath Visits per household} + 1 = 3.66\,(\text{Heath area within 1500m} + 1\text{ha})^{0.318}$$

Using this equation predicts that on average, if the amount of heath within 1500m doubles, the average annual number of visits to heaths per household increases by 25% ($2^{0.318} = 1.25$).

This example simple regression model is extended later in this study to include the effect of multiple distance bands and the nearby areas of coast and other types of greenspace.

The area of heath within 1500m was grouped into three classes (0, 1-60, 61-400 ha.) to help show the general pattern of increase of heath visitor rates with the amount of nearby heath area (Figure 7). The median number of annual visits per household to heaths is 4, 8 and 16 for the above three classes of area of heath within 1500m; for the 762 (52%) of households with no heath within 1500m, they still manage an average of 12.2 heath visits per annum which must all be over distances greater than 1500m (ignoring distance inaccuracies due to using postcode grid references for dwelling positions).

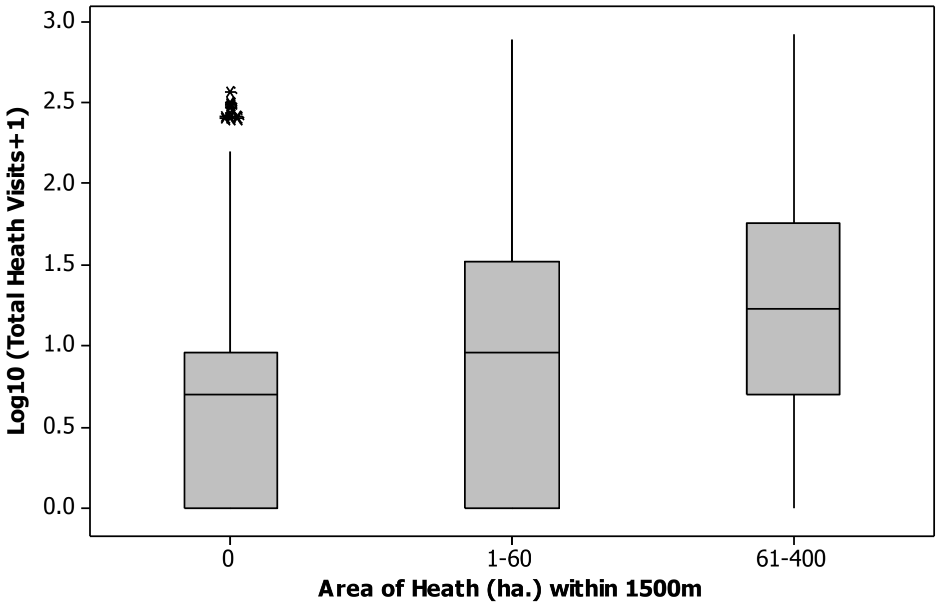

Figure 7 Boxplot of Log10 (Annual Heath visits per household + 1) in grouped by area of heath (ha.) within 1500m of the household

From the survey of visitors to heath access points, Clarke et al (2006) found that 91% of people arriving on foot to a heath lived within 1500m, while only 19% of people arriving by car lived within 1500m.

As this household survey found roughly equal proportions of people went to heaths on foot as by car (Table 2), combining these statistics implies that an estimated 55% of all visits to Dorset heaths are made by people living within 1500m.

The majority of the following exploratory analyses of effects of non-heath greenspace area concentrate on allowing for the area of heath within 1500m of households on the number of heath visits.

Summary of how the area of heathland surrounding a postcode determines visitor rates to heathland

People living in postcodes surrounded by more heathland visit heathland more. Correlations between the number of visits and the amount of heathland surrounding postcodes are strongest using a distance band of 1500m, but remain strong to 5km. An increase in the amount of heathland does not equate to a proportional increase in visits to heaths, for example people living at postcodes with double the area of heathland within 1500m on average make 25% more visits to heathland.

7 Heath visitor rates in relation to area of coast and other greenspaces within selected distance bands

The rate of visiting heaths per household declines with the amount of nearby coast with negative correlations stronger than -0.2 for most distance bands within 3000m of the household (Table 5(a)).

These small but statistically significant negative correlations of heath visits with the area of nearby coast were stronger for the number of visits made on foot than for the number made by car. This is likely to be because people drive a wide range of distances to visit coastal sites, but the most frequent visitors tend to live closer and be more likely to walk there.

Table 5 Spearman rank correlations between annual number of visits to any heath by a household (total, on foot, by car, other means) and the total area of (a) coast greenspace and (b) 'Other' greenspace within selected distance bands of the household (correlations <-0.2 highlighted in bold, correlations <-0.051, <-0.067 and <-0.086 are statistically significant at probability $p < 0.05$, <0.01 and 0.001 respectively)

(a) Heath visits in relation to area of coast greenspace within distance bands				(b) Heath visits in relation to area of 'Other' greenspace within distance bands			
Distance (m)	Total	on Foot	by Car	Distance (m)	Total	on Foot	by Car
<500	-0.14	-0.11	-0.09	<500	-0.04	0.01	-0.04
500-1000	**-0.20**	-0.19	-0.11	500-1000	-0.06	-0.01	-0.06
1000-1500	**-0.25**	**-0.24**	-0.14	1000-1500	-0.05	-0.04	-0.05
1500-2000	**-0.26**	**-0.25**	-0.14	1500-2000	-0.04	-0.06	-0.01
2000-2500	**-0.22**	**-0.23**	-0.10	2000-2500	-0.01	-0.01	0.01
2000-3000	**-0.21**	**-0.21**	-0.09	2000-3000	0.05	0.04	0.04
3000-4000	-0.17	-0.18	-0.09	3000-4000	0.13	0.10	0.07
4000-5000	-0.11	-0.10	-0.06	4000-5000	0.11	0.10	0.08
5000-6000	-0.08	-0.04	-0.05	5000-6000	0.18	0.18	0.08
6000-7000	-0.05	0.00	-0.03	6000-7000	**0.22**	**0.21**	0.12
7000-8000	-0.10	-0.07	-0.05	7000-8000	**0.24**	**0.24**	0.13
8000-9000	-0.09	-0.08	-0.01	8000-9000	**0.22**	**0.21**	0.13
9000-10000	-0.05	-0.03	-0.01	9000-10000	**0.24**	**0.21**	0.15
10000-12500	-0.10	-0.06	-0.04	10000-12500	0.18	0.16	0.14
12500-15000	-0.09	-0.07	-0.04	12500-15000	0.17	0.17	0.09
<1000	**-0.20**	-0.19	-0.11	<1000	-0.05	0.01	-0.06
1000-2000	**-0.26**	**-0.26**	-0.14	1000-2000	-0.05	-0.06	-0.03
<2000	**-0.26**	**-0.26**	-0.14	<2000	-0.06	-0.04	-0.05
<3000	**-0.25**	**-0.25**	-0.11	<3000	-0.02	-0.02	-0.01
500-1500	**-0.25**	**-0.23**	-0.14	500-1500	-0.06	-0.03	-0.06
<1500	**-0.25**	**-0.23**	-0.14	<1500	-0.06	-0.02	-0.07
1500-3000	**-0.23**	**-0.24**	-0.10	1500-3000	0.00	-0.01	0.01
3000-5000	-0.12	-0.13	-0.06	3000-5000	0.15	0.12	0.10
1500-5000	-0.18	-0.19	-0.09	1500-5000	0.12	0.10	0.07
<5000	**-0.20**	**-0.21**	-0.10	<5000	0.10	0.09	0.05
5000-10000	-0.02	0.00	0.01	5000-10000	**0.27**	**0.26**	0.15
10000-15000	-0.12	-0.10	-0.05	10000-15000	0.19	0.17	0.13

There are also some statistically significant rank correlations between the annual number of heath visits per household and the total area of 'Other' greenspaces (parks, woodland, etc), but the largest of these are unexpected positive correlations greater than 0.2 with the amount of Other greenspace in the range 5000-10000m from the household (Table 5(b)). The simple rank correlations of heath visitor rates with area of 'Other' greenspace within distance bands up to 2000m are negative, but weak. These effects will be assessed further in the joint modelling of all types of greenspace and household characteristics.

Summary of how other types of greenspace (coast and 'other') influence visitor rates to heathland
The more coast close (we highlight to 3km) to where people live, the fewer visits people make to heaths. These correlations are strongest for people who travel to the heaths on foot. There is little evidence, and certainly no consistent negative correlations, that the amount of 'Other' greenspace surrounding a postcode has any negative impact on how frequently people at those postcodes visit heaths.

8 Combined impact of different types of greenspace on heath visit rates

Coast greenspace

There is some indication that the mean annual number of heath visits is less when there is some or more coast within 3000m of the household; and this applies regardless of the amount of heath within 1500m, although it is clearest whether there is little or no heath within 1500m (Figure 8). However, with the large variability in individual household visitor rates, Kruskal-Wallis rank tests (adjusted for tied values) found significant differences in median visitor rates between coast area groups solely for the situation where there was no area of heath within 1500m of the household (p<0.001) (Figure 8).

This might suggest that if there is some heath nearby (i.e. within 1500m) then the presence of coast within 3km does not generally reduce the household's total visitor rates to heaths.

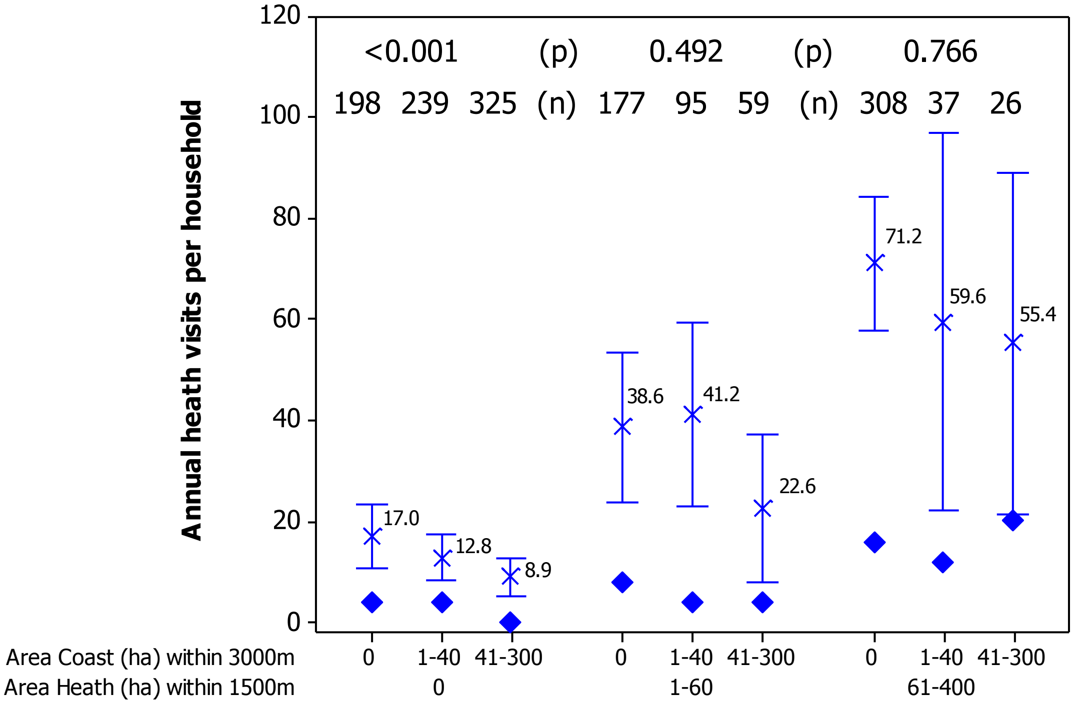

Figure 8 Means (labelled X) and their 95% confidence limits and medians (♦) of annual number of heath visits per household grouped by both area of heath (ha.) within 1500m and area of coast greenspace within 3000m of the household (n = households per group); p = Kruskal-Wallis test probability for effect of coast greenspace area group within each heath area group

'Other' greenspace

There are no consistent significant differences in annual heath visits per household in relation to the amount of 'Other' greenspace (parks, woodland, etc) within 3000m for any level of the amount of heath within 1500m of the household (Figure 9); i.e. even when there is no heath within 1500m and lots of 'Other' greenspace surrounding a particular postcode, households at that postcode do not visit heaths any less than postcodes surrounded by much smaller amounts of 'Other' greenspace. At intermediate levels of heath within 1500m (1-60ha), differences were just statistically significant (p = 0.049), arising from median annual heath visits of 8, 4 and 8 according to whether the amount of 'Other ' greenspace was below, equal to, or above the range 191-250ha. This result would suggest that households surrounded by a moderate amount of heath and lots of 'Other' greenspace visit heaths more than those surrounded by moderate amounts of heath and moderate amounts of 'Other' greenspace. There is no practical logic to this result and it is treated as statistical chance.

Thus there is no obvious evidence of a consistent effect of the amount of nearby 'Other 'greenspace on the rate of visiting heaths. However, this 'Other' category of greenspace excludes the special greenspaces of Hengistbury Head and the New Forest, whose effect will be included within the subsequent modelling along with the factors representing characteristics of households.

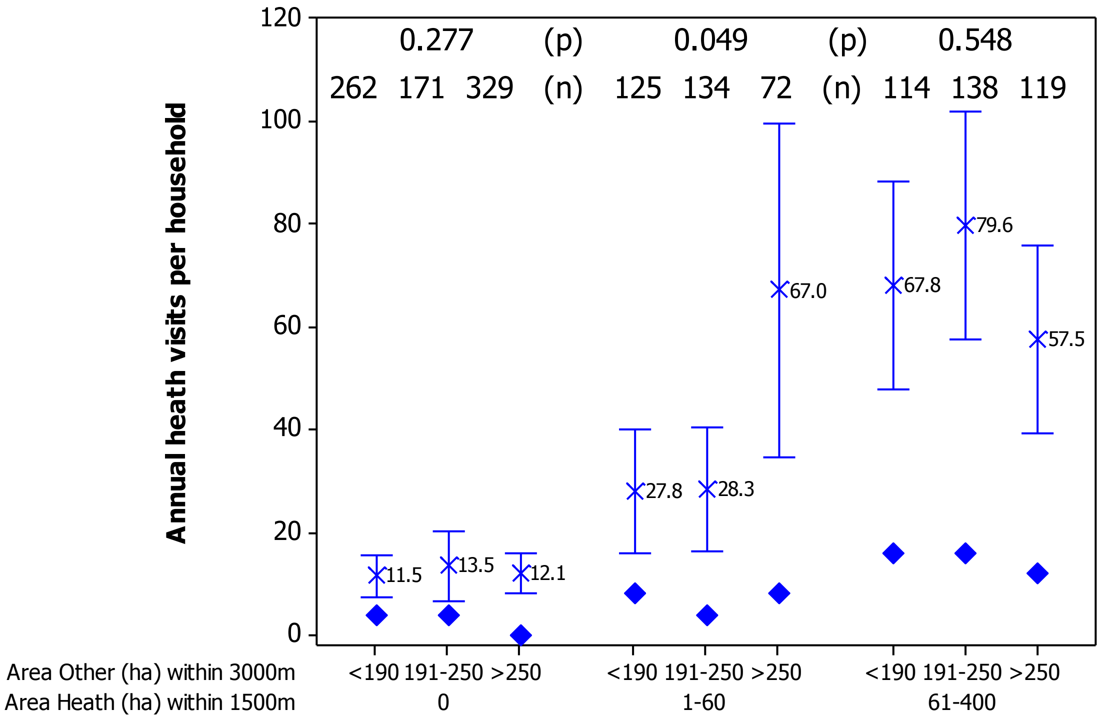

Figure 9 Means (labelled X) and their 95% confidence limits and medians (♦) of annual number of heath visits per household grouped by both area of heath (ha.) within 1500m and area of 'Other' greenspace within 3000m of the household (n = households per group); p = Kruskal- Wallis test probability for effect of 'Other' greenspace area group within each heath area group

All 'Alternative' (non-heath) greenspace combined

The lack of any detectable consistent or strong relationship between the amount of either coast or 'Other' greenspace near households on their overall rate of visiting heaths may be partly because, the type of alternative green space is not very important, just having other places to go, at least for regular local visitors, walking to the site, perhaps with their dog.

Therefore, we calculated new variables measuring the total area of all alternative (i.e. non-heath) greenspace within the same range of selected distance bands of each household. This combined areas of Coastal and Other greenspaces with Hengistbury Head and the New Forest.

The rank correlations between the annual number of heaths visits per household and the total area of all 'Alternative' greenspaces within a range of distance bands are all weak (all less than +/-0.14), although with the large number of households involved some positive and negative correlations are statistically significant (Table 6).

Table 6 Spearman rank correlations between annual number of visits to any heath by a household (total, on foot, by car, other means) and the total area of all 'Alternative' greenspaces (Coast, 'Other', Hengistbury Head and the New Forest) within selected distance bands of the household (correlations <-0.1 are highlighted in bold, correlations >0.051, >0.067 and >0.086 are statistically significant at probability p < 0.05, <0.01 and 0.001 respectively)

Distance (m) for area of 'Alternative' greenspace	Annual household visits to any heath			
	Total	on Foot	by Car	Other
<500	-0.091	-0.031	-0.067	-0.026
500-1000	**-0.115**	-0.065	-0.096	-0.043
1000-1500	**-0.108**	**-0.112**	-0.073	-0.048
1500-2000	-0.094	**-0.127**	-0.028	-0.070
2000-2500	-0.055	-0.080	0.004	-0.047
2000-3000	0.005	-0.027	0.034	-0.027
3000-4000	0.067	0.032	0.042	0.026
4000-5000	0.063	0.062	0.045	0.012
5000-6000	0.110	0.133	0.020	0.038
6000-7000	0.128	0.151	0.046	0.042
7000-8000	0.116	0.168	0.017	0.054
8000-9000	0.089	0.139	-0.001	0.046
9000-10000	0.100	0.132	0.014	0.043
10000-12500	-0.020	0.006	-0.026	-0.018
12500-15000	-0.082	-0.026	-0.104	-0.028
<1000	**-0.119**	-0.053	-0.103	-0.040
1000-2000	**-0.110**	**-0.137**	-0.050	-0.072
<2000	**-0.133**	**-0.133**	-0.076	-0.081
<3000	**-0.103**	**-0.127**	-0.035	-0.074
500-1500	**-0.124**	**-0.104**	-0.093	-0.056
<1500	**-0.130**	-0.098	-0.101	-0.054
1500-3000	-0.063	-0.099	0.001	-0.061
3000-5000	0.083	0.063	0.057	0.016
1500-5000	0.003	-0.036	0.020	-0.026
<5000	-0.013	-0.045	0.008	-0.032
5000-10000	0.139	0.194	0.027	0.046
10000-15000	-0.095	-0.056	-0.095	-0.035

The largest significant negative correlations occur with the total area of 'Alternative' greenspace within distance bands up to 2000m from households, and these are most pronounced for rates of visiting heaths on foot (Table 6).

By grouping all households into three equally-sized groups based on their total area of 'Alternative' greenspace within 2000m, we can assess any relationship of alternative greenspace area with rates of visiting heaths (Figure 10). There are no statistically significant relationships between amount of alternative greenspace within 2000m and the number of heath visits per household, neither when there is no heath, some heath (1-60ha.) or much (61-400ha.) heath within 1500m of the household (Figure 10).

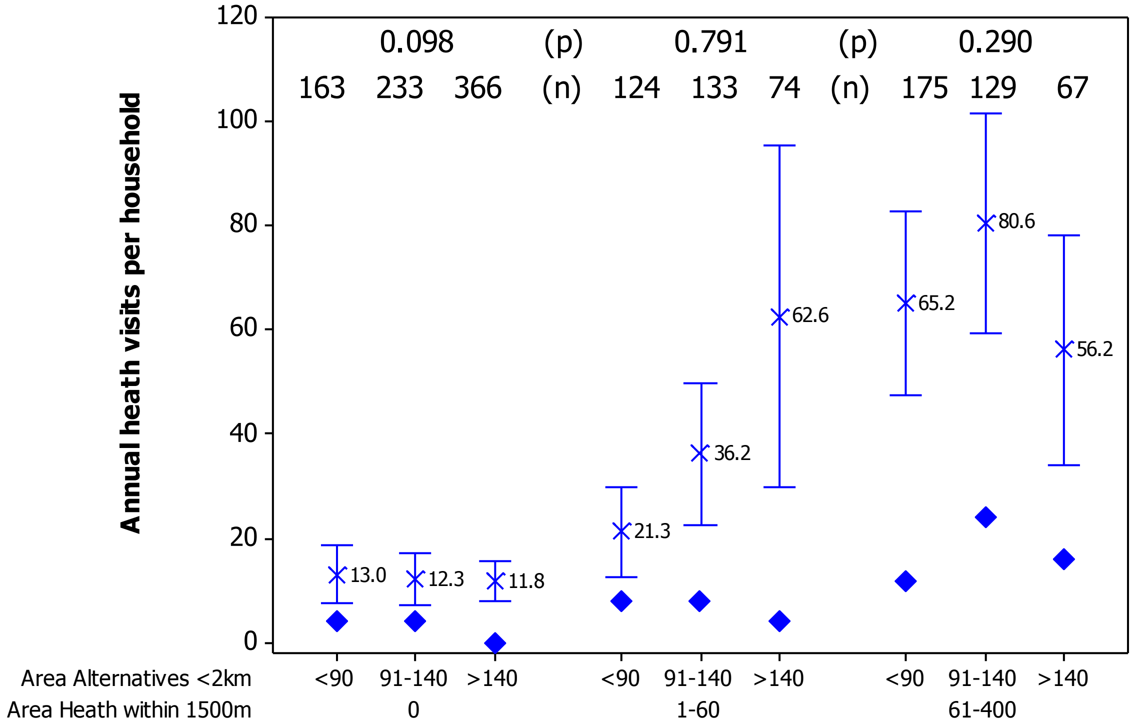

Figure 10 Means (labelled X) and their 95% confidence limits and medians (♦) of annual number of heath visits per household grouped by both area of heath (ha.) within 1500m and area of all 'Alternative' greenspace within 2000m of the household (n = households per group); p = Kruskal- Wallis test probability for effect of 'Alternative' greenspace area group within each heath area group

Summary

In this section we explore the combined effect on heath visit rates of different areas of different types of habitat. Coastal greenspace seems to 'deflect' people from heaths (i.e. there is an associated reduction in heath visitor rates) only when there is no heath nearby (within 1500m). There is no effect of 'Other' greenspaces in reducing visitor rates to heaths, regardless of how much heath there is surrounding a postcode.

9 Heath visits in relation to presence of greenspace types within distance limits

In the next analyses, we examined whether the mere presence of alternative greenspace, (rather than its actual area) within critical distances can influence the likelihood and number of heath visits made by a household. Specifically we classified all households according to whether there was any heath within a particular distance and whether there was any non-heath greenspace of a particular type (either Coast, Other or Hengistbury Head) within selected distances of the household. To assess the effect on attracting visitors away from nearby heath we chose distances of 500m and 1500m for the presence of heath, but selected a wide range of distances away (500m up to 15km) for the presence of alternative greenspace areas. Statistical tests for differences in the percentages of households visiting heaths were based on Fisher's exact test for two proportions and differences in the number of heaths visits per household were based on Mann-Whitney tests for differences based on ranked values (Minitab 15, 2007).

Presence of Coast

When there is no heath within 500m of a household, the presence of coast greenspace within any distance limit from 500m outwards up to 15km has a statistically significant reduction on both the likelihood of visiting a heath and the number of visits in a year (Table 7). Moreover, the probability of households without coast within a limit visiting any heaths increases from 59% for a coast distance limit of 500m up to 83% for coast distance limit of 10km, whereas the probability of visiting heaths remain roughly constant (48-57%) when coast greenspace is present within any distance limit from 500m to 15km (Table 7).

However, when there is some heath within 500m of a household, there is no statistical significant effect of the presence of coast greenspace within any distance limit on either the likelihood or rate of visiting heaths (the only exception was for coast within the largest measured distance limit of 15km) (Table 7).

When there was no heath within 1500m of a household, the presence of coast within outer limits ranging from 1.5km to 15km reduced the likelihood of a household visiting a heath with a year and the presence of coast within outer limits ranging from only 500m up to 15km statistically significantly reduced the annual number of visits made to heaths (Table 8).

When heath was present within 1500m of a household, the probability of visiting heaths was higher at all except the closest coast limits, but this only statistically significant for coast distance limits of 3km, 10km and 15km. The average annual number of visits to heaths was also statistically significantly lower when there was coast greenspace present within any distance limit from 1km up to 15km; for example the percentages visiting heaths amongst households with, and without, coast were 31.4% (n=43 households) and 55.1% (n=659) respectively for a coast limit of 1km and 47.2% (n=582) and 85.0% (n=120) respectively for a coast limit of 10km (Table 8).

Table 7 Percentage of households visiting heaths and mean annual heath visits per household classified by whether or not any heath is within 500m and any coast is within selected distances of the household; p = probability of test for effect of presence on coast on probability and number of heath visits (cases where p<0.05 in bold)

Heath within 500m ?	Coast present	Coast present within : 0.5km	1km	1.5km	2km	3km	5km	10km	15km
		(a) Percentage of households visiting heaths							
No Heath	No Coast	**59**	**61**	**64**	**65**	**66**	**71**	**83**	**80**
	Coast	**50**	**50**	**48**	**50**	**53**	**55**	**56**	**57**
	test *p*	0.028	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002
Heath present	No Coast	85	85	86	86	85	83	87	**100**
	Coast	100	90	79	81	86	87	85	**84**
	test *p*	1.000	1.000	0.405	0.372	1.000	0.420	0.841	0.033
		(b) Mean annual heath visits per household							
No Heath	No Coast	**21.6**	**24.0**	**26.2**	**28.3**	**29.3**	**35.1**	**59.5**	**46.2**
	Coast	**12.2**	**10.3**	**10.0**	**10.9**	**14.4**	**16.4**	**16.9**	**19.1**
	test *p*	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Heath present	No Coast	75.1	75.9	79.9	83.4	80.4	66.8	95.7	**153.9**
	Coast	290.0	73.6	36.3	32.9	61.5	82.3	71.0	**69.6**
	test *p*	1.000	0.593	0.076	0.091	0.449	0.340	0.051	0.001
		(c) Number of responding households in each category							
No Heath	No Coast	982	835	724	615	446	236	88	46
	Coast	169	316	427	536	705	915	1063	1105
Heath present	No Coast	312	303	284	266	237	131	61	23
	Coast	1	10	29	47	76	182	252	290

Table 8 Percentage of households visiting heaths and mean annual heath visits per household classified by whether or not any heath is within 1500m and any coast is within selected distances of the household; p = probability of test for effect of presence on coast on probability and number of heath visits (cases where p<0.05 in bold)

Heath within 1500m ?	Coast present	Coast present within : 0.5km	1km	1.5km	2km	3km	5km	10km	15km
		(a) Percentage of households visiting heaths							
No Heath	No Coast	54	54	**58**	**59**	**59**	**65**	**72**	**80**
	Coast	48	49	**47**	**48**	**50**	**51**	**52**	**52**
	test *p*	0.211	0.203	0.005	0.003	0.032	0.015	0.036	0.037
Heath present	No Coast	76	77	77	77	**79**	79	**88**	**89**
	Coast	91	65	65	69	**71**	75	**74**	**75**
	test *p*	0.474	0.095	0.028	0.065	0.035	0.204	0.001	0.020
		(b) Mean annual heath visits per household							
No Heath	No Coast	**12.8**	**14.0**	**16.2**	**17.8**	**17.0**	**19.5**	**29.9**	**21.1**
	Coast	**10.0**	**9.3**	**8.3**	**8.9**	**10.5**	**11.2**	**11.5**	**12.1**
	test *p*	0.033	0.020	<0.001	<0.001	0.002	0.001	0.005	0.049
Heath present	No Coast	53.4	**55.1**	**56.4**	**58.0**	**59.3**	55.5	**85.0**	**99.1**
	Coast	69.5	**31.4**	**29.4**	**29.5**	**41.0**	52.5	**47.2**	**49.9**
	test *p*	0.350	0.029	0.004	0.020	0.003	0.133	<0.001	<0.001
		(c) Number of responding households in each category							
No Heath	No Coast	603	479	378	286	198	93	29	15
	Coast	159	283	384	476	564	669	733	747
Heath present	No Coast	691	659	630	595	485	274	120	54
	Coast	11	43	72	107	217	428	582	648

Presence of 'Other' greenspace

A problem with trying to assess the effect of the presence of 'Other' greenspace (parks, etc) within critical distances household heath visits is that there were only two, one or no responding households which had no 'Other' greenspace within distance limits of 1.5km or more (Table 9(c) and Table 10(c)). However, there was no apparent effect of the presence of 'Other' greenspace within either 0.5km or 1km on reducing either the likelihood or frequency of visiting heaths regardless of whether heath was present or not within either 500m (Table 9) or 1500m (Table 10). The Mann-Whitney test gave statistically higher heath visiting rates when there was no 'Other' greenspace within limits of 1.5km (or 2km) and heath was present within 1500m, but this was based on just two households with estimated annual heath visits of 80 and 306 which were higher than 85% and 100% of all 700 households with some 'Other' greenspace within 1.5km (Table 10).

Presence of Hengistbury Head

When no heath was present within 500m of a household, the presence of Hengistbury Head within distance limits from 1.5km onwards statistically significantly reduced both the likelihood and annual rate of visiting any heaths (Table 11). When Hengistbury Head was present within any outer limit ranging from 1.5km to 15km, the percentage of households visiting heaths varied from 42-53% but when absent the percentage varied from 59% up to 73% (Table 11).

There were no responding households which had heath within either 500m or 1500m that were within 2km of Hengistbury Head and therefore it was not possible to test for the effect of Hengistbury Head on heath visiting rates to households with heath within 500m or 1500m (Table 11 and Table 12).

However, when no heath was present within 1500m, the presence of Hengistbury Head within distance limits of 3km, 5km, 10km or 15km statistically significantly reduced the percentage of households visiting heaths from 55-71% down to 40-48% and the average heath visits per year from 13.7-25.3 down to 6.6-9.2 (Table 12). The presence of heath within 1500m of a household increased both the likelihood and annual frequency of visiting heaths was higher, but amongst these households, both the likelihood and frequency were statistically less when Hengistbury Head was within limits of 5km, 10km or 15km (Table 12).

Summary of how the presence (rather than amount) of different types of greenspace influences heath visitor rates

The presence of nearby coast greenspace reduces both the likelihood of households visiting heaths and their annual number of heath visits, this occurs at all coast distance limits from 0.5-15km when the is no heath within 500m and for a wide range of coast distance limits both when there is and is not any heath within 1500m of the household.

There is no detectable effect of the presence of 'Other' greenspace on either the likelihood or rate of visiting heaths. However, this may be partly due to the way in which we lumped together all non-coast greenspaces and kept Hengistbury Head and the new Forest separate, and also due to the fact that, as formed, there were very few or no households which did not have some 'Other' greenspace within 1.5km making it impossible to test for effects of 'Other' greenspace with any higher distance limits.

The presence of Hengistbury Head within 1.5km and within 3km reduces both the likelihood and rate of visiting heaths regardless of whether or not there is any heath within 500m or 1500m respectively.

Table 9 Percentage of households visiting heaths and mean annual heath visits per household classified by whether or not any heath is within 500m and any 'Other' greenspace (parks, etc) is within selected distances of the household; p = probability of test for effect of presence on 'Other' greenspace on probability and number of heath visits (cases where p<0.05 in bold)

Heath within 500m ?	'Other' present	'Other' greenspace present within : 0.5km	1km	1.5km	2km
(a) Percentage of households visiting heaths					
	No Other	61	70	100	100
No Heath	Other	58	58	58	58
	test *p*	0.544	0.533	1.000	1.000
	No Other	88	86	100	100
Heath present	Other	85	85	85	85
	test *p*	0.547	1.000	1.000	1.000
(b) Mean annual heath visits per household					
	No Other	19.6	48.6	306.0	306.0
No Heath	Other	20.3	19.9	19.9	19.9
	test *p*	0.755	0.110	1.000	1.000
	No Other	101.7	28.0	80.0	80.0
Heath present	Other	69.7	76.9	75.8	75.8
	test *p*	0.398	0.806	1.000	1.000
(c) Number of responding households in each category					
No Heath	No Other	110	10	1	1
	Other	1041	1141	1150	1150
Heath present	No Other	60	7	1	1
	Other	253	306	312	312

Table 10 Percentage of households visiting heaths and mean annual heath visits per household classified by whether or not any heath is within 1500m and any 'Other' greenspace (parks, etc) is within selected distances of the household; p = probability of test for effect of presence on 'Other' greenspace on probability and number of heath visits (cases where p<0.05 in bold)

Heath within 1500m ?	'Other' present	'Other' greenspace present within : 0.5km	1km	1.5km	2km
(a) Percentage of households visiting heaths					
	No Other	60	50	---	---
No Heath	Other	52	53	52	52
	test *p*	0.192	1.000	---	---
	No Other	80	91	100	100
Heath present	Other	76	76	76	76
	test *p*	0.427	0.474	1.000	1.000
(b) Mean annual heath visits per household					
	No Other	14.6	10.0	---	---
No Heath	Other	12.0	12.3	12.2	12.2
	test *p*	0.293	0.976	---	---
	No Other	78.7	56.5	**193.0**	**193.0**
Heath present	Other	50.0	53.6	**53.3**	**53.3**
	test *p*	0.158	0.097	0.045	0.045
(c) Number of responding households in each category					
No Heath	No Other	80	6	0	0
	Other	682	756	762	762
Heath present	No Other	90	11	2	2
	Other	612	691	700	700

Table 11 Percentage of households visiting heaths and mean annual heath visits per household classified by whether or not any heath is within 500m and Hengistbury Head (HH) is within selected distances of the household; p = probability of test for effect of presence on Hengistbury Head on probability and number of heath visits (cases where p<0.05 in bold)

Heath within 500m ?	**HH present**	**Hengistbury Head (HH) present within :**							
		0.5km	**1km**	**1.5km**	**2km**	**3km**	**5km**	**10km**	**15km**
(a) Percentage of households visiting heaths									
No Heath	No HH	58	59	**59**	**59**	**61**	**63**	**71**	**73**
	HH	67	43	**42**	**45**	**44**	**42**	**45**	**53**
	test *p*	0.604	0.081	0.009	0.010	<0.001	<0.001	<0.001	<0.001
Heath present	No HH	85	85	85	85	85	85	85	88
	HH	---	---	---	---	100	92	85	84
	test *p*	---	---	---	---	1.000	0.700	1.000	0.339
(b) Mean annual heath visits per household									
No Heath	No HH	20.2	**20.5**	**20.9**	**21.3**	**21.9**	**23.2**	**29.6**	**32.4**
	HH	23.6	**11.1**	**9.0**	**8.0**	**10.7**	**11.2**	**10.6**	**16.3**
	test *p*	0.839	0.022	0.003	0.001	<0.001	<0.001	<0.001	<0.001
Heath present	No HH	75.8	75.8	75.8	75.8	76.0	77.5	78.9	72.7
	HH	---	---	---	---	12.0	38.0	58.9	78.3
	test *p*	---	---	---	---	---	0.626	0.597	0.295
(c) Number of responding households in each category									
No Heath	No HH	1136	1116	1087	1054	977	866	580	278
	HH	15	35	64	97	174	285	571	873
Heath present	No HH	313	313	313	313	312	300	265	137
	HH	0	0	0	0	1	13	48	176

Table 12 Percentage of households visiting heaths and mean annual heath visits per household classified by whether or not any heath is within 1500m and Hengistbury Head (HH) is within selected distances of the household; p = probability of test for effect of presence on Hengistbury Head on probability and number of heath visits (cases where p<0.05 in bold)

Heath within 1500m ?	**HH present**	**Hengistbury Head (HH) present within :**							
		0.5km	**1km**	**1.5km**	**2km**	**3km**	**5km**	**10km**	**15km**
(a) Percentage of households visiting heaths									
No Heath	No HH	52	53	53	54	**55**	**58**	**67**	**71**
	HH	67	43	42	45	**42**	**40**	**43**	**48**
	test *p*	0.306	0.299	0.090	0.157	0.005	<0.001	<0.001	<0.001
Heath present	No HH	76	76	76	76	77	**77**	**80**	**82**
	HH	---	---	---	---	59	**63**	**63**	**73**
	test *p*	---	---	---	---	0.143	0.026	<0.001	0.005
(b) Mean annual heath visits per household									
No Heath	No HH	12.0	12.3	12.5	12.8	**13.7**	**14.1**	**18.5**	**25.3**
	HH	23.6	11.1	9.0	8.0	**6.6**	**8.4**	**8.3**	**9.2**
	test *p*	0.383	0.146	0.061	0.065	0.001	<0.001	<0.001	<0.001
Heath present	No HH	53.6	53.6	53.6	53.6	53.8	**55.4**	**59.4**	**56.4**
	HH	---	---	---	---	49.5	**31.9**	**32.9**	**51.9**
	test *p*	---	---	---	---	0.059	0.013	<0.001	0.005
(c) Number of responding households in each category									
No Heath	No HH	747	727	698	665	604	515	296	143
	HH	15	35	64	97	158	247	466	619
Heath present	No HH	702	702	702	702	685	651	549	272
	HH	0	0	0	0	17	51	153	430

10 Regression modelling of heath visitor rates

The number of visits to each type of greenspace (per household) was estimated by converting the questionnaire categorical responses of frequency of visiting (i.e. daily, weekly, etc.) into estimates of the quantitative total number of visits to each type of greenspace by each household (see Table 3 in the original report).

We then tested which variables are significant predictors of this visitor rate, per household. Our regression models fit the best multiple linear relationship between the annual total number of heath visits by a household and a selected set of variables measuring characteristics of the household (e.g. dog-owning or not) and distance to, or amounts of each type of greenspace within selected distance bands of the household.

The results of optimal models in each sub-section are presented; for each variable involved we give its regression coefficients, the standard error of the coefficient and the test *p* value measuring the likelihood of an effect of this size by chance if this variable had no real additional effect on heath visiting rates once the effect of all the other variables involved in this regression model have been allowed for. The overall fit of model is measured by the cross-validation R^2 (R^2_{cv}), for further details see methods.

Models involving area of each greenspace within distance bands

In our regression modelling, we have tried to model and predict the annual number of visits to heaths by each household as a function of household characteristics and the area of heath and area of alternative greenspaces within critical distance bands.

We developed a range of regression models introducing and testing factors sequentially in the following order:

(i) Dog Owner (No=0 /Yes=1)

(ii) Area (ha.), Log_{10}(Area) and number of heath patches within distance bands

(iii) Presence of Hengistbury Head and the New Forest within selected distance bands

(iv) Area (ha.) and Log_{10}(Area) of Coastal greenspace within selected distance bands

(v) Area (ha.), Log_{10}(Area) of Other greenspaces within distance bands

The Log(Area) variables were actually Log_{10}(Area + 1) to overcome the problem of zero areas within distance bands for some households; the selected distance bands were as in Table 4.

The best regression model (Table 13) involving the area of 'Other' greenspaces within a selected distance was one involving the area of 'Other' greenspaces within 5000m of a household, namely:

$$\begin{aligned}Log_{10}(\text{Heath Visits} +1) = \; & 1.093 + 0.491 \text{ (if Dog Owner)} + 0.506\, Log_{10}(\text{Heath area within 500m}) \\ & + 0.247\, Log_{10}(\text{Heath area within 500-5000m}) \\ & - 0.199 \text{ (if Hengistbury Head within 10km)} \\ & - 0.139\, Log_{10}(\text{Coast greenspace area within 15km}) \\ & - 0.246\, Log_{10}(\text{Other greenspace area within 5km})\end{aligned}$$

However, the partial regression coefficient for the 'Other' greenspace area term was not quite statistically significant at the standard 0.05 probability level with p=0.052 and p=0.071 in the models which respectively do and do not allow for the increased use of heaths by households with a dog (Table 13). Moreover, in alternative versions of the above model, the equivalent partial regression coefficients for the Log_{10} area of 'Other' greenspace within all shorter distances (1km, 1.5km, 2km or 3km) were not significant (*p* = 0.604, 0.715, 0.560 and 0.166 respectively), nor was it significant using longer distances (10km, *p* = 0.543). Therefore, we conclude that there is no detectable effect of the total area of all 'Other' greenspaces within any distance of households on heath visiting rates.

Table 13 Best-available summary regression model for predicting (log10) annual number of heath visits per household, involving area of Coast and 'Other' greenspaces and (a) allowing for and (b) ignoring dog ownership

Predictor	Coefficient	SE	t	P
(a) allowing for dog ownership (R^2_{cv} =27.2%)				
Constant	1.092600	0.353100	3.09	0.002
Dog Owner	0.491240	0.042350	11.60	<0.001
Log_{10}(Heath area within 500m)	0.506100	0.044750	11.31	<0.001
Log_{10}(Heath area within 500-5000m)	0.247050	0.036140	6.84	<0.001
Hengistbury Head within 10km (no=0,yes=1)	-0.199320	0.042820	-4.65	<0.001
Log_{10}(Coast greenspace area within 15km)	-0.138900	0.032090	-4.33	<0.001
Log_{10}(Other greenspace area within 5km)	-0.246400	0.126500	-1.95	0.052
(b) ignoring dog ownership (R^2_{cv} =20.6%)				
Constant	1.214800	0.368700	3.29	0.001
Log_{10}(Heath area within 500m)	0.508220	0.046750	10.87	<0.001
Log_{10}(Heath area within 500-5000m)	0.245430	0.037750	6.50	<0.001
Hengistbury Head within 10km	-0.213800	0.044720	-4.78	<0.001
Log_{10}(Coast greenspace area within 15km)	-0.152870	0.033500	-4.56	<0.001
Log_{10}(Other greenspace area within 5km)	-0.239000	0.132200	-1.81	0.071

Summary of regression modelling

The annual numbers of visits to heaths per household increase with the amount of heath within critical distance bands and the best parsimonious regression models involve the area of heath within two distance bands, 0-500m and 500-5000m, of the household.

The presence of Hengistbury Head can reduce the number of visits to heaths (optimally represented by the presence or absence of Hengistbury within 10km of a household). The area of coast greenspace can also reduce heath visits (optimal distance limit for coastal greenspace area calculation was 15km).

However, there was no statistically significant detectable effect of the combined area of all residual greenspace types referred to as 'Other' greenspace on heath visitor rates. This may be because this group of 'Other' greenspaces vary from parks to common land to woods and may vary enormously in the attractiveness, especially to people who like to visit heaths.

11 Models involving greenspace areas weighted by distance

As another method of trying to weight and combine the importance of having greenspace within different distance bands of the household, we then calculated the following for each greenspace type *g* in turn:

- the number of visits made by each individual household to that greenspace type within each distance band
- the area of the greenspace type within each distance band of each individual household
- the sum (V_{gd}) across all responding households of the total number of visits made to greenspace type *g* within each distance band *d*
- the sum (A_{gd}) across all responding households of the total area of greenspace type *g* within each distance band *d*

Then the ratio ($R_{gd} = V_{gd} / A_{gd}$) estimates the overall annual household rate of visiting each greenspace type *g* per hectare of that greenspace type within distance band *d*

Visitor rates (R_{gd}) per hectare of each greenspace type within each distance band from each household are shown in Table 14 and Figure 11 (no area of the New Forest National Park was within 1500m of any responding household and only 1.7-2.0ha. within the next two distance bands up to 2500m).

Table 14 Overall household annual visitor rate (R_{gd} , visits per ha. of greenspace) to each greenspace type within each distance band

Distance band (m)	Heath	Coast	Other	Hengistbury Head	New Forest
<500	3.4367	13.7961	3.2230	29.9428	---
500-1000	0.3839	1.7532	0.5043	2.2618	---
1000-1500	0.1145	0.6267	0.2463	0.8878	---
1500-2000	0.0580	0.3779	0.0912	0.2095	316.8942
2000-2500	0.0258	0.2430	0.0506	0.3119	88.6409
2500-3000	0.0346	0.1700	0.0377	0.1689	19.2487
3000-4000	0.0211	0.1532	0.0339	0.0826	0.4137
4000-5000	0.0139	0.0426	0.0120	0.0585	0.1253
5000-6000	0.0087	0.0675	0.0095	0.1249	0.0213
6000-7000	0.0061	0.0375	0.0097	0.0792	0.0175
7000-8000	0.0060	0.0249	0.0056	0.0445	0.0042
8000-9000	0.0028	0.0233	0.0042	0.0326	0.0060
9000-10000	0.0033	0.0151	0.0031	0.0318	0.0015
10000-12500	0.0021	0.0130	0.0022	0.0332	0.0005
12500-15000	0.0020	0.0067	0.0014	0.0172	0.0004

Heath visitor rates per hectare of heath within 500m of households average 3.44 per year, rates fall rapidly to 0.38 and 0.11 per heath of heath with 500-1000 and 1000-1500m respectively.

For all distance bands the estimates of visitor rates per hectare of greenspace are much higher for coast greenspace than for heaths. Although this may be partly due to the subjective problem of measuring area for some coastal greenspaces, it is the relative rate of decline with distance which is most important here.

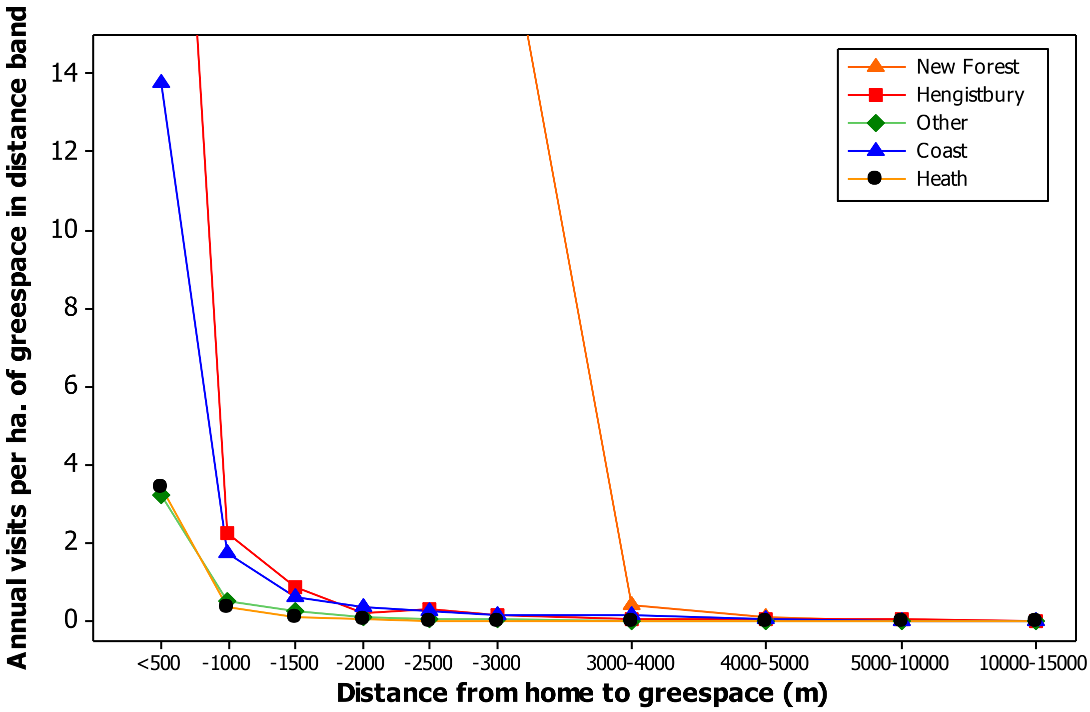

Figure 11 Overall household annual visitor rate (visits per ha. of greenspace) to each greenspace type within each distance band (excludes outlier very high short distance rates for Hengistbury head and the New Forest – see Table 14)

The overall rate of visiting 'Other' greenspaces per hectare are very similar to those for visiting heaths and show a very similar rate of decline with distance (Table 14).

The highest visitor rates per unit area within distance bands from households are to the New Forest for distances up to 5000m and to Hengistbury Head for greater distances.

The visitor rates (R_{gd}) per unit area of any particular type of greenspace in Table 14 can be used as a means of weighting and combining the area of greenspace in different distance bands from a household. Specifically, if A_{gdk} is the area of greenspace type *g* in distance band *d* from household *k*, then we formed a new variable:

$AreaW_{gk}$ = sum of (A_{gdk} x R_{gd}) over all distance bands

This provides a measure of the total amount of each particular greenspace type within 15km of each household but where decreasing weight is given to areas at increasing distance from the household.

The Spearman rank correlation between the total number of heath visits by a household and the weighted area (AreaW) of heath within 15km was 0.426 (Table 15). This is higher than the equivalent rank correlation with un-weighted area of heath in any single distance band, for which the highest correlation was 0.379 with the area of heath within 1500m of the household (Table 4). However, the rank correlation of the number of heath visits made on foot per household with weighted heath area is 0.447, which is slightly lower than the rank correlation with the un-weighted heath area within 1500m (Table 4).

Annual heath visits per household are negatively correlated with the weighted area of coast greenspace within 15km (r_s = -0.249), but not with the weighted area of 'Other' greenspace within

15km (r_s = 0.010). Across the region of respondents as a whole, annual total heath visits per household are also negatively correlated with the weighted area of Hengistbury Head (r_s = -0.324) and to a lesser extent the weighted area of the New Forest (r_s = -0.138) within 15km (Table 15).

Table 15 Spearman rank correlations between annual number of visits to any heath by a household (total, on foot, by car, other means) and the weighted area of each type of greenspace within 15km of the household (correlations (regardless of sign) >0.051, >0.067 and >0.086 are statistically significant at probability p < 0.05, <0.01 and 0.001 respectively)

Weighted area (AreaW) of greenspace type:	Annual household visits to any heath			
	Total	on Foot	by Car	Other
Heath	0.426	0.447	0.197	0.151
Coast	-0.249	-0.242	-0.124	-0.075
Other	0.010	0.065	-0.022	-0.010
Hengistbury Head	-0.324	-0.210	-0.215	-0.163
New Forest	-0.138	-0.071	-0.138	-0.060

The regression models involving the weighted area of each individual type of greenspace within 15km of the household (either (a) allowing for or (b) ignoring the increased use of heaths by dog walkers) shows statistically significant increased visits to heaths with increasing area of heaths (p<0.001), reduced heath visits with weighted area of Hengistbury Head (p = 0.007), no significant partial effect of either weighted area of Coast or 'Other' greenspace and an unexplainable increase in household heath visits with increasing weighted area of the New Forest near the household (p<0.020) (Table 16).

Table 16 Regression model for predicting (log10) annual number of heath visits per household, involving the (log10) weighted area (AreaW) of each greenspace type within 15km of the household (a) allowing and (b) ignoring dog ownership.

Predictor	Coefficient	SE	t	P
(a) allowing for dog ownership (R^2_{cv} =26.6%)				
Constant	-0.4273	0.2677	-1.60	0.111
Dog Owner	0.5167	0.0425	12.15	<0.001
Log_{10}(Heath weighted area)	0.9598	0.0725	13.25	<0.001
Log_{10}(Coast greenspace weighted area)	-0.0041	0.0465	-0.09	0.930
Log_{10}(Other greenspace weighted area)	-0.1614	0.1107	-1.46	0.145
Log_{10}(Hengistbury Head weighted area)	-0.1411	0.0515	-2.74	0.006
Log_{10}(New Forest weighted area)	0.1254	0.0486	2.58	0.010
(b) ignoring dog ownership (R^2_{cv} =19.3%)				
Constant	-0.2409	0.2804	-0.86	0.390
Log_{10}(Heath weighted area)	0.9334	0.0760	12.29	<0.001
Log_{10}(Coast greenspace weighted area)	-0.0344	0.0487	-0.71	0.481
Log_{10}(Other greenspace weighted area)	-0.1627	0.1162	-1.40	0.161
Log_{10}(Hengistbury Head weighted area)	-0.1450	0.0541	-2.68	0.007
Log_{10}(New Forest weighted area)	0.1183	0.0509	2.32	0.020

After allowing for the effect of surrounding heath area and all the other variables, the weighted areas of neither Coast greenspace (p>0.481) nor Other greenspace (p>0.161) had any statistically significant relationship with the number of heath visits per household,.

However, a model with all variables having a statistically significant effect involved the area of heath within 500m and within 500-5000m (as used in previous section analyses), together with weighted area of each of coast and Hengistbury Head (Table 17). The cross-validation R^2 values were 26.6%

including dog ownership and 19.7% ignoring dog ownership, with residual SD of 0.649 and 0.679 respectively.

Table 17 Regression model for predicting (log10) annual number of heath visits per household, involving the (log10) weighted area (AreaW) of each of heath, coast and Hengistbury Head within 15km of the household (a) allowing for and (b) ignoring dog ownership.

Predictor	Coefficient	SE	t	P
(a) allowing for dog ownership (R^2_{cv} =26.6%)				
Constant	0.3216	0.1185	2.71	0.007
Dog Owner	0.5005	0.0426	11.76	<0.001
Log_{10}(Heath area within 500m)	0.5043	0.0452	11.17	<0.001
Log_{10}(Heath area within 500-5000m)	0.2028	0.0339	5.98	<0.001
Log_{10}(Coast greenspace weighted area)	-0.0732	0.0365	-2.00	0.045
Log_{10}(Hengistbury Head weighted area)	-0.2425	0.0419	-5.79	<0.001
(b) ignoring dog ownership (R^2_{cv} =19.7%)				
Constant	0.4562	0.1234	3.70	<0.001
Log_{10}(Heath area within 500m)	0.5063	0.0472	10.71	<0.001
Log_{10}(Heath area within 500-5000m)	0.1997	0.0355	5.633	<0.001
Log_{10}(Coast greenspace weighted area)	-0.0955	0.0382	-2.50	0.012
Log_{10}(Hengistbury Head weighted area)	-0.2433	0.0438	-5.56	<0.001

Summary of models involving greenspace area weighted by distance

In summary of this strand of analysis using greenspace areas weighted by distance band, the presence of Hengistbury Head and the presence of Coast greenspace in the vicinity of households both appears to cause, or at least be associated with, a reduction in the number of visits made to heath, but there is no suggestion that there is a statistically consistent effect of the weighted area of ‘Other’ greenspace (i.e. non- heath, non-coast greenspace) on the number of heath visits per household.

12 Models involving distance to nearest greenspace and number of greenspaces of each type

Hengistbury Head is a single specific greenspace with its own special combination of headland coast, coast and harbour views, heath and amenities. Therefore, in retrospect, we do not need to consider its area within distance bands of household, but merely how far it is from each household.

Similarly, but less obviously, the most important factor influencing the use of coast greenspace may simply be the distance to the nearest coastal greenspace. The area of coastal greenspace is difficult to quantify (the un-measurable area of viewable sea is part of their attraction) and along the Sandbanks to Boscombe promenade and beach, many people may be most likely to routinely go to the nearest accessible part.

Therefore, in this modelling section, we assessed the potential effect of Hengistbury head and Coast greenspace on heath visitor rates by measuring the shortest straight-line distances from the household (postcode) to Hengistbury Head and to any coast greenspace.

The potential overall effect of all 'Other' greenspaces is complex, as this type includes parks, common land, woods and many others of varying sizes and character. The presence of one or more attractive 'Other' greenspaces nearby may draw people away from heaths. The more 'Other' greenspaces there are in the vicinity of a household, the more likely that one or more may be attractive to that household. Therefore, in this modelling section, we assessed the effect of the number (rather than the total area) of all 'Other' greenspaces with a range of selected distances from each household (i.e. within 1.5km 3km, 5km and 10km).

The area of heath in the vicinity of the household was represented by two variables representing the area of heath within 500m and within 500-5000m of the household, as these were found in earlier analyses and sections to provide a good simple representation of how heath visitor rates increase with the area of heath in the vicinity.

Having allowed for the effect of heath visitor rates increasing with the surrounding area of heath (with 0-500m and to a lesser extent within 500-5000m), there is a statistically significant increase in heath visitor rates per household with increasing distance from the nearest coast greenspace (p=0.003) and within increasing distance from Hengistbury Head (Table 18). In other words, heath visitor rates are negatively influenced by closeness to the coast and closeness to Hengistbury Head.

The models and regression coefficients for each of the greenspace variables are similar in models (a) allowing for, and (b) ignoring the effect of whether household owns a dog (dog-owning households make on average about three times as many heath visits per year as households without a dog.).

Table 18 Regression model for predicting (log10) annual number of heath visits per household involving shortest distances to coast greenspace and to Hengistbury Head (a) allowing for and (b) ignoring dog ownership.

Predictor	Coefficient	SE	t	P
(a) allowing for dog ownership (R^2_{cv} =26.6%)				
Constant	-0.1534	0.0771	-1.99	0.047
Dog Owner	0.4937	0.0424	11.65	<0.001
Log_{10}(Heath area within 500m)	0.4939	0.0448	11.01	<0.001
Log_{10}(Heath area within 500-5000m)	0.2022	0.0326	6.20	<0.001
Distance to nearest Coast greenspace (km)	0.0121	0.0041	2.95	0.003
Distance to Hengistbury Head (km)	0.0173	0.0033	5.29	<0.001
(b) ignoring dog ownership (R^2_{cv} =19.7%)				
Constant	-0.0652	0.0802	-0.81	0.416
Log_{10}(Heath area within 500m)	0.4958	0.0469	10.58	<0.001
Log_{10}(Heath area within 500-5000m)	0.2005	0.0341	5.88	0.000
Distance to nearest Coast greenspace (km)	0.0145	0.0043	3.40	0.001
Distance to Hengistbury Head (km)	0.0176	0.0034	5.13	<0.001

When the number of 'Other' greenspaces within selected distances of a household is added to these models, the statistical significance of its effect based on each distance limit is p= 0.026 at 1.5m p<0.001 at 3km, p=0.002 at 5km, p=0.042 at 10km and p=0.106 at 15km, indicating that the strongest effect of 'other' greenspace on heath visits per household is with the number of 'other' greenspaces within 3km (or perhaps 5km) of the household.

This suggests that number, rather than the simple total area, of 'Other' greenspaces within the vicinity (i.e. within a limit of 3km-5km) of a household can reduce the number of visits the household would otherwise make to heaths.

However, it must be remembered that these results are purely correlative, being derived from the sample household questionnaire data. They do not provide direct evidence of the nearby presence of 'Other' greenspaces, or coast or Hengistbury Head reducing the number of visits households would have made to heaths if they had not been there.

Within that limitation, the best regression models to summarise the relationship between the number of heath visits and extent of nearby heath and alternative types of greenspace is explained in detail in the next sub-section.

Summary of models involving distance and number of sites

Simply using the linear distance from the postcode to the nearest piece of coast provides a measure that is significant in predicting heath visitor rates. People further away from the coast visit heaths more, regardless of how much heath there is surrounding the postcode. There is also a significant negative effect of the number of Other greenspaces surrounding a postcode. People living at postcodes surrounded by more Other greenspace sites tend to visit heaths less.

13 Overall best model for predicting heath visitor rates

The best fitting parsimonious model for predicting the annual number of heath visits by a household that we could develop from all of our statistical analyses and modelling involves the following variables:

- area of heath within 500m of the household
- area of heath within the distance band 500-5000m of the household
- straight-line distance to the nearest coast
- straight-line distance to Hengistibury
- number of ‘Other’ greenspaces within 3km (i.e. all non- heath, non-coast greenspaces except Hengistbury and the New Forest)

The best fitting regression model is given in Table 19, for both the case which (a) allows for the increased use of heaths by households with dogs, and case (b) which ignores whether or not a household has a dog.

Table 19 Overall best-fitting regression model for predicting (log10) annual number of heath visits per household (based area of heath within 5km, shortest distances to coast greenspace and Hengistbury Head and the number of ‘Other’ greenspaces within 3km both (a) allowing for and (b) ignoring dog ownership.

Predictor	Coefficient	SE	t	P
(a) allowing for dog ownership (R^2_{cv} =27.6%)				
Constant	0.0154	0.0907	0.17	0.866
Dog Owner	0.4880	0.0423	11.55	<0.001
Log_{10}(Heath area within 500m)	0.4948	0.0447	11.08	<0.001
Log_{10}(Heath area within 500-5000m)	0.2252	0.0332	6.79	<0.001
Distance to nearest Coast greenspace (km)	0.0206	0.0047	4.34	<0.001
Distance to Hengistbury Head (km)	0.00907	0.00403	2.25	0.025
Number of ‘Other’ greenspaces within 3km	-0.00329	0.00094	-3.50	<0.001
(b) ignoring dog ownership (R^2_{cv} =21.2%)				
Constant	0.1238	0.0942	1.31	0.189
Log_{10}(Heath area within 500m)	0.4968	0.0467	10.65	<0.001
Log_{10}(Heath area within 500-5000m)	0.2265	0.0346	6.54	<0.001
Distance to nearest Coast greenspace (km)	0.0241	0.0050	4.87	<0.001
Distance to Hengistbury Head (km)	0.00825	0.00421	1.96	0.050
Number of ‘Other’ greenspaces within 3km	-0.00370	0.00098	-3.78	<0.001

The model can be written the following predictive equation:

Log_{10}(Heath Visits +1) = 0.0154 + 0.488 (if Dog Owner)
+ 0.495 Log_{10}(Heath area within 500m + 1ha.)
+ 0.225 Log_{10}(Heath area within 500-5000m +1ha.)
+ 0.0206 (Distance to nearest coast greenspace)
+ 0.00907 (Distance to Hengistbury Head)
- 0.00329 (Number of ‘Other’ greenspace patches within 3km)

Because the number of heath visits is intentionally expressed on a logarithmic scale (logs to the base 10), the effect of each factor is multiplicative, meaning that a change in the value of a variable is predicted to change the number of heath visits made by a household by a percentage, rather than by a fixed number of visits.

Interpretation of the regression coefficients in the best model (Table 19(a)) suggests that on average:

- Dog-owning households visits heaths roughly three times more often than households without dogs (10 to the power 0.488 = 3.076)
- Households with twice the area of heath within 500m visit heaths 41% more frequently (2 to the power 0.4948 = 1.41)
- Households with twice the area of heath within the band 500m to 5000m visit heaths 17% more frequently (2 to the power 0.22524 = 1.17)
- For every 1km nearer to coastal greenspace there is an associated reduction in the number of heath visits per household of 4.6% (10 to the power -0.0206 = 0.954)
- For every 1km nearer to Hengistbury Head there is an associated reduction in the number of heath visits per household of 2.1% (10 to the power -0.00907 = 0.979)
- Extra 'Other' greenspaces within 3km of a household are associated with an average reduction in the number of heath visits of 0.75% per greenspace (10 to the power -0.00329 = 0.9925)

These estimates of the potential impacts of greenspaces on heath visits are just that, estimates based on the best currently available data; they have errors, often large associated with them.

More importantly, they are statistical estimates based on the average observed relationships across the whole south east Dorset survey region, all heaths and all greenspaces. Therefore, it does not mean the quantitative effects listed above will necessarily happen in any particular situation. The occurrence and extent of any impact of an alternative greenspace on reducing visits to a heath will depend on the characteristics, quality and perceived attractiveness and relative attractiveness of the heaths and greenspaces near each household.

Summary of the best model

This section essentially combines the previous sections and we present an equation that will allow, for each postcode, an average prediction for the number of visits made to heaths. This equation demonstrates that the number of visits made to heaths by a household in a given location is dependent on whether the household owns a dog or not; the area of heath surrounding that postcode (to 5km); the distance to the nearest piece of coast; the distance from Hengistbury Head and the number of other greenspaces within 3km. While significant, the effect of the other greenspaces is weak, as an example the effect of an additional greenspace within 3km of a postcode is an associated average reduction in heath visits of 0.75%.

14 Current context: area and extent of existing green space in relation to heaths

In this section we look purely at the spatial distribution of the different types of greenspace in relation to the distribution of housing. We explore the current distribution of greenspace, the number of greenspace sites and how these relate to heaths. This is an important step in determining the potential for new greenspace and the locations where there are currently limited places for people to visit, apart from the heaths.

Current and planned distribution of housing

Table 20 shows the number of dwellings around the Dorset Heaths SPA/SAC. It shows the current values both in total and just those within the five districts/unitary authorities. It also indicates for the five districts/unitary authorities where the planned housing may be located, with those values as a percentage of both the current housing values and of the total housebuilding, and what the potential future number of dwellings may be. The percentage increase in the number of dwellings close to the SPA/SAC boundary (0-1 km) is 11.4 %, representing 21.6 % of the total housebuilding for the five districts/unitary authorities. Moving further from the SPA/SAC boundary but still relatively close (1-3 km), the planned housebuilding equates to an increase of 21.9 %, 54.3 % of the housebuilding for the five districts/unitary authorities. Further still from the SPA/SAC boundary (3-5 km) the percentage increase in the number of dwellings is 14.8 %, representing 18.0 % of the total housebuilding for the five districts/unitary authorities.

Table 20 Number of dwellings, in total and within the 5 districts/unitary authorities currently, planned and in the future at 0-1 km, 1-3 km and 3-5 km around the Dorset Heaths SPA/SAC boundary, within the five districts/unitary authorities and within the whole of the study area

	Total number of dwellings (all districts/unitary authorities)	Dwellings within the 5 districts/unitary authorities			Percentage increase	Percentage of total housebuilding
	Current	Current	Planned	Total		
0-1 km around SPA/SAC	82,860	82,860	9,465	92,325	11.4	21.6
1-3 km around SPA/SAC	198,074	108,452	23,803	132,255	21.9	54.3
3-5 km around SPA/SAC	41,512	53,298	7,894	61,192	14.8	18.0
Within the five districts/unitary authorities	244,450	244,450	43,837	288,287	17.9	100.0

Current distribution of greenspace

Table 21 shows the number of greenspaces of each category currently around the Dorset Heaths SPA/SAC. It shows that within 3 km of the boundary there are 27 coastal sites (57 % of those within the study area), and there are 877 ‘other’ sites (53 % of those within the study area). These values equate to 421 ha (25 % within study area) and 5457 ha (47 % within study area) by area respectively (Table 22).This would therefore suggest that while the majority of both coastal and ‘other’ greenspace sites identified were within 3 km of the Dorset Heaths SPA/SAC boundary, they represent a proportionally smaller area, indicating that greenspace sites within 3 km are smaller than those further than 3 km.

When this distance is increased to 5 km, there are 42 coastal sites (89 % of the coastal sites identified), while there are 1061 'other' sites (65 % of those within the study area) (Table 21). These values equate to 1308 ha (80 % within study area) and 6,524 ha (56 % within study area) by area respectively (Table 22). Nearly all the coastal greenspace sites (by both number and area) are therefore found within 5 km of the Dorset Heaths SPA/SAC boundary. However, for the 'other' greenspace sites the same is not true. Similarly the area of 'other' greenspace site is proportionally lower than the number, again indicating that those close to heathland tend to be smaller than those further away.

Table 21 Number of greenspaces of each category within 3 km and 5 km of the Dorset Heaths SPA/SAC boundary, within the five districts/unitary authorities and within the whole of the study area

	Total number of each type of greenspace				
	Coast	**Heath**	**Other**	**Hengistbury Head**	**New Forest**
3 km around SPA/SAC	27	138	877	1	0
5 km around SPA/SAC	42	138	1061	1	1
Within the five districts/unitary authorities	43	136	1124	1	0
Within the whole Study Area	47	138	1642	1	1

Table 22 Total area of greenspaces of each category within 3 km and 5 km of the Dorset Heaths SPA/SAC boundary, within the five districts/unitary authorities and within the whole of the study area

	Total area (ha) of each type of greenspace				
	Coast	**Heath**	**Other**	**Hengistbury Head**	**New Forest**
3 km around SPA/SAC	421.0	10706.1	5457.1	115.9	0.0
5 km around SPA/SAC	1308.3	10706.1	6523.9	115.9	39.2
Within the five districts/unitary authorities	1313.9	9160.6	7749.6	115.9	0.0
Within the whole Study Area	1633.1	10706.1	11694.2	115.9	30926.2

Figure 12 shows the areas of greenspace sites of each type. It shows that heathland sites tend to be larger than both coastal and 'other' sites, while 'other' sites tend to be the smaller than all other types.

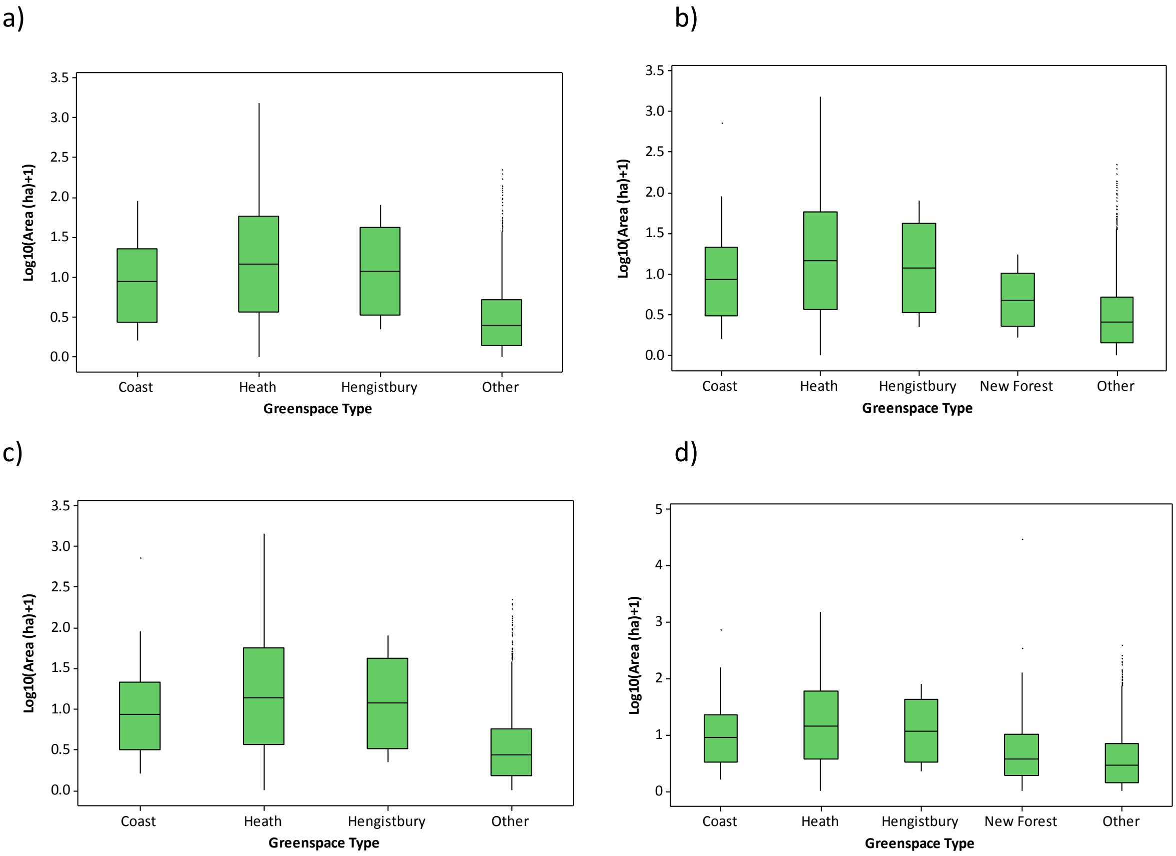

Figure 12 Box-plots showing the areas (ha) of individual greenspace sites within a) 3 km of the SPA/SAC boundary b) 5 km of the SPA/SAC boundary c) the five districts/unitary authorities and d) the whole of the study area

Figure 13 shows the local availability of greenspace, indicated by those categories present within 500 m across the five districts/unitary authorities, averaged by 250 m grid cells. We have chosen 500m as this allows us to reduce the complexity in terms of the range of different types of sites nearby. It shows that throughout the urban/suburban areas, such as Poole, Bournemouth, Christchurch and southern East Dorset, there are large areas with only ‘other’ greenspace within 500 m, and very few with no greenspace available.

In the north and northeast of the Borough of Poole, the north of Christchurch district and the southeast of East Dorset, there are areas for which the only greenspace available within 500 m is heathland. Unsurprisingly in the rural areas of the north of East Dorset and Purbeck there are large areas with no greenspace within 500m and, in the case of Purbeck, large areas of heathland only greenspace. This is reflected in Table 23 where the percentage by area of each type of local (within 500m) greenspace access is shown.

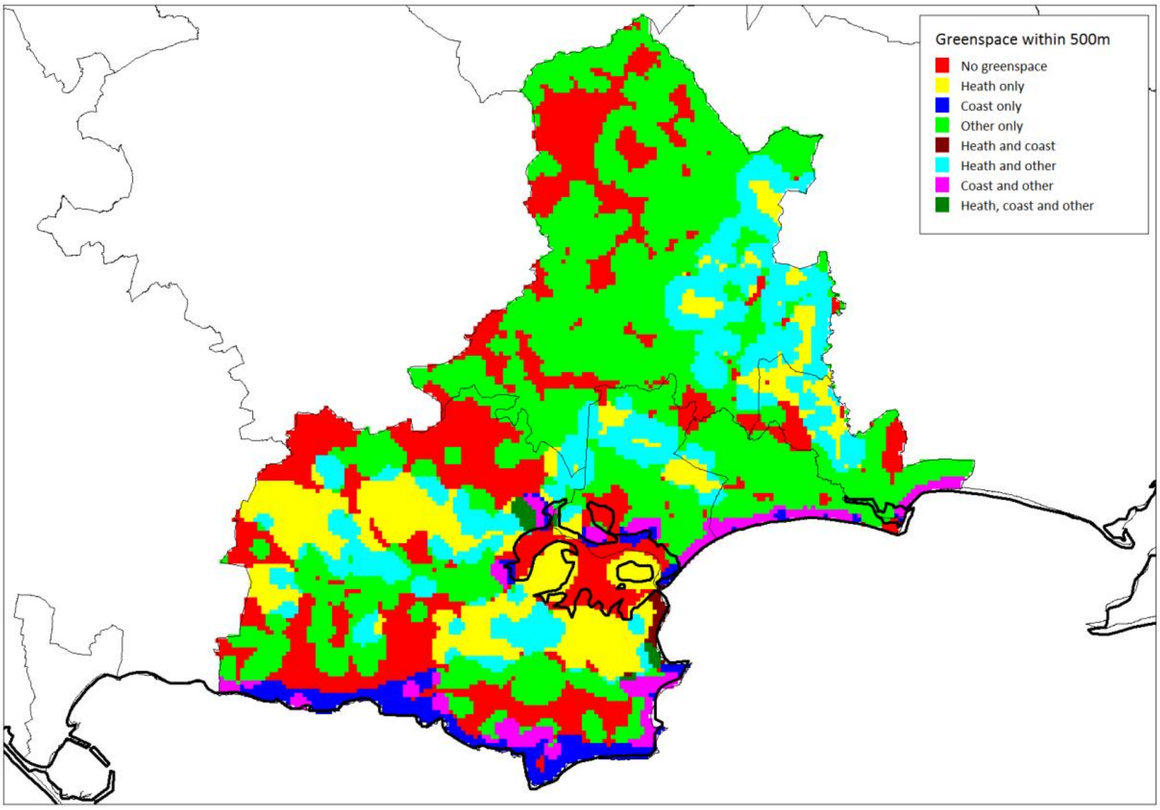

Figure 13 Map showing the availability of greenspace within 500 m, averaged by 250 m grid cells

Table 23 Percentage (by area) of each category of greenspace availability within 500m for each district/unitary authorities

Greenspace within 500 m	Percentage (by area) within each district/unitary authorities				
	Bournemouth	Christchurch District	East Dorset District	Poole	Purbeck District
No greenspace	8.1	15.2	19.6	15.8	30.1
Heath only	1.1	15.8	3.8	11.0	22.5
Coast only	1.9	0.1	0.0	4.2	6.9
Other only	72.2	41.4	58.7	40.4	22.5
Heath and coast	0.0	0.0	0.0	0.3	0.6
Heath and other	5.1	21.8	17.8	21.3	12.4
Coast and other	11.7	5.8	0.0	6.7	4.2
Heath, coast and other	0.0	0.0	0.0	0.3	0.8

Current and planned distribution of housing in relation to current greenspace provision

Figure 14 shows the current distribution of housing within the five districts/unitary authorities, heath and 'other greenspace. It shows the greatest density of housing to be within the urban centres of Poole and Bournemouth and along the coastline of those boroughs. It shows that high numbers of houses are situated near heathland in the north of Poole and Bournemouth, throughout southern and central East Dorset and in the centre of Christchurch. Purbeck has the least housing situated close to heathland, with a small area in the centre of the district.

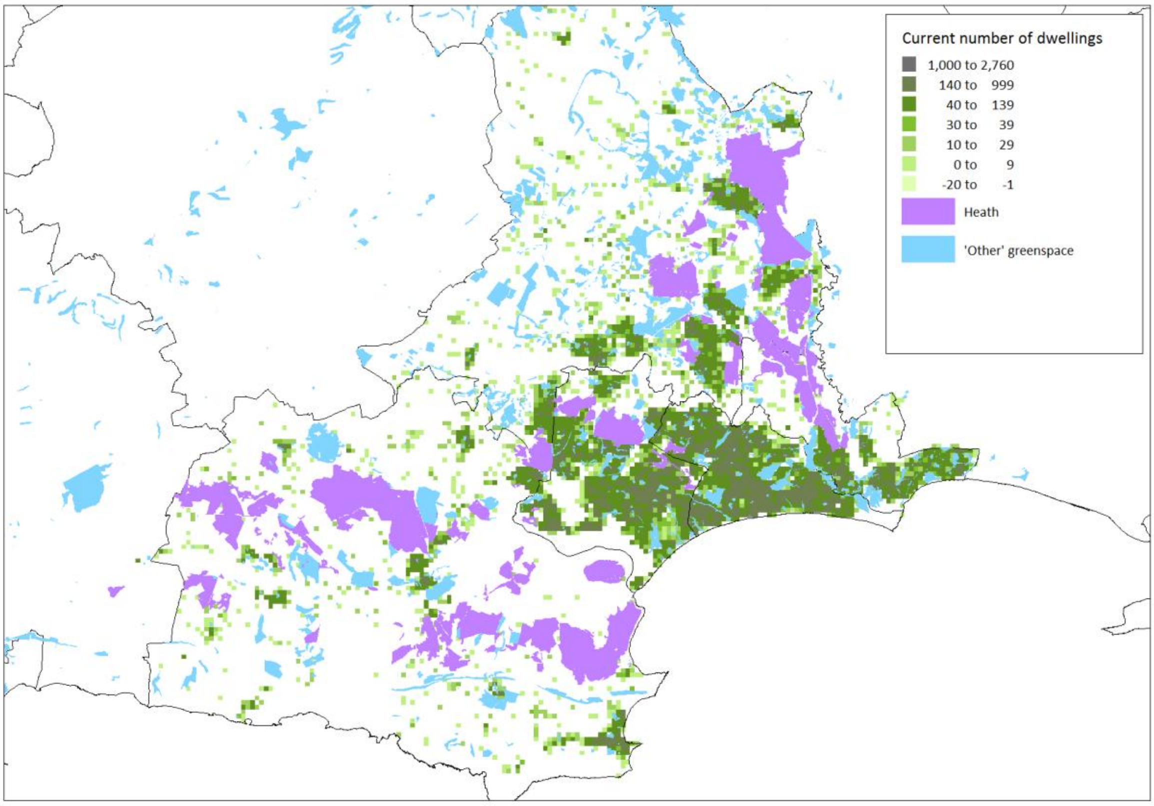

Figure 14 Current distribution of housing, heath and 'other' greenspace within the five districts/unitary authorities

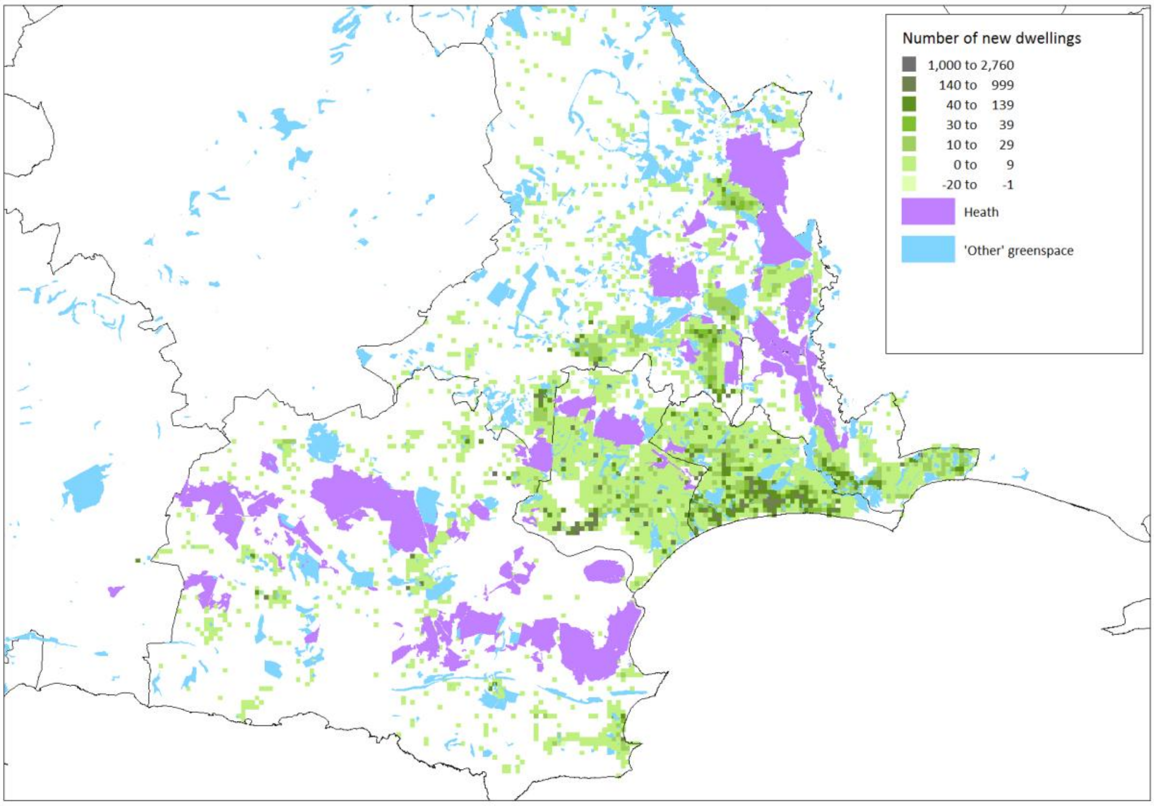

Figure 15 Distribution of proposed new housing, heath and 'other' greenspace within the five districts/unitary authorities

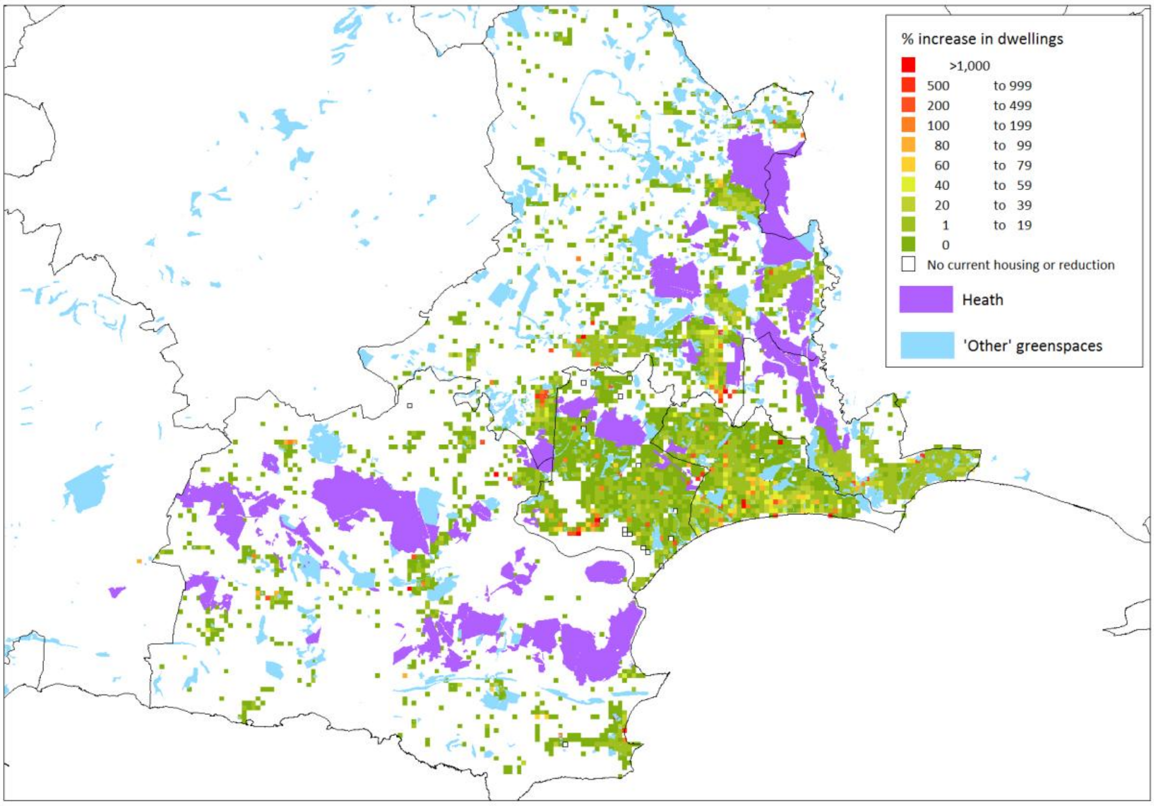

Figure 16 Distribution of planned housing, as a percentage increase, within the five districts/unitary authorities

Figure 15 shows the actual values for proposed housing within the five districts/unitary authorities, while Figure 16 shows this as a percentage increase. They both show that there are planned large increases in housing in the south of the boroughs of Poole and Bournemouth and in Corfe Mullen and West Parley in East Dorset

The relationship between current and proposed housing and greenspace available within 500 m is addressed in Table 24. Table 25 breaks this down to district/unitary authority level. Table 24 shows that a 44 % increase in housing is planned in areas without any greenspace within 500 m. It also demonstrates that an increase of 8.4 % is planned in areas where the only local greenspace (within 500 m) is heathland, although this only makes up 1.8 % of the total housebuilding over the five districts/unitary authorities. Additionally Table 24 also shows that over half of planned housebuilding is planned for areas with only 'other' greenspace available locally.

Table 24 Number of dwellings within the 5 districts/unitary authorities, currently, planned and future, and the types of greenspace available within 500 m

Available greenspace within 500m	Dwellings within the 5 districts/unitary authorities			Percentage increase	Percentage of total housebuilding
	Current	Planned	Future		
No greenspace	15,369	6,770	22,139	44.0	15.5
Heath only	9,572	806	10,378	8.4	1.8
Coast only	5,180	1,465	6,645	28.3	3.3
Other only	148,589	24,877	173,466	16.7	56.8
Heath and coast	61	3	64	4.9	0.0
Heath and other	38,563	3,066	41,629	8.0	7.0
Coast and other	26,912	6,822	33,734	25.3	15.6
Heath, coast and other	198	3	201	1.5	>0.01
Total	***244,444***	***43,812***	***288,256***		

Table 25 Number of dwellings for each district/unitary authority, currently, planned and percentage increase, and the types of greenspace available within 500 m

Available greenspace within 500m	Bournemouth			Christchurch District			East Dorset District			Poole			Purbeck District		
	Current	Planned	*% Increase*	Current	Planned	*% Increase*	Current	Planned	*% Increase*	Current	Planned	*% Increase*	Current	Planned	*% Increase*
No greenspace	4648	717	***15.4***	487	30	***6.2***	1325	236	***17.8***	6999	2992	***42.7***	1910	2795	***146.3***
Heath only	711	8	***1.1***	229	11	***4.8***	617	49	***7.9***	6999	728	***10.4***	1016	10	***1.0***
Coast only	2642	864	***32.7***	0	0	***0.0***	0	0	***0.0***	2187	595	***27.2***	351	6	***1.7***
Other only	60166	11866	***19.7***	18598	3191	***17.2***	22526	5210	***23.1***	36374	3172	***8.7***	10925	1438	***13.2***
Heath and coast	0	0	***0.0***	0	0	***0.0***	0	0	***0.0***	60	3	***5.0***	1	0	***0.0***
Heath and other	3135	427	***13.6***	2159	77	***3.6***	16479	1651	***10.0***	11928	518	***4.3***	4862	393	***8.1***
Coast and other	14138	3483	***24.6***	3086	372	***12.1***	3	2	***66.7***	6033	2396	***39.7***	3652	569	***15.6***
Heath, coast and other	0	0	***0.0***	0	0	***0.0***	0	0	***0.0***	44	0	***0.0***	154	3	***1.9***

Table 25 shows that percentage increases in housing over the districts/unitary authorities vary considerably with the amount of greenspace available within 500m. It shows that Purbeck plan an increase of nearly 150 % in areas without any current greenspace provision, however this is predominately due to the proposed development at Lytchett Minster. The proposed plans for the borough of Poole would result in a 43 % increase in housing in areas also without greenspace provision within 500 m, while it would also see a 10 % increase in areas where heathland is the only greenspace. When these values are calculated as a percentage of the total housebuilding they show that for all districts / unitary authorities except Poole, the value is less than 1 %, while for Poole it is 7 % (Table 26). Table 26 also shows that both Poole and Purbeck plan a large proportion of their housing in areas with no local (within 500m) greenspace, 29 % and 54 % respectively. While all district/unitary authority plans include some housing within 500m of both heath and 'other' greenspace sites, East Dorset have a the greatest proportion, with 23 % being allocated to those areas.

Table 26 Housebuilding in relation to available greenspace as a percentage of total housebuilding for each district/unitary authority

Available greenspace within 500m of area to be developed	Percentage of total housebuilding within district/unitary authority				
	Bournemouth	Christchurch District	East Dorset District	Poole	Purbeck District
No greenspace	4.1	0.8	3.3	28.8	53.6
Heath only	0.0	0.3	0.7	7.0	0.2
Coast only	5.0	0.0	0.0	5.7	0.1
Other only	68.3	86.7	72.9	30.5	27.6
Heath and coast	0.0	0.0	0.0	0.0	0.0
Heath and other	2.5	2.1	23.1	5.0	7.5
Coast and other	20.1	10.1	0.0	23.0	10.9
Heath, coast and other	0.0	0.0	0.0	0.0	0.1

Summary of the context: where current greenspace is in relation to the heaths and to current and future housing

Over 41,000 new houses are proposed to be built within 5km of the European heathland sites. Within 3km of the boundary of the European sites there c.5,500 ha of Other greenspace, compared to over 10,000 hectares of heathland and associated habitats. Heathland sites also tend to be larger in themselves. A large proportion (44%) of the new housing is likely to be in areas with no greenspace (heath, coast or other) within 500m.

15 Discussion

We have explored how many visits households currently make to heathlands, in particular focusing on the extent to which the presence of other types of habitat surrounding the household serves to 'deflect' heath visitors. Key points from our results are:

- Households surrounded by more heath tend to visit heaths more than those surrounded by less heathland.
- Proximity to coast has an important effect on visit rates to heathland, with households close to the coast making fewer visits to the heaths.
- The extent (i.e. area) of other types of greenspace (parks, farmland, woods etc) surrounding a household has no bearing on the number of visits households make to heaths.
- There is however a weak effect of the number of other greenspace sites on heath visitor rates, with households surrounded by more individual greenspace sites visiting heaths less.

The lack of an effect of greenspace area means we have been unable to make predictions of how visitor rates to heathland will change in the future as a result of new housing and new greenspace addition: there is no significant effect of increasing the area of green space.

Implications for the IPF and DPD

It is clear that that some types of site do attract people away from heaths: proximity to the coast, proximity to Hengistbury and the number of other greenspaces surrounding a postcode were variables which were significantly associated with a reduced number of visits (per household per annum) to heaths.

We also found that the amount (area) of other greenspaces in the vicinity of a postcode had no significant effect on the number of visits made to heaths. This is potentially important. If we had found that the area of other greenspace surrounding a household did influence the amount that household visited heathland, then this would have been strong evidence that SANGS would be effective. The fact that there was no such effect does not necessarily mean that SANGS will not work, as we have not implicitly tested greenspace targeted as alternatives to the heaths. Our other greenspace category includes a wide range of sites, none of which have purposefully been designed to attract people that otherwise might visit heaths.

The fact that the number of greenspaces, rather than total area of greenspace, was significant suggests that quality of greenspace could be important. With more sites it is more likely that one of those sites will actually deflect visitors. It may therefore be that the 'right' new space may well attract people, but at this stage we cannot fully describe the characteristics of the right type of site. Our category of 'Other' greenspace is perhaps unlikely to truly capture how SANGS could be – we can only use existing sites in our analyses and we consider current visitor patterns. SANGS could be radically different to existing greenspace. New housing may attract residents from outside the region who establish new patterns of access, which therefore might be different to that presented here. The provision of alternative sites will also not happen in isolation, it is part of a package of measures which also includes access management on the heaths, wardening, education programmes etc. These other measures may serve to push people off the heaths (for example through the enforcement of dogs on leads on heaths), and as such may increase the effectiveness of SANGS. Patterns of access may well take long time periods to change. Our results are therefore not necessarily negative in terms of the effectiveness of SANGS, but there is a need for caution.

Our analyses do not give a basis for confidence that simply extending the existing type and extent of greenspace will be a simple solution to allow new development to occur and there be no net increase in visitor numbers on the heaths. It seems likely that new sites will need to be different to the existing network of greenspace sites and designed and carefully targeted so as to provide a suitable alternative to the heaths.

It would therefore appear critical that SANGS are different to existing greenspace. In terms of design SANGS potentially need to replicate the experience visitors have when visiting the heaths or the coast. It may therefore be features such as extensive vistas, sense of space and presence of semi-natural habitats (or at least a wild feel) that are important. Previous surveys have highlighted that many heath visitors do come to walk their dog (e.g. Clarke et al., 2006; Liley et al., 2006c), but here we are actually able to compare the ratio of dog walkers to non dog walkers on different kinds of sites. Heaths are disproportionately attracting dog walkers. There are various reasons why this might be. The heaths tend to be larger than other types of green space. They have a semi-natural, wild feel and they have relatively low densities of other visitors (compared to the coast and other types of site). Other features which are likely to be important (see the initial household survey report) are the ability to let dogs off leads and not have to clear up after dogs. Parking (cost of parking and the ease of parking) are also important. A major focus for future SANGS provision and access management in the region must therefore be addressing the needs of dog walkers. The features described above should be incorporated into the design of SANGS if they are to function to attract dog walkers away from heaths. We were unable to assess our 'Other' category to determine which have such features.

There is also the potential for proactive work with dog walkers, for example the promotion of dog friendly sites, for through leaflets or web-based material providing lists of sites ideal for dog walking. These should be produced at a sub-regional level, spanning multiple local authorities. The GIS data collated within this report could provide a foundation for mapping the sites. Community-based education work could also promote site switching and responsible access such as dogs on leads. Proactive work could include face-to-face contact on the heaths, with wardens / site managers engaging with visitors and creating a visible presence, actively ensuring dogs on leads etc.

We have not directly addressed heath support areas within our analysis. These are essentially extensions to heaths, thereby increasing the site area, providing extra space and potentially diluting visitor pressure (see Liley et al., 2006a). Our results show that households with more heath surrounding them make more visits to heath, but that the increase in visitor rates is not in proportion to the increase in area. This would suggest that heathland support areas do have a role, as mean visitor density, per ha of heath, essentially decreases as the area of heath increases.

As many people walk to heaths as travel to them by car. This is different from results from previous studies (see Clarke et al., 2006), and highlights the benefits of this survey approach compared to sampling a small number of access points. For foot visitors, the strongest correlation with the number of visits to heaths (per household per year) and area of heathland in the vicinity was found using a distance band of 1500m. For car-visitors the strongest correlation was using pooled bands from 1500-5000m. These results lend support to the current zoning (no new residential development within 400m of SPA / SAC and developer contributions per dwelling within 400m – 5000m). The high numbers of foot visitors supports the use of a zone directly adjacent to the heaths and the use of a 5km zone is clearly appropriate as a broad catchment for car-borne visits.

Our approach

In our analyses we treated heaths and coast separately, and then grouped all other types of site (with the exception of Hengistbury Head and the New Forest which we felt warranted treating separately). Our 'other' category therefore included recreation grounds, playgrounds, urban parks, woodland, copses, urban green space, country parks and more rural sites. Examples of such sites included Moors Valley Country Park, Wareham Walls, Holt Forest, Kings Park and Baiter. As stated above, it may be the breadth and variation in these sites that meant there was no consistent effect of attracting people away from the heaths. We also tried simply categorising all sites as heath or not heath, and patterns were consistent between the two analyses.

It may also be that there was too little variation in greenspace provision across the whole sub region (i.e. areas with and without lots of greenspace) for us to detect significant effects. For 88% of respondents there was greenspace (non-heath) within 500m. Just 8% of all respondents had no heath and no other types of site within 500m. By contrast for both Hengistbury Head and the coast there were locations that were far away and others close.

The questionnaire did not directly ask whether people would consider visiting an alternative type of site and how that might look. We considered these questions to be too hypothetical and difficult to analyse at the scale at which the household survey was conducted. Such questions need to ideally be asked in face-face contact by skilled interviewers allowing the potential to prompt, give examples and fully explore how alternative sites might function and be successful. Ideally such work would be conducted with specific examples (named sites or equivalent). Our approach in this piece of work has been very much to consider current access patterns at a broad spatial scale, and use this understanding to address the implications for greenspace provision within the sub-region. The original aim was to generate predictions for different scenarios of new housing and greenspace provision. Such predictions are not within our grasp at present. The model we have developed would allow us to make predictions of heath visitor rates and how they might change in the future with new housing, and even new greenspace provision. However, because the effect of additional greenspace is so slight, and purely based on the number of sites, any scenarios tested would need dramatic increases in the number of different greenspace sites, scattered widely across the study area, in order to predict any reduction in heath visitor rates. Further refinement is necessary, and it seems that such refinement can only come through actually creating new spaces and implementing other mitigation measures and then directly testing their effectiveness.

Further work

There is a real need for trial SANGS to be created and put in place within a framework of other measures, such as access management, that are all carefully documented. Detailed monitoring must take place across the SANGS and the heaths to determine how visitor rates change. Ideally different types of SANG, with different features (and in different locations) should be compared. This represents a large body of difficult and complex further work and is set out in the monitoring strategy (see Liley, 2007)

We need to better understand how greenspace quality influences choice of site. While there is some body of information on the quality of greenspace (Bell et al., 2006; Bradley and Millward, 1986; Dunnett et al., 2002; Handley et al., 2003; Harrison et al., 1995; Liley et al., 2006b), we do not fully appreciate how the attractiveness of sites works to deflect people from other sites. Future modelling and predictive work should therefore incorporate the attractiveness and features of different sites. Scores could be developed for different heathland sites in terms of their attractiveness to different types of users. Such scoring would enable us to differentiate the visitor experience provided by the wide range of sites present; for example Turbary Common (a small urban site), Arne (a scenic site with coastal and heath habitats) and Wareham Forest (an extensive area of conifer plantation, heathland and valley mire) represent three totally different visitor experiences. SANGs could also vary markedly, in terms of size, scenery, landscaping and vegetation cover. It may be that, in order to deflect visitors from sites such as Arne or Wareham Forest a SANG would need to be very different to that required to deflect visitors to Turbary Common. By incorporating attractiveness into the analysis it should be possible to determine whether SANGS will only work for certain types of heaths and whether certain features are necessary for SANGS to function at all.

The creation of a new piece of greenspace will provide opportunities for direct questioning, asking people that visit whether they also visit the heaths, and also the opportunity to ask people on the heaths themselves whether they had visited site X and the rationale behind the choice of site to visit. Such work must be coordinated across the region and the results collated.

We have also used straightline distances in the analyses, rather than travel distances or travel times. The study area is not uniform: Poole Harbour and the large urban conurbations mean that these measures will vary, for example Arne is only a few km from Poole Quay yet the journey takes some 40 minutes or so to drive at certain times, due to the slow road speeds and need to drive around Poole Harbour. The use of drivetime could potentially help to refine the analyses and should be incorporated into future work.

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Appendix 1: What is the effect of changing the estimate of the annual number of visits for each category of 'frequency of visits' used in the household questionnaire ?

Table 27 shows that if the values we used our analyses are replaced by a maximal realistic range of alternative values, then the correlation between the consequent different estimates of annual heath visits per household among all responding households was always greater than 0.99. This means that similar results would be obtained if any of these alternative systems has be used in the statistical analyses and regression modelling of the annual number of heath visits.

Table 27: Effect of three alternative scoring systems (A1, A2 and A3) for converting household questionnaire 'frequency of visit' categories into estimates of annual number of visits; 'Used' denotes the system used in all analyses and modelling and the correlation are those between the estimates annual total heath visits per household based on the used and each alternative system.

	Equivalent days per year					Correlation	
Frequency (categorical)	Used	Alternative scoring system					
		A1	A2	A3		Used v A1	1.000
Most days	250	300	200	300		Used v A2	0.997
Most weeks	40	50	20	20		Used v A3	0.991
Roughly every month	12	12	12	8			
A few times per year	4	6	2	6			
Blank	1	1	1	1			

Appendix 2: Rational of statistical tests

This section provides an overview of statistical testing and background to the approaches used within the report.

Having collected data about a population (human or otherwise) and/or a geographic region of interest either from designed experiments, from observations in the field, or as here from questionnaire surveys, we usually examine and analyse the information to try to make conclusions about the existence, extent and patterns of differences between sub-groups of the population or relationships between different features, measurements or variables within the population or region of interest. Because all individuals, (habitats, plants, animals, and especially humans) vary naturally and in complex interacting ways, it can be difficult to identify with high confidence the underlying patterns (in modelling terms often referred to as the “signal”) from the background variation (referred to as the “noise”). This is the subject and purpose of statistical methods.

The aim of statistical analysis is to build up an understanding of the relationships between variables and to assess using statistical tests whether the differences between groups (e.g. dog-owning households versus non dog-owners) and correlations between measured variables (e.g. are number of heath visits per household related to the amount of coast greenspace with a fixed distance) observed in the available data are likely to be indicate real patterns in the population as a whole or whether they are just due to the chance random variation and joint variation in the sample of individuals on which we have information.

Most statistical tests are based on assuming what is termed a “null hypothesis” under which it is assumed that there are either no differences in values of a particular variable between two or more sub-groups of the population or no relationship between two measured variables. We then calculate an appropriate statistic to summarise some aspect of the data (e.g. differences in means or difference in medians between two sub-groups, or the correlation between the values of two variables for individuals). If this assumption holds, it is possible to calculate the frequency distribution of values of the statistic we could have obtained by chance. If the probability of getting a value of the statistic as large or greater than our observed value of the statistic calculated from our sample data is sufficiently small, we assume our null hypothesis was wrong and conclude there was some effect (difference or correlation)

As an example suppose we wish to test whether dog-owning households (respondent group A) visit heaths more (or less) than non dog-owners (group B) in our population in south-east Dorset. Suppose we have a sample of 11 dog owners and 15 non-dog owners whose estimated annual number of heath visits were (sorted into order of increasing values):

	Mean	Median (50% value)
Group A: 0 0 0 4 4 8 12 44 80 250 290	63.3	8
Group B: 0 0 0 0 0 0 0 4 4 4 4 8 12 16 40	6.1	4

First impression might be that, although a proportion of households in both groups do not visit heaths and the estimated number of visits varies enormously between households, the dog-owning households as a whole may tend to make more visits to heaths.

There are numerous statistical methods to test whether the observed differences between these two small samples of households are likely to be indicative of real differences in frequency of visiting heaths between dog and non-dog owning households in the whole population and region, or whether they could be just due to the random sample of households we have data for.

For illustration, we use a test based on the ranks of the values rather than the values themselves; these are often referred to a non-parametric tests. All 26 values are placed in order and ranked (1-smallest, 26=largest; in reality the ranks of equal values are averaged, so for example, the 10 households with zero visits are all given the average rank of 5.5, the next 6 households with 4 visits are all given average ranks of 13.5, etc). The test statistic is the mean rank of the 11 households in group A, the observed mean rank is 16.2.

Under the null hypothesis of no difference between the two groups of households, in terms of their rate of visiting heaths, the 11 dog-owning households could equally be any random 11 households from amongst the overall sample of 26.

Therefore, assuming our null hypothesis is true, we can work out the chance probability of getting any possible value for the mean rank of 11 households by randomly selecting 11 households from the 26, calculating the mean rank of their house visits and repeating this say 10000 times to build up a frequency and probability "null" distribution for the mean rank, as shown in **Error! Reference source not found.**.

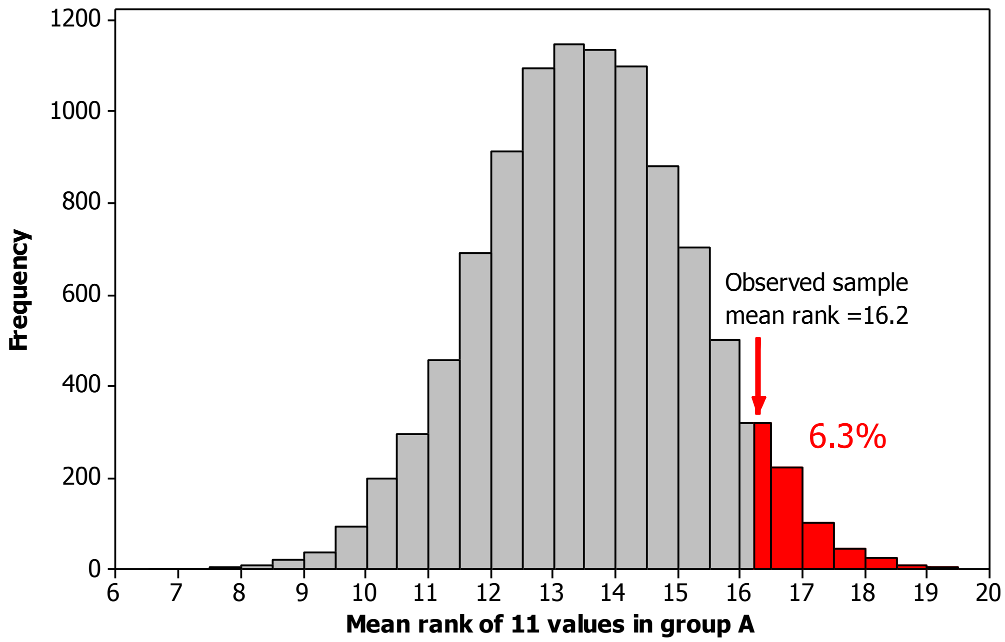

Figure 17 Illustrative frequency distribution of the mean rank of 11 values randomly selected from the heath visitor rates of 26 households (based on m=10000 random selections); 6.3% of this null distribution are greater than or equal to the observed mean rank of 16.2 for the actual 11 dog-owning households

If the null distribution holds, then the probability getting a mean rank as large or larger than the observed mean rank of 16.2 is 6.2%. Expressed as a proportion (p), this is $p = 0.062$; this p is the statistical test probability of getting our observed differences or larger effects if the null hypothesis (upon which the null probability distribution has been based) is true. If the test probability is sufficiently small then our observed data is sufficiently unlikely under the null hypothesis, and we conclude that the null hypothesis is false (referred to as rejecting the null hypothesis) and accept and alternative hypothesis, in this case that the two groups differ and that dog-owning households have some overall tendency to visit heaths more.

Although this purely illustrative example test p is quite small (equivalent to 1 in 16), it is almost universally standard (albeit it semi-arbitrary) practice in the research journals literature to reject the null hypothesis and conclude there are effects (differences or correlations) if the test p values is less than 0.05 (i.e. less than a 1 in 20 chance).

This type of test based on ranking the values for number of visits is the basis of the Kruskal-Wallis tests used later in this report to test for differences in level of heath visits between households grouped according to the presence and amount of heath, coast and other types of greenspace within selected distance bands.

The same principle of a null hypothesis also applies for the multiple regression models used to assess the effect of area of individual greenspace types within selected distances.

In all statistical tests, the test probability p values decreases with the size of the effect being tested and the precision with which the effect can be measured. The precision is often represented by the standard error (SE) of the effect (often the estimate of the effect plus and minus twice its estimated SE gives us limits within which the true value of the effect for the population as a whole lies with roughly 95% confidence. The SE decreases with the number of observations involved (i.e. the larger the sample we can obtain the smaller the SE of the effects we are estimating, the greater the precision and the greater our power (i.e. ability) to detect effects with statistically confidence and high precision. Although we were fortunate to have a large number (1642) of households respond to our questionnaire, when the overall data is sub-divided by one, two or more factors into categories, there are sometimes few observations in some “naturally relatively rare” categories which reduces our statistical power to detect effect amongst those sub-categories.