Report

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Impacts of Recreation to Cannock Chase SAC

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Summary

Recreational use of Cannock Chase SAC is varied and widespread. It is known that the site has a wide appeal and a large catchment from which people visit. There are many signs of damage and wear to the designated heathland habitat, especially that fringing the path network. These indicators of damage from recreational uses include:

- trampling and vegetation wear, including a shift away from typical heather to grass-dominated vegetation
- widening of paths with damage to path-side vegetation
- erosion of vegetation cover or soils
- eutrophication from dog waste and horse dung, again causing a shift away from typical heathland plants to those indicating higher nutrient status
- fire
- litter and vandalism
- remedial works to contain damage, such as path surfacing, that has changed or removed heathland vegetation cover

The path and track network at Cannock is extensive and the edge zone where paths and habitat blocks have an interface is thus large and pervasive. The signs of adverse impact, though predominantly in a linear form, amount to a significant area of habitat. Moreover some of the causes of impact have increased markedly, notably the spread of mountain bike use. Indeed there are few paths that do not show the signs of cycle use as well as walking, often with dogs, and to a lesser extent, use by horses. The extent of the impacts from path use, even estimated conservatively, in our view constitute significant damage to the SAC, and therefore any increase in visiting pressure will add to that damage without mitigation.

Impacts on habitat are more difficult to ascribe to specific recreational uses and visitor numbers than for instance the link with disturbance to key bird species, but the combination of this range of indicators of adverse impacts, the observational study, experience of the surveyors and long knowledge of the site by managers, together presents a picture of chronic habitat deterioration, at least locally. This is notwithstanding the significant maintenance and enhancement of habitat that has been carried out in the SAC over recent years.

We suggest that there are clear indications of habitat deterioration at Cannock Chase that show all the signs of emanating from recreational pressures on the SAC. Moreover if the present levels of visiting and recreational use are causing such adverse impact, any increase in visitor numbers will be bound to intensify the degree of damage. A precautionary response to managing these impacts and avoiding or mitigating any potential increase in damage is called for, to adequately protect the SAC.

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1. Introduction

1.1 The Cannock Chase Site of Special Scientific Interest (SSSI) was notified in 1987 and covers 1264.3 hectares. Almost all of this area (1236.93 ha) has subsequently been designated, in June 2005, as a Special Area of Conservation (SAC) under the provisions of the European Habitats Directive. Cannock Chase represents the largest area of heathland habitat surviving in the English Midlands and though much diminished in area from its original extent, as with all lowland heathland zones, the habitat and dependent species are of very high nature conservation importance.

1.2 Cannock Chase is designated as a SAC because of the extent of European Dry Heath habitat, for which it is regarded as one of the best areas in the UK. The heathland here shows characteristics intermediate between the lowland heaths of southern England and the more montane heaths of upland Britain. The dry heath vegetation types, together with some areas restored recently from scrub invasion, occupy some 76% of the SAC. In addition to the important vegetation communities, Cannock's dry heathland supports populations of several scarce invertebrates and is an important breeding site for the Annex I European nightjar (though this in itself is not a SAC feature).

1.3 In addition to the primary reason for SAC designation – the dry heathland – Cannock Chase is also designated for the further European Annex I habitat, North Atlantic Wet Heaths with Erica tetralix. There is only a small area of this habitat represented at Cannock, so wet heath is not a primary reason for SAC designation. The small populations of European Annex II white- clawed crayfish and great crested newts are also of interest, though not a reason for SAC designation.

1.4 Although not interest features of the SAC, Cannock Chase also supports breeding populations of nightjar, woodlark and Dartford warbler, all Annex I species under the Birds Directive which places an obligation on Member States to avoid pollution or deterioration of habitats. Based on the last national survey, nightjars occur in nationally important numbers at Cannock Chase and the site could be recommended as an SPA at the next review. Natural England has advised that authorities take a risk based approach in relation to such sites elsewhere.

1.5 The condition assessment of the SSSI by Natural England in 2011 records the great majority of the SSSI units as being in 'unfavourable recovering' condition with a few units being 'favourable'. There are relatively few comments to supplement these assessments but the comments that are available relate to presence of different stages of heather growth or, in wooded units, tree regeneration. The recent management to control bracken is also cited.

1.6 There is no mention of impacts on the SSSI/SAC features resulting from recreational activities and this broadly reflects the nature of the common standards monitoring guidelines for lowland heathland. Apart from the option to record the presence of certain plant species that are indicative of non-heath habitat, such as weeds of enriched soils, such monitoring is not generally directed towards impacts from

recreation or other human influence. Moreover, the standard condition assessment will tend to concentrate on stands of typical, homogeneous vegetation rather than the edges of such stands along the path network which is the focus of this study. Indications of adverse trends from such sources may thus not be detected, at least until there are widespread changes in vegetation condition.

1.7 The number of visitors to Cannock Chase is high and at least on a level with other lowland heathland areas – often much larger in extent – where adverse impacts on habitat and some characteristic species are well documented. The human population within relatively easy reach of Cannock Chase is particularly high. There are currently over 1.1 million properties within a thirty mile radius of the SAC. Assuming average occupancy rates[1] then this equates to some 2.7 million people living within 30km of the SAC boundary.

1.8 Though the general health of the heather-dominated communities may be satisfactory as judged against the common standards monitoring schedule, there are reported signs of adverse impacts in some areas. Moreover the threat of further adverse impact from new development close to the site was noted in the Habitats Regulations Assessment of the West Midlands RSS in 2007. Concern was especially raised about the possible increased adverse impacts from water abstraction, air quality and recreational pressure. There has been major effort from site managers in place for several years to maintain and enhance the primary heathland resource of the site but in general these actions have not been aimed at tackling such impacts.

1.9 This present report presents an initial assessment of the impact of visitor use on the Cannock Chase SSSI and in particular on the SAC habitats of the site. Based on extensive experience of many lowland heathlands where there is recreational pressure and on discussions with the site managers at Cannock, a list of potential indicators of pressure was drawn up. Instances of such impacts, either as observed activities or their results, were recorded when encountered on the site, as indicated in subsequent text.

1.10 It is difficult to show conclusive proof of a link between signs of habitat deterioration and recreational pressure. Similar links of cause and effect using key bird species, as have been shown on some of the southern heaths, for instance with nightjars and visitor numbers, are not appropriate for the SAC and in any case would need repeated survey effort. Importantly however, the designated features here are the SAC habitat types rather than populations of important individual bird species, as is the case with heathland Special Protection Areas (SPAs). Thus the clear and now widely accepted links between housing density, visitor numbers and response of nightjar or woodlark numbers in SPAs would not be an approach that could be used for an SAC.

[1] National average occupancy rates are 2.4 people per household.

1.11 This study attempts to identify instances and potential causes of habitat deterioration from recreational pressure on a representative sample of the SAC, but can only represent a snapshot of the site and cannot necessarily reveal trends. There will be the need for further intensive survey and monitoring to confirm the cause and effect of recreational impacts. In the meantime any warning signs of habitat deterioration in the SAC would require a precautionary approach and steps should be taken to halt such adverse impacts. Such steps may need to address visitor management as well as visitor numbers. The risk of increased impacts, from more visitors as a result of additional housing within easy reach of the SAC, must also be avoided or effectively mitigated.

2. Context

2.1 Human access to important biodiversity sites can result in a variety of effects and consequent impacts on habitats and species of conservation importance. These can range from damage to soils and vegetation caused by trampling, to impacts on birds and animals from disturbance and fires. At the same time it is important to recognise that human access can have benefits for biodiversity, for example the creation of bare and open ground habitat that can be colonised by ruderal plants and used by invertebrates.

2.2 One of the consequences of the activities of humans and their animals is an increase in nutrients from the deposition of litter, from dog waste and horse dung. Compared to the wider effects of atmospheric nitrogen deposition, such effects are localised but can result in severe impacts where they occur; a complete change in vegetation communities and species alongside paths where dogs are walked onto heathland, for example.

2.3 The side effects of litter can include mortality to small mammals and birds and the attraction of predators like crows and foxes to uneaten food.

2.4 It is unclear to what extent horses introduce non-heathland species onto heathlands through their dung, or whether animals and humans accidentally introduce invasive alien species onto heathland ecosystems on their coats, clothes or footwear. However, deliberate introductions of alien species can be a serious problem particularly in low-nutrient systems such as heathland where existing species have low competitive abilities. Deliberate introduction of fish and aquatic plants into ponds, or garden plants or trees onto dry heaths, can result in serious damage to native communities and a major management problem.

2.5 At Cannock the arrival of a damaging pathogen *Phytophthera pseudosyringae* on bilberry and the scarce hybrid bilberry has had serious consequences, and taken a considerable investment of time and resources by managers in having to institute control measures. There is no indication that this pathogen was introduced by visitors but the possibility of the spread of this or other alien species across the site, once arrived, by the activities of people, dogs, horses and deer, cannot be ignored.

2.6 The creation of desire lines and new paths, the widening of existing paths, compaction, erosion and deposition of soil can all accompany access on foot, by bicycle and on horseback. Problems can be particularly acute on the light soils of heathland sites, and on wet or sloping ground. At Cannock the evidence suggests that this is a developing problem in some areas with evidence of all these effects and considerable evidence that cyclists and horse riders are not keeping to designated routes. If these users continue to increase in numbers, this has the potential to lead to major problems for the management of the SAC, where signs of widespread deterioration are already apparent.

2.7 The literature suggests that damage to soils and vegetation can be particularly harmful on wet soils and on sloping ground, with damage greatest from ridden horses followed by cyclists. In some conditions the creation of such sites may be beneficial to invertebrates, particularly, but not exclusively on drier soils, suggesting management rather than outright prevention may be a way forward. This will however be balanced by the direct damage done to invertebrate nesting sites by trampling, particularly by horses.

2.8 Wild fires can be particularly damaging on heathland, resulting not only in the direct destruction of vegetation and those organisms unable to escape, but a reduction in the quality and quantity of heathland habitat for some years after the event. However, in the absence of human intervention, most heathland would rapidly change to woodland and scrub, so some controlled winter burning is a beneficial management activity. Wild fires often occur at times of year when they can be particularly damaging, when large numbers of invertebrates and reptiles are killed, along with destruction of birds' nests. Frequent fires can release nutrients and encourage the spread of grasses and bracken. Wild fires can sometimes burn large areas, with the result that it can be many years before re-colonisation takes place from surrounding areas.

2.9 The research suggests that most fires are started accidentally or deliberately by people, that often children are involved, that lowland heathland and moorland is particularly susceptible to wild fires, and that generally the vegetation recovers in a few years from a single event, but that repeated and severe fires can have longer-term consequences. The advent of the mobile phone and faster reporting of wild fires as a consequence has helped to reduce the extent, if not the frequency of wild fires on heathlands and grasslands.

2.10 Disturbance from people and animals is a far more difficult effect to quantify and most relevant studies have been carried out on effects on birds. The research on disturbance to heathland birds has been considerably more comprehensive than on most other bird communities, and much is known about the probable thresholds and effects of disturbance.

2.11 Effects can range from nest failure through increased predation of eggs from nightjar nests, to a failure by woodlarks to colonise suitable habitat where this is heavily disturbed. For Dartford warblers, the delay in breeding in disturbed territories leads to reduced productivity through reduced numbers and size of broods, and increased nest failure rates.

2.12 There is also strong evidence that these effects are greater where paths are closer to nest sites or more frequent within nesting territories. The multiplicity of paths and desire lines on the Cannock heathlands suggest that disturbance could be a problem for the Annex I bird species here.

2.13 This report outlines the impacts of human access as evidenced by the physical state of the SAC, and summarises the views and observations of those who have a special

knowledge of the site and its history of human use in recent years. This is followed by a comprehensive literature review of the effects of human access and activity on heathland and closely related habitats.

3. Cannock Chase SAC – Visitor Impacts Assessment

Background and methodology

3.1 A requirement of the overall contract is an assessment of the impact of visitor use, in particular on the SAC habitats of Cannock Chase. Part of this assessment, reported here, was carried out on site in two periods, over three and five days, during August 2011. The conclusions from the wider literature review, this study, together with the observational studies, questionnaire survey of staff and others and visitor survey, (and a separate habitat condition assessment by Natural England as part of their ongoing monitoring of SSSIs) will be used to inform a report with recommendations for mitigation of visitor impacts.

3.2 For the Visitor Impact Assessment each of the compartments that have public access, and that comprise the SSSI and SAC, was visited and a selection of paths and routes was walked. When impacts from any cause were observed these were noted, both directly onto aerial photos and as a GPS point, and a note made of the effect on habitat. In many cases digital images were recorded of the impact and a selection from these has been made to illustrate typical effects.

3.3 Before the field walking was undertaken there was a preliminary discussion on methodology with Staffordshire County Council's Principal Ecologist, Biodiversity Officer, and Field Manager. During the second visit there was a Land Rover tour of most of the area with the Biodiversity Officer and Head Ranger.

3.4 The field walking was largely restricted to the path network. This reflects the nature of heathland vegetation which is relatively impenetrable, meaning that most impacts from recreational uses will be encountered along or close to the paths. Where impacts deviate from the existing paths this will usually be in the form of a new linear feature – effectively a new desire line. Most of the impacts are observed as linear effects, though the few instances of larger fires do affect much wider areas of habitat. Instances of enrichment, though originating along paths, can also affect a wider zone of vegetation.

3.5 This survey is thus necessarily different from the standard condition assessment method which will tend to inspect and focus on blocks of habitat of homogeneous character, probably deliberately away from the edge effect of paths.

3.6 Detailed target notes and maps showing locations where impacts where observed are given in Appendix 1. The overall length of the path system and time available on site, and a need to record in as many units as possible, meant that it was impossible to record and accurately map all instances of damage. The distribution of dots and target notes does indicate a measure of intensity of impact across the site, and the occurrence of each impact can be compared. The route followed was to a large degree influenced by available time and the geography of the site but repeat sampling along this route would be possible. In total, about 23% of the recorded paths on the site were walked which represents a substantial sample of the whole

path network. Additionally, five lengths of paths, in different units were recorded in more detail, and the vegetation present described at measured points, allowing comparison of some impacts and the opportunity to repeat the sampling over time. These sample lengths are described in Appendix 4.

Types of impact observed

3.7 Based on the likely impacts outlined in the Context section and on discussion with site managers, a list of probable impacts to record was drawn up. These were adapted in the light of experience once field work started and covered the following general impact categories:

- Path widening – caused by both increased trampling or new desire lines forming, and also from the widening caused by mowing a wider firebreak
- Erosion – where the surface vegetation has been worn away
- Cycles – where clear evidence of tracks or actual cyclists were noted
- Horses – as for cycle use, or dung observed
- Dogs – where dogs were seen or where dog mess noted
- Enrichment – where vegetation has been changed away from heath species to plants indicative of higher nutrient levels (e.g. grasses, bramble, ruderal weeds)
- Vehicles – either unauthorised or where management vehicles have affected path-side vegetation
- Litter and vandalism – dumped or dropped items or deliberate damage
- Fire

The table shows the occurrence of each impact, for units with public access (units 28-30 are therefore not part of the calculation)

Unit	C	X	D	H	R	E	V	W	F	Total	Unit ha	Total path length km	Paths walked km	Impacts /km
1	1		1		1		3	1		7	37.9	2.5	1.32	5.31
2	1	5		1	2		4			13	40.1	4.2	2.52	5.16
3		3	1		3		2	1	1	11	46.1	7	1.33	9.7
4	2	6	1	2		1	2	1		16	85.1	12.3	3.78	4.2
5	2	2	2							6	15.4	2.9	1.28	4.7
7											22.5	3.9	1.27	
10		3	4	1		1		7		16	78.2	13.1	3.2	5
11	1	6	6	4		3	1	3		20	130	19.7	4.34	4.61
13	2	12	1	5	7	4	2	4		37	79.5	17.6	3.3	11.2

15		2		4	3	1	2			12	54.9	20.4	1.69	7.1
16	2	2	1	2	1	3		3		14	45.4	9.6	1.14	12.3
17	4	4	9	8		4			2	31	83.9	13.8	3.1	10
18	3		1	1	1	2				8	77.6	4.2	0.68	11.76
19	3	1		2		1	1	3		11	83.6	6.9	1.94	5.67
20	2	6	2			4	1	1	3	19	52.5	9.8	2.94	6.46
24	7	9	6	6	1	1	2	2		34	108.1	23.4	3.63	9.32
25	1									1	11.7	2.9	0.25.	4
26	4	7	3	3	2	1				20	23.6	2.7	2.74	7.3
27	3	3	2	3		1				12	16	2.6	1.77	6.78
28		2					2			4	12.5		**0.91**	**4.4**
29		1								1	7.6		0.12	8.3
30	2		2	1		2	1			8	65.8		1.04	7.69
Total	40	74	42	43	21	29	23	28	6	304		182.8	42.24	Av 7.24

C-cycling; X- Path expansion; D- Dogs; H- Horses; R- Enrichment; E- Erosion; V-Vehicles; W- Widening

3.8 A strict comparison of the units is not possible as time spent on each unit and thus observer effort varied and the sampling was not randomised. Nonetheless some measure of the spread of impacts and the most affected units can be gained. In very general terms the units closest to main access points (heavily used car parks) or nearest to settlements (i.e. within close walking distance of houses, e.g. Unit 17) show a higher than average number of impacts. Unit 18 - Brocton Coppice - is somewhat anomalous as here the paths walked were all peripheral to the mainly wooded habitat.

3.9 The study is a snapshot at one time and to detect trends would need to be repeated in future monitoring. If these impacts do represent trends – and there is no reason to suppose they do not – then the study should be seen as a warning signal and appropriate precautionary steps taken to reduce or eliminate the impacts.

3.10 The most widespread impact was of path expansion, as evidenced by worn or trampled vegetation or the development of new paths and desire lines. Additionally, in most cases the widening of tracks by mowing as firebreaks had also encouraged recreational uses to expand to occupy the full mown width.

3.11 The next most widespread impacts arose from cycle use, horse riding and dog walking. The linear nature of the sampling, along paths and tracks means that an occurrence of dog walking, cycle or horse use recorded at a given point implies a much greater impact. Such activities are bound to be linear impacts and one record

may conceal the fact that the effect applied for tens or even hundreds of metres rather than at a single spot. For example, the concentration of dog impacts at unit 4 only rates as one instance.

3.12 Whereas enhanced nutrient levels from atmospheric deposition would be expected to affect the SAC vegetation communities generally, enrichment from dog waste or horse dung will be concentrated along the path network. Changes in path-side vegetation were clear, from typical heath species to grasses and weed species such as thistles, or the enhanced frequency of brambles near paths. Such changes in vegetation will be gradual and also long-lasting, so in many respects these impacts are the most disturbing.

3.13 Erosion with vegetation worn away or soil being washed off by rain to expose underlying stone is especially linked with steeper slopes or very heavy pressure at access points. Remedial work to control erosion has been successfully carried out in the past on some steep routes but in doing so has usually modified the original heathland soil and natural vegetation cover.

3.14 The passage of vehicles for management work along some narrow paths has in some instances affected heather growing along the edge of the path. This would not be a serious adverse effect in itself, as the heather would recover in time but the effect, as with firebreak mowing, is very often the trigger for the path to become permanently widened.

3.15 Fire, though potentially very damaging in that the impact of a single instance can be very widespread, was encountered far less frequently than perhaps expected. This may reflect enhanced awareness of the potential damage by visitors and also effective site wardening and response. Similarly the numbers of cases noted of litter dumping or vandalism were small, again reflecting the wardening effort.

3.16 Unit 7 has no recorded impacts. This is an unusual unit with a regular grid of paths, the result of the area having been part of a military camp. The paths have a firm foundation of non-heath soils and are covered with grassy vegetation. More typical heathland occurs in most of the cells between the paths, albeit with a fair amount of scrub. The site is used by walkers and dog walkers but the path vegetation is already heavily modified from heathland so the usual enrichment effects are not relevant and as the whole unit is on level ground with no slopes, there is no erosion apparent from this use.

3.17 Many impacts noted across the SAC are inter-related with one perhaps resulting from the initial impact of another. For instance, some damage to a path surface that causes the terrain to be less comfortable to use, may be a reason for the path to become wider, to find a more acceptable surface. The impacts and their possible relationships are explored in more detail below.

3.18 Detailed target notes and maps showing locations where impacts where observed are given in Appendix 1. These maps show specific locations as points on the map.

Many of the impacts were in fact widespread across the site and difficult to plot as single points. During the fieldwork it was not possible to cover the entire site – all units were visited but in most cases only a selection of paths was walked. The points therefore provide examples and allow cross reference with the target notes. The points should not be interpreted as showing the full extent of each impact.

Widening of paths

3.19 This was a very widely observed feature that appeared to be the result of one or more causes. It could be detected by the path route appearing as a series of parallel tracks, often separated by narrow bands of vegetation, or slight differences in elevation. The original single path has been added to by another track, or with one on each side; or multiple such tracks may have formed, giving rise to a corrugated appearance.

3.20 A common cause of path widening appeared to be that the original surface had become uncomfortable to walk on. Thus if the surface was very stony, an alternative track or tracks had commonly formed alongside, as users elect to travel along a softer surface. Those in turn are added to as their surface changes from trampled vegetation, through bare sandy soil, eventually perhaps to stone. Foot pressure, cycles and horses all appeared to be using or creating these extra pathways. Indeed it was noted that on almost every one of the paths sampled in these assessment visits there was clear evidence of the use by cycles, and in many cases horses, as well as by walkers.

3.21 Another frequent reason for the widening of paths was the previous passage of vehicles, for instance to gain access to management sites or as a result of fire break mowing. Once the vegetation alongside the original route has been cut back or killed off, by vehicle movement, the wider space that results invariably becomes available and used as an access.

3.22 It was common to see groups of users choosing to walk alongside one-another, effectively filling the available space sometimes four or five abreast, where the adjoining terrain or vegetation allowed. Where a restriction applied, such as vigorous heather growth or the slight confining of the path route in a shallow cutting, the path usually reverted to its narrower form.

3.23 Another reason for path widening was observed where there is vegetation growth, such as an overhanging tree or spreading gorse. Users, especially horse riders that require greater height, or cyclists moving at speed without the time to avoid twigs and hanging foliage, routinely deviate from the original route to avoid the slight obstruction, causing the path to swing out into the adjoining vegetation.

3.24 Corner cutting is also a frequent observation, for instance where there is a bend or curve along the route of a path. It seemed that cycles might be particularly the cause of such widening (from the evidence of tyre tracks), easing the bend or simply taking a very slightly shorter course.

3.25 The effect of all of these path-widening impacts is to spread the effect of traffic – feet, hooves or cycle tyres – and alter or destroy the adjoining heath vegetation. Dwarf shrubs are rapidly affected by such pressure and become replaced by grasses or other herbaceous vegetation, or eventually bare ground.

Damage to path surfaces

3.26 Any route that is a used path will be bound to have an altered surface. This will range from trampled but essentially original vegetation cover, through modified vegetation cover, to increasingly bare ground and ultimately in some cases to an eroded surface and then perhaps to an artificial layer. All of these features are visible along the path system through the SAC.

3.27 The least damaging impacts on SAC features are where the pressure is sufficiently light that the modified path surface still retains, or provides, features that contribute to SAC interest. This occurs where a path retains elements of heath vegetation, albeit with the dwarf shrub component reduced or replaced by heath grasses and herbaceous cover, and with any bare ground appearing as firm sand that is not excessively disturbed by traffic. Examples of such paths or sections of paths occur locally but quite widely, and typically the firm exposed sandy surface shows the undisturbed burrows of solitary bees and wasps.

3.28 Much more frequent is the path surface that is sufficiently heavily used that vegetation is absent and the surface continuously trampled. Such bare loose sand can quickly become eroded to expose stones, especially where there is some slope. Here the soil and stones can then be transported down slope by water, both leaving an erosion gully and burying further vegetation at the point of deposition.

3.29 Examples of all stages in this evolution of such gully features can be seen, from initial breaking of the vegetation cover by horse hooves cutting into turf, to cycle ruts forming a gash through vegetation and soil down a steep slope, to obvious and active erosion gullies visible from a considerable distance. Such features are very often accompanied by avoidance behaviour of path widening, as described above, to circumnavigate the uncomfortable surface.

3.30 Stony paths are by no means confined to sloping ground. They frequently occur on the flat, either because of constant heavy pressure or sometimes because the surface has been hardened by bringing in further stone. Though this makes a surface that is robust, and perhaps necessary for the movement of management or emergency services vehicles, signs that the stony surface is being avoided are often apparent. Subsidiary paths very frequently accompany stretches of stone track with both horses and pedestrians choosing to create and use a softer walking surface alongside. Imported track materials are now only inert or acidic in nature, so the effect of altered soil chemistry should not increase but the historical use of other materials has left a long-term legacy.

3.31 Heavily used stony routes are unsuitable for heathland plants or invertebrates. Moreover, the importation of surfacing materials brings the risk of introduction of alien plant material and the even stronger risk of modification of the adjoining heathland vegetation, resulting from the effect of soil and rock of different chemical composition to the natural geology.

3.32 Repeated trampling rapidly converts dwarf shrub vegetation to grasses and eventually bare ground, but the impacts of trampling are not confined to heathland habitats. Many tracks, usually being made and used by mountain bikes, were noted within the Brocton Coppice compartment. Though the ground vegetation here is often bracken, and thus not particularly important in the context of the SSSI/SAC, soil compaction

could be a serious adverse impact, especially where such tracks pass close to veteran trees as they often do.

New paths

3.33 In addition to the subsidiary paths that form alongside existing tracks, to accommodate more traffic or avoid uncomfortable surfaces, it is also apparent that new routes are created into otherwise unfrequented blocks of heathland. These new paths show as narrow, single tracks, deviating markedly from the main existing route. They usually still have vegetation showing trampling damage or with an exposed humus layer that has not yet been eroded down to bare sand or stone.

3.34 The impression is that the user – perhaps a single daily dog walker or horse rider – wishes to avoid the main route and take off into more remote country. The impact is to cause further degradation of the vegetation cover and perhaps more seriously to introduce an element of disturbance into otherwise undisturbed habitat. There is also the likelihood that once such a new path becomes obvious, the route will be followed by other users, so increasing the risk of disturbance and bringing the attendant impacts of path widening and eutrophication and the spread of 'edge effect'.

3.35 New routes are also being utilised by cyclists, especially those seeking a more adventurous experience by avoiding the main routes and taking off into remote areas, especially where the added challenge of steep slopes can add excitement. In these cases disturbance and the risk of added erosion are impacts likely to follow.

3.36 A short length of new path frequently occurs where there is a junction of routes. It is often the case that a corner is cut, for instance if the main desire line route leads off at a different angle. The effect is to damage more vegetation and increasingly to isolate the piece of habitat that is cut off by the paths, making this area more prone to further degradation by path trampling and eutrophication.

Eutrophication

3.37 The natural nutrient status of the soils of Cannock Chase is acidic and nutrient-poor, giving rise to and sustaining predominantly heathland vegetation, where there has not been subsequent afforestation. The traditional land uses of the heath – grazing, turf cutting, bracken harvesting, fuel gathering – have all helped to maintain this soil condition in the past. In the absence of these activities over recent years, and with the past and current input of nutrients from atmospheric deposition, a gradual increase in soil nutrients will have occurred. The latest measurement from the Air Pollution Information System (APIS) [2], based on 2005 figures shows that the total nitrogen inputs to the Cannock SAC are 20.58 kg/ha/yr and that this is expected to decline to 16.66 kg/ha/yr by 2020. However the critical load for both wet and dry heath is 10-20 kg/ha/yr so currently levels are approximately at or above the higher critical level, and are expected to remain above the lower critical level for some years. These high nutrient levels may account for the relative and apparently increasing frequency of nutrient-demanding plants like bracken and bramble.

3.38 A more localised and intense impact of such eutrophication can be seen along many of the paths across the SAC. It is very common to see a band of grassy vegetation fringing paths and replacing dwarf shrubs, with the addition of further nutrient-demanding species including bramble, thistles and non-heath grasses such as cock's-foot and tall oat-grass.

3.39 Such features may occur along the length of paths but very often there is a concentrated effect where there is some impediment to drainage, such as a slight hollow in the path where water draining down the path can accumulate. This may then be transferred further into heathland where a natural drainage route allows run-off to leave the track. The effect can also be seen where there is a gradient across a track, with the evidence of grassier and nutrient-demanding vegetation more apparent on the down-slope side of the path.

3.40 There could be a slight import of nutrients onto paths by the passage of feet and cycle and vehicle tyres, but a much more concentrated source is from the dung of horses and the urine and faeces of dogs. Very few of the paths walked during this assessment had no evidence of such depositions and some had many such visible traces of dog mess in particular. For instance, in one 70m length of track, 61 separate piles of dog mess were counted. Moreover, unlike a situation with grazing

[2] http://www.apis.ac.uk/index.html

animals, where the dung and urine would be to a large extent recycled within the system, the inputs from dogs and ridden horses will all be entirely additional to the functioning of the heathland system.

3.41 If deposited on the surface of the path, the nutrients from the breakdown of the faeces may be transferred to the soil and become washed down or across the slope in rain, or if dry, blown into surrounding vegetation. It was often observed however that dog mess was deposited onto the fringing vegetation of the heath edges, perhaps because the dog chose to defecate (and very probably urinate) off the track, or was encouraged to do so. In such cases, the nutrient load would be directly impacting heathland vegetation, adding to the shift of plants away from dwarf shrubs and other heathland species to more nutrient-demanding and competitive species, like coarse grasses, thistles and bramble.

Litter and dumping

3.42 Litter is dangerous to wildlife if ingested and, where it will decompose, will add to eutrophication effects and thus damage to heathland vegetation.

3.43 Surprisingly little litter was noted, perhaps because litter is spotted and quickly removed by rangers. Such action probably avoids copycat behaviour and is especially desirable in the case of dumped rubbish such as white goods, electrical items or vehicles, most of these also introducing additional pollution or fire risks.

3.44 Occasional water bottles, paper and wrappers were seen and in a few spots, the remains of a picnic or party, with food containers and bottles. In one case several filled plastic rubbish sacks had been dumped on the roadside or thrown from a passing vehicle. Perhaps most unacceptable and unnecessary was the instance, in several locations, of filled plastic bags of dog mess left beside the path or thrown into surrounding vegetation.

Vandalism

3.45 Vandalism that directly affects heathland habitat or wildlife was not noted during the assessment visits, but an instance was seen of damage to a car park barrier, which if left could have allowed unauthorised vehicles to gain access to heathland. Some damage to signs was also noted, in one case a notice giving information about *Phytophthora* infestation, so indirectly there could be an adverse impact on SAC features if the sign became unreadable or ignored.

Fire

3.46 As with most heathland areas with a high degree of public access, Cannock Chase experiences occasional deliberate damage from arson or accidental fires started by the public (wild-fires). That said, the number of such recent wild-fire events was surprisingly few. There had been a significant wild-fire in 2010, affecting several hectares of compartment 11, and a much smaller wild-fire in the early part of 2011, in compartment 3. Otherwise, evidence of fire was restricted to a few square metres associated with picnic or barbeque spots. Nonetheless, such small fires could easily

get out of hand and spread across much greater areas, so the threat they potentially pose is considerable.

3.47 Intentional fires (controlled burns), in the right weather conditions in winter, can be a useful management technique to restore or regenerate ageing heather. These are controlled by law and carefully managed. Repeated wild-fires, especially summer fires in dry conditions, however can be very damaging and encourage a change from dwarf shrub communities to grasses or bracken, and allow birch scrub to invade. It is understandable therefore that considerable effort is made to prevent unwanted fire through the provision of firebreaks.

3.48 It was somewhat surprising though to see firebreaks being mown in the height of heather flowering, in August. In some cases, despite the care of the operator, the mower was accidentally scraping the ground surface, so destroying any vegetation. It was even more surprising to see the density of firebreaks in some compartments, and the width to which many were being extended, in particular in compartments 16 and 19. It may be no coincidence that these two compartments adjoin parts of the Chase that have been extensively planted with conifers.

3.49 With the level of visitor access to Cannock Chase and the apparently ubiquitous presence of mountain bikes and to some extent horse riding, it can reasonably be assumed that once mown, the width of each firebreak will come to be used as a regular access route. This was born out by our observations that confirmed almost all firebreaks had come to be used as public access routes, and that such use extended across the entire width of the firebreak. Once the heather edges are mown back, as was frequently the case, the foot, hoof and tyre pressure that has followed precludes heather re-growth and instead sees a change to grasses or bare ground.

3.50 There is abundant evidence that a bad summer fire, in dry or windy conditions, will leap wide expanses, even sterile gaps as wide as dual carriageways. The main value of breaks is as safe access for fire-fighting vehicles. At Cannock in 2010 clearly a number of the existing firebreaks failed to stop the large summer fire.

3.51 In itself mowing heather need not necessarily be damaging, since in the absence of other management it may provide for young or pioneer stage heather growth. If often repeated however, as in annual firebreak mowing, it provoke a gradual shift from heather to grasses. The almost inevitable subsequent use of the full mown width as an access route for cycles, horses and walkers, together with accompanying eutrophication, will greatly consolidate that vegetational change.

3.52 In addition to the impacts outlined above, affecting directly the fabric of the SAC habitats by causing vegetation modification, there is also the potential impact to some component species of the SAC that could be caused through disturbance.

3.53 There is a relatively dense system of paths/firebreaks across the site that provides for ready access, used by horse riders, cyclists and walkers, with or without dogs. The volume and frequency of traffic along these routes, and the nature of the use, may affect some species vulnerable to disturbance, notably some bird species and mammals such as deer. The blocks of vegetation between these routes are largely unfrequented but instances of new routes cutting into these otherwise coherent expanses of habitat were noted in several places (see 'New paths' above). The effect of such new pathways will be to reduce the size of the unbroken expanses of heathland or woodland, increase 'edge effect' and bring potential disturbance impacts closer to vulnerable species.

3.54 This study of the range of impacts arising from visitor use of the Cannock Chase SAC was not designed to capture instances of disturbance, which would need more systematic and repeated observation over time. It is covered better by the observational study and reported on separately, and also features in the literature review.

Summary

There are currently impacts from recreational use on SAC habitat and these were noted along a selection of paths within the units of the Cannock Chase SAC and SSSI that have public access. These were recorded on maps and aerial photographs and as target notes, so that similar points could be recorded at some stage in the future.

It is apparent that very many of the paths and routes used by the public show signs of widening. Typically, strips of heath vegetation appear as one or more narrow bands separated by walked, trampled or bare strips. The widening may be the result of a single activity or several factors acting in sequence or in combination. The passage of a vehicle, used for management work or patrol may have weakened or killed heath vegetation beside the path and walkers, cycles and horse riders now follow this line. It is also apparent from the evidence of cycle tyre tracks that few routes are exempt from use by cycles as well as walkers, and many are also used by horses.

The path may have been surfaced with more robust stone, or wear may have eroded the sand down to a stony base and users chose to avoid this less comfortable surface by adopting a parallel route that is softer underfoot. Path users often chose to travel beside one another in a group, again widening the trampled path where the nature of the path allows for such expansion.

The path-side vegetation may also cause a local diversion, for instance where trees or scrub grow out over the route, making it more difficult to follow the original line. A shorter route is also sometimes created where a new desire line is followed, for instance on a bend or to cut a corner where paths join. Entirely new paths also form, recognisable by their initially narrow form and with humic soil not yet eroded down to sand or stone. These new routes may follow tracks established by deer or may be the result of a wish to strike out into new terrain or avoid more heavily used routes.

Enrichment from atmospheric deposition will affect all of the vegetation of the Chase, whether on paths or not. More localised and intense eutrophication can be seen to be affecting paths especially where natural drainage of surface water runs down a slope and collects where flow is impeded, for instance in a hollow or on the down-slope side of the path. The frequency of dog faeces on paths, and to some extent horse droppings, must add considerably to these effects of enrichment. The immediate path-side vegetation shows clear signs of higher soil nutrient status, with heath vegetation replaced by more nutrient-demanding species.

Signs of litter dumping and vandalism noted were surprisingly few perhaps because the rangers are quick to remove such effects to prevent copycat behaviour developing. There had been a large fire in the central part of the site in the previous year (2010) and a smaller fire in part of Cpt 3, earlier in 2011. Otherwise, instances noted of fire were small-scale, often limited to a single bonfire or barbeque site. The density of mown firebreaks and their apparent expansion to greater width is notable. Mowing may provide an acceptable form of management for heath vegetation, especially in the absence of more gradual management such as grazing, but the pattern of use on almost all paths is for the available space to become traversed by all forms of usage. It must be assumed that once mown the whole path width will become a used walking, cycle and horse-riding route, effecting a shift in the character of heath vegetation along the firebreak from dwarf shrubs to grass or bare ground

4. Determining the Extent of the Path Network

4.1 One of the potential impacts identified in the previous section is the creation of new paths. In order to assess the extent of the path network within the SAC, the path network was digitised from aerial photographs. The aim was to map all paths, tracks etc. that were visible from the aerial photographs, not simply the public rights of way and main tracks.

4.2 Aerial photograph coverage was provided by Staffordshire County Council, dated 2010 with the images taken in the spring. Paths were largely digitised at standard zoom settings (0.5km and 0.25km visible), although it was sometimes necessary to change the zoom, for example to check particular features. Paths were mapped as polylines. Originally it was hoped to categorise each line, for example separating firebreaks from tracks, however it was soon realised that this was impossible from aerial photographs and two simple categories were therefore used, "Paths" and "Firebreaks/Tracks", the latter clearly being used or created by vehicles.

4.3 We recognise a number of difficulties in mapping the path network in this way. In many places paths disappeared into trees or were obscured by tree cover, and within the wooded parts of the site many paths will not have been mapped. On open grass areas paths were often difficult to differentiate and earthworks and other features often caused confusion. In some areas (particularly bracken dominated) there seemed to be a very dense network of very fine paths, with more paths visible when the zoom level was increased within the GIS. We recognise that some of these may be deer paths. Despite the limitations, we believe the approach is useful in highlighting the scale and extent of the path network.

4.4 Maps of the path network are shown in Appendix 3. Map 14 shows the paths as mapped: the total length of mapped paths (and firebreaks) is 190km (86km of tracks/firebreaks and 104km of 'paths'). Map 15 summarises the data using a 100m grid. Grid cells that were within wooded habitats (Phase I data showing scrub and woodland were provided by Staffordshire County Council) were excluded and the total length of paths within each remaining 100m cell were calculated. The colours in the map reflect the length of paths within each cell. The red points in Map 15 are the car-parks (as surveyed in the visitor survey car-park counts), and it can be seen that the path density does appear to be particularly high around certain access points, particularly around the glacial boulder and towards the north of the SAC.

4.5 The amount of the SAC that is path or track is significant. If a conservative estimate of the path width and influence zone (the area affected by trampling damage, eutrophication etc.) is taken as 2m (and many of the paths and firebreaks are considerably wider), the total area taken by paths is some 36ha. This represents 3.1% of the SAC, a significant area impacted by existing visitor use of the site.

4.6 The path length walked in this study is shown on Map 16 and amounts to 42.24 km (44.34km including the units 28-30). This represents some 23% of the total path/track network that was sampled in this study.

5. Questionnaire and Discussion with Site Managers and Others

Introduction

5.1 This brief questionnaire has been prepared in the hope that we can draw on the extensive experience of those who know the area best. It is not intended to be a precise analysis, but rather a broad investigation to add a fuller long term picture to the visitor and observational surveys already carried out.

5.2 These visitor and observational studies were undertaken at Cannock Chase (Refs) to ascertain visitor numbers and patterns and to gauge their impacts on the habitats of the Cannock Chase SAC.

5.3 However, whilst both of these surveys provide a snapshot of visitor activity and pressures at a moment in time, neither can give a picture of how these have changed over the years, nor draw out trends in public use and their impacts on Cannock Chase.

5.4 We have therefore attempted to investigate these issues by consulting with those you know Cannock Chase best; the rangers, access managers, foresters and ecologists who have for many years worked on Cannock Chase, who have seen public access change and develop, who have wrestled with the problems that access can bring, and who have an intimate knowledge of the site, its uses and users.

5.5 A questionnaire was sent out to ten knowledgeable people (“our expert panel”) asking them a range of questions about how Cannock Chase is used, what problems this has brought and how uses and problems have changed over time; this report is a summary of their answers followed by some further investigation of specific issues following further telephone interviews. The answers are summarised in boxes with any majority view in bold.

5.6 Not all panel members answered all questions and in a few cases a “don’t know” box was ticked. Several questions invited further comment from the panel and these are summarised at the end of each question. The results, although from a small sample size and based on opinions and not quantitive data, nevertheless provide a revealing and useful window into the public use of Cannock Chase and some of the consequences of that use over time.

The questions and responses

5.7 One of the impacts observed on site and detailed in an earlier section of this report, was the creation of additional paths and tracks, widening of existing paths and tracks and the creation of ‘desire lines’, a consequence of which is the division of undisturbed habitat into smaller and smaller parcels.

5.8 We wished, in the first group of questions, to know from our expert panel which users were most likely to create new paths and tracks, whether the number of users was changing and if there were other factors contributing to the pattern of new or changing access routes.

Question 1: Do visitors create new paths/desire lines?

Options offered	Response %	Response count
No new paths created	10.0	1
New paths created by horse riders	50.0	5
New paths created by cyclists	**90.0**	**9**
New paths created by walkers	60.0	6
New paths created by other users*		7

5.9 *Two additional users who created paths were mentioned by the panel, orienteers and deer. Deer paths get used by people, particularly cyclists, horse riders and runners and can eventually become part of the network of regularly used routes.

Question 2: Do people create new access routes on fire breaks or managed areas. If so are this primarily cyclists, horse riders or walkers?

Options offered	Response %	Response count
Cyclists	**77.8**	**7**
Horse riders	44.4	4
Walkers	55.6	5

5.10 It was suggested that from a horse riders perspective, a fire break may already look like a track, and that, as such newly created breaks are soft underfoot, they may be particularly favoured by horse riders looking for soft going. However, probably all types of user could use firebreaks.

Question 3: Have the numbers of walkers (with or without dogs) changed over the last ten or so years?

Options offered	Response %	Response count
No change	0.0	0
Slight increase	33.3	3
Slight decrease	11.1	1
Marked increase	**44.4**	**4**
Marked decrease	11.1	1

5.11 Two of the panel suggested that numbers had increased at honeypots and key visitor destinations, but one felt that there had been no increase in more locally used areas such as around the SAC.

Question 4: Has the number of cyclists visiting Cannock Chase changed in the last ten or so years?

Options offered	Response %	Response count
No change	0.0	0
Slight increase	0.0	0
Slight decrease	0.0	0.0
Marked increase	**100.0**	**10**
Marked decrease	0.0	0

5.12 Although all were agreed that cyclists had increased in numbers, and put this down to the creation of new trails and more on-line advertising of routes, it was suggested that such increases had not been consistent across Cannock Chase, dependant partly of car park charges in some locations and not others. One of the panel believed that cycling had decreased on the SAC and another that it had increased in the Country Park.

Question 5: Has the level of horse riding at Cannock Chase changed over the last ten or so years?

Options offered	Response %	Response count
No change	20.0	2
Slight increase	**50.0**	**5**
Slight decrease	10.0	1
Marked increase	10.0	1
Marked decrease	0.0	0
Unsure/don't know	10.0	1

5.13 Two panel members specifically mentioned trekking centres as sources of additional riders.

Question 6: Do users generally stick to paths? If no, why do you think that people leave paths?

Options offered	Response %	Response count
Yes	**90.0**	**9**
No	10.0	1

5.14 It was pointed out that very few users will cross undisturbed vegetation unless there is some sort of track already, even if this is very narrow. However this can happen where paths are not clearly delineated and on areas cleared of vegetation for other purposes, e.g. bilberry cutting following Phytophthora. It was suggested that cyclists might follow narrow deer tracks.

Question 7: Are you aware of particular problems related to soil compaction/erosion linked to any particular user or area, if so, who and where?

5.15 Specific areas mentioned were Oldacre Valley and Sherbrook, due to horse riders and Brocton Coppice due to cyclists, although cyclist compaction damage was believed to be superficial compared to horses and vehicles. Impacts by horse riders occur near to riding stables and compaction on heavily used horse riding and cycling routes as well as by rangers or other vehicles was also mentioned. Erosion on tracks running into Sherbrook Valley was also noted. One panel member commented that most erosion by water is due to poor design, poor materials or poor maintenance of tracks and paths. Some path widening is caused by mountain bikers who will also cut extreme routes through new areas.

Question 8: Are there any areas where repeated management to paths and tracks has been necessary due to soil erosion, is so, where?

5.16 Sherbrook Valley is mentioned by two panel members, while another notes that all waymarked facilities across the FC area need routine maintenance. Areas of soft, humid ground and steep slopes are most vulnerable.

Question 9: Are there any areas where there has been serious trampling damage to vegetation, if so, where?

5.17 Brocton Coppice, around honey pot areas and track edges where these are cobbly or muddy e.g. Katyn track, top of the Hill Fort, edges of routes around Oldacre Valley, picnic areas, wild tracks in new restock plantations, area from Springslade Lodge through to the Chase and the firebreaks around the cemeteries are all mentioned. The last of these is believed to be a favoured dog training area.

5.18 *The next series of questions relate to littering, dumping and the introduction of non-native plants and animals. Non- native plants and animals are sometimes introduced or released deliberately, but can also be introduced accidentally when other rubbish, particularly garden waste is illegally dumped.*

Question 10: Have the levels if litter present at Cannock Chase changed over the last ten years or so?

Options offered	Response %	Response count
No change	20.0	2
Slight increase	0.0	0
Slight decrease	30.0	3
Marked increase	**40.0**	**4**
Marked decrease	0.0	0
Unsure/don't know	10.0	1

5.19 Litter has increased in some areas e. g. around visitor centre and honeypots but also some quiet areas such as Milford Quarry and the Hill Fort, but roadside litter has decreased slightly. It is suggested that any increase is in line with considerable increase in visitor numbers, I. E. amount of littering per person has not increased.

Question 11: Is there a problem from fly tipping (e.g. old mattresses, sofas, fridges etc.)?

Options offered	Response %	Response count
Yes	**80.0**	**8**
No	10.0	1
Unsure/don't know	10.0	1

5.21 Yes, over roadside barriers, in and near car parks, especially those at Duffields at Brindley Heath, at Stile Cop and Brindley Village, most entrances to woodland blocks and Cavens Wood. It is seen as more a problem at small car parks (rather than big ones) and at lay byes. One panel member thought the problem was no worse than previous years and possibly decreasing.

Question 12: Is there a problem with dumped/burnt out cars and if so, where does this mostly happen?

Options offered	Response %	Response count
Yes	**60.0**	**6**
No	20.0	1
Unsure/don't know	20.0	1

5.22 Less of a problem than in the past as cars now have scrap value. Still a problem at Rifle Range Corner area, Stile Cop, Beaudesert car park and possibly Penkridge Bank.

Question 13: Is there a problem with dumped garden waste?

Options offered	Response %	Response count
Yes	**60.0**	**6**
No	30.0	3
Unsure/don't know	10.0	1

5.23 This is a problem behind the properties that neighbour Cannock Chase and alongside roads and inside barriers. Specific location at Duffields car park, Brindley Heath, could be commercial e.g. tree surgeon. Appears to happen sporadically and seasonally

Question 14: Are there problems with introduced invasive plants e.g. aquarium plants, dumped plants such as Michaelmas daisies or cultivated yellow archangel?

Options offered	Response %	Response count
Yes	20.0	2
No	**50.0**	**5**
Unsure/don't know	30.0	3

Question 15: Are there any problems with introduced animals or fish, e.g. goldfish in ponds, abandoned cats?

Options offered	Response %	Response count
Yes	20.0	2
No	**50.0**	**5**
Unsure/don't know	30.0	3

Question 16: Are there any established stands of potentially harmful or invasive plants e.g. Himalayan balsam, Rhododendron, Shallon, New Zealand pigmyweed, Japanese knotweed?

Options offered	Response %	Response count
Yes	**90.0**	**8**
No	0.0	0
Unsure/don't know	10.0	1

Question 17: Apart from Phytophthora, has there, to your knowledge been any management of alien plants or animals over the last ten years?

Options offered	Response %	Response count
Yes	**90.0**	**8**
No	0.0	0

5.25 Time and money is spent on managing grey squirrels and fallow deer.

5.26 The next series of questions relate to dogs and visitor numbers and management.

Question 18: has there been a change in the amount of dog walking over the last ten years?

Options offered	Response %	Response count
Increase	**70.00**	**7**
Decrease	10.00	1
No change	20.00	2

Question 19: Has there been a change in the number of commercial dog walkers?

Options offered	Response %	Response count
Increase	**60.00**	**6**
Decrease	0.00	0
No change	20.00	2
Unsure/don't know	20.0	2

Question20: Are there any particular areas where visitors come to train gun dogs, if so, where

5.27 Locations for gun dog training were Aspens car park, Brindley Heath, above the Sherbrook valley, near to German Cemetery, rifle ranges on FC and Cemex land and on the heathland.

Question 21: Are you aware of any problems relating to dogs?

Options offered	Response %	Response count
Yes	**60.0**	**6**
No	40.0	4

5.28 Problems with dogs mentioned by the panel were fouling, disturbance to ground nesting birds (including gun dog training during the breeding season), chasing deer, mountain bikers and rangers/contractors vehicles. Dogs can be a nuisance to visitors in heavily used areas, and there are occasional conflicts with other pedestrians and concerns when dogs run at other visitors. Some dog owners can be aggressive.

Question 22: Do you consider the number of visitors to Cannock Chase is currently

Options offered	Response %	Response count
About right	22.2	2
Too high	33.3	3
Could be increased without detriment	**44.4**	**4**

Question 23: If you consider that visitor numbers are too high, what effect is this having?

5.29 High numbers of visitors increases conflicts between different users, results in path erosion, increase in litter, car parking problems, wild fires, wildlife disturbance and vandalism. Other effects mentioned were footpath spread and creation of new paths, fragmentation of heathland, local enrichment at path edges and dumping areas, possible spread of plant and animal disease and impacts on ground nesting birds and reptiles. However, impacts are variable between weekday and weekends, between tourists and visitors from local communities, and between ecologically and physically robust areas with the capacity to take more visitors without detriment (e.g.Shugborough and Birches Valley) and the SAC. Impacts of visitors will also be moderated where sufficient resources are available to manage them. Management of access and charges can also permit sustainable visitor management.

Question 24: Have any methods been tried to direct visitors away from sensitive or damaged areas (apart from Phytophthora infected areas)? If yes, please specify methods used and how successful.

Options offered	Response %	Response count
Yes	**90.0**	**9**
No	0.0	0
Unsure/don't know	10.00	1

5.30 Methods tried have included site zoning, promotion of honeypot sites, interpretation, signage and ranger presence, siting of self-guiding trails, siting of car parks and restrictions on vehicle access including car park closures,, construction of

bike trails, promotion of waymarked routes for different users and designation of areas for particular users (e.g. sled dogs, orienteers) and designation of conservation areas. Also asking visitors to keep to main paths and keep dogs on leads. Organisations have also worked together to manage cyclists into the most robust areas of Cannock Chase and away from the SAC.

5.31 A number of panel members noted however that some of these methods do not necessarily work. For example, people tend to ignore signs, they tend to go to favourite areas regardless of the availability of other options, they will choose routes convenient to their home or where there is easy parking and tend to walk where they like and not where it is suggested or promoted.

Question 25: What measures were taken to direct visitors away from Phytophthora areas, and how successful were these measures?

5.32 Direct methods used included extensive signage, interpretation and press coverage and ranger patrols with access prohibited in some areas and requests that dogs be kept on leads. Indirect methods included promotion of honeypots and more extensive programmes of activities in less sensitive areas. It is not clear how successful the indirect measures were.

5.33 The result of the direct measures was seen as being nearly all unsuccessful or, as having no perceived or only limited success. Signs were removed, local dog walkers took no notice and rangers were regularly verbally abused when asking people to keep away or put dogs on leads.

5.34 It is suggested that site closures only ever work for a fixed period of time and that only physical measures work in the longer term.

Question 26: Did you notice any particular changes following visitor exclusion during the Foot and Mouth outbreak? If yes, please specify.

Options offered	Response %	Response count
Yes	**55.6**	**5**
No	0.0	0
Unsure/don't know	44.4	4

5.35 The main response was that deer were more widespread and more visible in the daytime. No observations were made on birds or reptiles. Areas that remained open were more heavily used by people, management on unvisited areas was easier to carry out and there were no summer fires on closed areas. Visitors seemed more appreciative of the area for a while when it was opened back up.

5.36 *The next series of questions relate to transport and parking.*

Question 27: Over the past ten years, how has roadside parking changed?

Options offered	Response %	Response count

Increased	**66.7**	**6**
Decrease	0.00	0
No change	22.2	2
Unsure/don't know	11.1	1

Question 28: Have steps been taken to reduce roadside parking? If yes, please specify steps taken and how successful they have proved.

Options offered	Response %	Response count
Yes	**50.0**	**5**
No	20.0	2
Unsure/don't know	30.0	3

5.37 Some lay-bys have been in-filled or contained with barriers including ditches, earth mounds and bollards. Barriers have been erected on access points with signs explaining that access is required for emergency vehicles. Where bollards have been put too far back then cars are still parked partly in road. Other measures have been successful. Problems remain where there are services such as café or toilets and where car park is free, because cars spill out onto roadside. At Birches Valley car park there is an enforced pay and display and measures to prevent roadside parking and this has been successful.

Question 29: Are there any car parks where problems of litter, unacceptable behaviour etc. are particularly prevalent?

Options offered	Response %	Response count
Yes	**80.0**	**8**
No	10.0	1
Unsure/don't know	10.0	1

Question 30: If you answered yes to question 33, do you think car park closure should be considered?

Options offered	Response %	Response count
Yes	**25.0**	**2**
No	37.5	3
Unsure/don't know	37.5	3

5.38 Police guidance is that car park closures would displace problems not solve them. Car park closures should be considered for management reasons such as discouraging people from visiting the most sensitive areas rather than to solve problems of littering etc. It would be impossible to close car parks on this type of site and closures could set a precedent and lead to further closures. Car parks can be a problem at night but nor during the day.

Question 31: Would you be in favour of car park charges?

Options offered	Yes	No	Unsure/don't know	Response count
In all car parks	42.9 (3)	42.9 (3)	14.3 (1)	7
In particular car parks	100.00 (8)	0.0	0.0	8

Question 32: Do you think car park charges would have any effect on visitor numbers? If yes, please specify how.

Options offered	Response %	Response count
Yes	30.0	3
No	**70.0**	**7**

5.39

5.40 It would depend on the level of charging, and whether season tickets were available. It could create more indiscriminate parking. Charges would have an effect on visitor patterns and behaviour rather than numbers. It could reduce night time/evening visitor levels. Would help to redistribute pressures and could move visitors to less sensitive sites. It could help to pay the high costs of running the Country Park.

Question 33: Do you think that car park charging could have an effect on visitor distribution? If yes, please specify how.

Options offered	Response %	Response count
Yes	**60.0**	**6**
No	30.0	3
Unsure/don't know	10.0	1

5.41 Would depend on level of charges and could lead to more roadside parking. Would probably not lead to dramatic redistribution of visitors and some responses would be short lived. Free or lower charged parks should serve local and frequent users with higher charges at visitor hubs where there are facilities for infrequent or occasional visitor. Introduction of car park charging at FC and free parking at edges of Marquis Drive have increased use of latter area.

Question 34: Please specify any factors which have noticeably changed patterns of visiting in the last ten years (e.g. opening of new facilities or car parks, traffic restrictions on roads).

5.42 Factors mentioned by the panel were improved facilities at visitor centre, development of cycling and mountain bike trails and walking routes, emphasis on health and wellbeing and development of healthy heart trails. The WWI hut and children's play areas, the development of the Springslade Café, and Go Ape at Birches Valley

Question 35: Are you aware of any conflicts between different types of visitor user groups? If yes, please specify.

Options offered	Response %	Response count
Yes	**77.8**	**7**
No	11.1	1
Unsure/don't know	11.1	1

5.43 There can be conflicts between all user groups with inconsiderate people in all groups and conflicts even within groups. Specific mention is made of impolite or fast cycle riders, walkers not moving over and loose dogs, bike riders scaring horses, horse riders off bridleways.

5.44 The next series of questions relate to wild fires.

Question 36: Are there particular places where wild fires (accidental fires or those started by arsonists rather than management burns) are regularly started? If yes, please specify location(s) using grid co-ordinates.

Options offered	Response %	Response count
Yes	**70.0**	**7**
No	10.0	1
Unsure/don't know	20.0	2

5.45 Fires are more likely in areas close to housing and on heathland rather than in forestry. Specific locations mentioned were Brindley Heath, especially nearest Pye Green, Badger Hills, Huntington belt, Anson's Bank and occasional large fires in the Sherbrook valley started along Katyn track

Question 37: If you answered yes to Q 35, approximately how regularly do you consider wild fires are started?

5.46 Nearly all fires tend to be small fires quickly brought under control. There were slightly differing views on how frequent fires are; from 2-3 times annually (1), 3 times annually (1), 3-4 times annually (2) to 1-10 times annually.

Question 38: Where fires have been started have fire breaks been of material assistance in containment?

Options offered	Response %	Response count
Yes	**55.6**	**5**
No	11.1	1
Unsure/don't know	33.3	3

Question 39: Where there have been wild fires, have you any idea of the causes?

5.47 Nearly all fires are arson. Occasionally accidental due to discarded cigarettes, broken glass or (once) an unauthorised BBQ.

Question 40: Are wild fires more prevalent at any particular time of year? If yes, please specify.

Options offered	Response %	Response count
Yes	**88.9**	**8**
No	0.0	0
Unsure/don't know	11.1	1

5.48 Wild fires are more prevalent during school holidays, in spring and summer and after dry periods.

Question 41: Over the last ten years do you think that the frequency of wild fires has:

Options offered	Response %	Response count
Increased markedly	0.0	0
Increased slightly	**11.1**	**1**
Decreased markedly	0.0	0
Decreased slightly	33.3	3
Not changed	44.4	4
Unsure/don't know	11.1	1

Question 42: Is there a comprehensive fire plan for the whole of Cannock Chase?

Options offered	Response %	Response count
Yes	**80.0**	**8**
No	0.0	0
Unsure/don't know	20.0	2

5.49 The plan is being currently updated. It requires further thought about number and location of fire breaks and types of access for emergency vehicles.

Question 43: Is the system of fire breaks on the SAC now complete?

Options offered	Response %	Response count
Yes	11.1	1
No	22.2	2
Unsure/don't know	**66.7**	**6**

Question 44: How often and when are fire breaks cut?

5.50 Cut annually or twice a year or regular maintenance as necessary

5.51 *The final questions are about disturbance issues to wildlife. As the literature search in the Appendix notes, there is considerable evidence that disturbance by people and their pets can have serious impacts on the nesting birds of heathland.*

Question 45: Are you aware of any disturbance problems for ground nesting birds (e.g. predation by dogs or disturbance by people leading to nest failure? If yes, please specify.

Options offered	Response %	Response count
Yes	**60.0**	**6**

No	30.0	3
Unsure/don't know	10.0	1

5.52 Panel members mentioned dogs off leads, dog trainers and loose dogs, mountain bikers and egg collectors. It was suggested that field workers from a consultancy and the West Midland Bird Club had both commented on the high numbers of off-lead dogs running into vegetation. It was suggested by one panel member that disturbance had a far lower impact than weather and habitat management.

Question 46: Are there any areas you believe to be particularly sensitive to disturbance by people? If yes, please specify where, when and why.

Options offered	Response %	Response count
Yes	30.0	3
No	**40.0**	**4**
Unsure/don't know	30.0	3

5.53 Panel members mentioned heathland, the streams and mire communities and the humid heath near the cemeteries. Specific locations mentioned were Sherbrook Valley, Brocton Field, the southern part of Brindley heath, Milford Quarry and Womere .

General points

5.54 Panel members also made a number of more general points which are summarised here.

5.55 It is important to distinguish between visitor problems relating to the SAC and the wider AONB and between visitor types (e.g. local and frequent, tourists). Clear objectives needed to distinguish between the SAC and wider biodiversity targets for the AONB.

5.56 Achieving a balance between safeguarding fragile and sensitive habitats and providing for the legitimate rights of the public to visit beautiful countryside is a difficult balance. We must be careful not to see Cannock Chase as an under-used tourist attraction, but to maintain its interest and attractiveness to visitors some access controls are inevitable.

5.57 Many of the features for which Cannock is important are subtle and rare and not immediately apparent or quantifiable, but there is nevertheless a responsibility to protect them for the future.

5.58 There is a need for some very sensitive areas (e.g. Milford Quarry to be off limits to public visiting.

5.59 Does not believe there are real issues with visitors provided they are actively managed with provision of safe, well marked access to less sensitive areas. Cannock

Chase is of sufficient size with good woodland cover to carry greater numbers of visitors without a negative impact on local ecology.

5.60 Many of the problems could be better managed by having an area wide car parking strategy, with trails and facilities that deliver visitor requirements and resources could be found for this through car parking charges.

5.61 There are inconsistencies and inadequacies in the messages and information given to the public but different organisations with some promoting visiting and some not. Having well managed visitors with a basic understanding of the area they have come to visit is a better alternative to not promoting the area at all. If visitors do not understand and appreciate the area they will not value it, and will not change their behaviour to protect or contribute towards it.

Telephone discussions

5.62 A number of issues were further explored during telephone discussions with some of those who answered the questionnaire. These fell into a number of categories. Car parks, cycling, user patterns

5.63 Although those who answered the questionnaire were not in favour of car park closures, a car park had been closed some years ago with apparently little opposition from the public. Currently those car parks which have particular problems include Duffields on Brindley Heath, the car park opposite Duffields, Penkridge Bank, Coppice Hill and Marcus Drive. However, if these were to be closed at night they would either have to be re-opened very early in the morning (5.30 am) or early morning dog walkers would be moved elsewhere.

5.64 Car park charges (e.g. Milford Common and Marcus Drive) may have diverted people towards the SAC, and they may also have increased roadside parking although at the FC car park, verge works and policing by staff prevented road side parking nearby when charges were introduced. People might be channelled to different areas by charges in some car parks or differential parking charges between car parks. Season tickets for frequent visitors could be considered and are already available in the FC car park. Whilst the closure of Chase Road was not seen as possible, the suggestion that the road or part of it might be turned into a toll road was not rejected outright.

5.65 There was a clear consensus that cyclists had increased in recent years and that night riding with bright lights is on the increase. It was suggested that only some 20% of visiting cyclists hire bikes, the rest bring their own. On the FC land there are coloured cycle trails for beginners through to extreme sports cyclists although most are intermediate level, many of them as families. FC issues maps and a code of conduct for cyclists although these do not mention the SAC and there is no enforcement.

5.66 The view was that visiting tourists who wanted to cycle were easier to guide onto preferred routes than residents, as the former (at least when they start visiting) do not know the area and prefer to stick to marked Trails. Signs and way marks were

widely ignored by cyclists, although those put up by Chase Trails (a voluntary group that creates and repairs cycle trails) tended to be obeyed.

5.67 Temporary signage can work for a time but in the longer term physical barriers only are effective. Using brash to block off path entrances are simply bypassed by cycle riders and obstruction of the whole length of a path is often necessary. There are some websites on local cycle routes but it is also possible that there are unofficial networks whereby cyclist can communicate with each other. Visiting cyclists can see the route ahead more easily on open heathland than in closed woodland which may be a factor in making the former an attractive destination.

5.68 It seems clear that there are marked differences in attitudes and behaviours of local users and tourists and that there is a marked increase in visitors at weekends. There is no comprehensive strategy for the giving of information on the sensitivity of the SAC although the AONB has tried to introduce a more strategic approach to the giving of information.

Summary

There was a general view that walkers, dog walkers and commercial dog walkers as well as numbers of cyclists had increased over the last ten years but there had only been a slight increase in horse riders, with an increase in trekking centres suggested as the main cause of the increase.

Responses were fairly evenly divided between those who thought visitor numbers were about right or too high and those who thought they could be increased without detriment. It was noted, however that there were existing conflicts between almost all types of user, and in some cases within user groups.

Increases in visitor numbers could lead to increases in all the problems derived from visiting including conflicts between users, erosion, litter, problems in car parks, fires, disturbance to wildlife, widening of paths and creation of new routed leading to habitat fragmentation, soil enrichment and spread of disease. However, panel members pointed out that these effects were not evenly spread either temporarily or spatially. Established alien plants were seen as a problem but additional introductions of non-native plants and animals were not.

Most users stay on paths and there are a number of places where soil compaction and erosion have occurred due to heavy local use and topography (steep slopes for example). The SAC was specifically mentioned as having suffered soil erosion and where repeated management to deal with this has been necessary. Trampling damage to vegetation has also taken place within the SAC and SSSI and the Katyn track and Brocton Coppice are both mentioned in this context. The most sensitive areas were seen to be the heathland and wetland habitats.

Dogs were seen to cause problems by fouling, chasing deer, cyclists and vehicles and causing disturbance to wildlife. Disturbance to ground nesting birds was seen as a problem with dogs and mountain bikers being the main causes.

Littering is a problem in both heavily used and more quiet areas with fly tipping and dumping of garden waste more concentrated near to housing areas. The dumping of burnt out cars is less of a problem as scrap prices have increased. Methods of managing visitors by signage, interpretation, press articles, prohibited access and asking for dogs to be kept on leads have almost all been unsuccessful. Properly designed and enforced car parking with physical barriers to prevent roadside parking can work.

However the expert panel did not see car park closures as effective in combating illegal or undesirable activities although closures might be useful for management reasons: to protect sensitive or fragile habitats for example, and night time closures might also help to prevent unsocial activities in some car parks.

There was only moderate support for car park charges in all car parks but considerable support for charging in selected car parks. This was seen as a way of redistributing visitor pressures rather than reducing them overall, depending on charging levels. It was suggested that an overall car park charging strategy was need for Cannock Chase.

It was also suggested that visitor numbers and distribution could have been affected by the siting of new commercial attractions e.g. Go Ape and trekking centres, as well as by better facilities for visitors and development of new trails dedicated to particular users particularly cyclists.

Wild fires had not increased in frequency in recent years but tended to occur in the same areas and were almost all arson. Fires are most frequent in school holidays and during dry weather. Further thought need to be given to the system of fire breaks

6. Literature Review of Impacts of Access to Heathland Habitats

Litter

6.1 Litter is a ubiquitous problem across any type of public space and can pose a large problem in the natural environment. It can range from large volumes of roadside fly tipping to a small number of discarded food wrappings. It can occur anywhere, regardless of habitat, although generally more prevalent in areas with greater public access. Despite the unpleasant visual impact it may have, there are other, potentially more damaging, effects that litter may pose in the natural environment.

6.2 Wildlife can become trapped inside, caught up in or injure themselves on discarded litter. While injuries can be relatively minor, it can also result in death, especially in the cases of entanglement or entrapment. This can include items such as bottles, small containers or broken glass. One study in 1965 noted that ten different species of British mammals were found trapped in discarded bottles (Morris and Harper, 1965), while a more recent study in North America found that 795, or 4%, of the discarded bottles found alongside roads contained either a small mammal, lizard or salamander (Benedict and Billeter, 2004). Alternatively, wildlife may ingest litter which can cause internal injury or infection and may also result in death.

6.3 Discarded food litter, be it deliberate or accidental, can pose a problem. In some cases animals can learn that people provide food and as a result may either endanger themselves by approaching people or vehicles or become dependent on it as their source of food. The consequences of both deliberate and accidental feeding of wildlife are well documented and include increased tameness resulting in greater vulnerability to poaching or harm, the spread of disease and waste food attracting rats (see Green and Higginbottom 2001) and Higginbottom 2004 for review). In other cases food can attract rats and other scavengers, such as foxes and crows, which are in turn predators of other species. The association of crows (Neatherlin and Marzluff, 2004, Taylor 2002) and foxes (Harris and Rayner, 1986) with people is well documented. In other circumstances, when broken down, food may also enrich the soil which can have local impacts to vegetation (see later section on fouling and enrichment).

6.4 Litter may also contain toxic substances which can pollute the soil, and may either find their way to and pollute a water course, kill or damage the immediate vegetation, or once assimilated into plants have damaging effects on those animals which consume them. Litter can also be non-biodegradable which can affect local vegetation by producing indefinite shading. There are no known studies on the impacts of litter to the natural environment by this mechanism.

6.5 Despite such concerns, litter and dumping of rubbish are rarely explicitly identified as a nature conservation issue, and there is cause for concern for few habitats – but see work on heathlands (Underhill-Day, 2005).

6.6 The occurrence of litter in the natural environment can be deliberate, for example by people leaving behind the remains of their picnic, or accidental, for example blown out of overflowing refuse bins. While the information or number of studies that show litter as being a problem for wildlife is limited, there is a wealth of anecdotal evidence of its potential impacts. Nevertheless there is no evidence that any of the impacts of litter have any significant population consequences, and may only be of conservation concern to the rarest species. Similarly, very few studies attribute the impacts that litter can have to a particular habitat, however habitats that would be most vulnerable to the effects of litter are likely to be those supporting small to medium vertebrates such as mice, shrews, badgers, foxes. The seasonality of the impacts of litter will vary according to habitat and when the most vulnerable species are present or most active, however the persistence of litter within the natural environment may result in some impacts being present year-round.

Nutrient Enrichment

6.7 The commonest and most widespread cause of nutrient enrichment to the natural environment as a direct result of recreational access is through fouling is by domesticated dogs. The deposits of horses may also cause localised problems and human fouling can be a very localised problem in more remote areas a long distance from toilet facilities, especially where overnight parking or camping takes place. Along roadsides discarded food waste can also be a problem.

6.8 A number of reviews have addressed the impacts of dog fouling (Taylor et al., 2005, Taylor et al., 2006, Bull, 1998). Dogs will typically defecate within 10 minutes of a walk starting, and as a consequence most (but not all) deposition tends to occur within 400m of a site entrance (Taylor et al., 2005). In addition most deposits are approximately 1m from the path edge (Shaw et al., 1995). Similarly, dogs will typically urinate at the start of a walk, but they will also urinate at frequent intervals during the walk too. The total volume deposited on sites may be surprisingly large. At Burnham Beeches NNR over one year, Barnard (2003) estimated the total amounts of urine as 30,000 litres and 60 tonnes of faeces from dogs. Limited information on the chemical composition of dog faeces indicates that they are particularly rich in nitrogen and that modern dog food contain an excess of nutrients to improve flavour and any excess is excreted (see work cited in Taylor et al. (2006) and Taylor et al. (2005). Semi-natural grasslands generally have levels of available phosphorous below 8 mg kg-1 (Gilbert, 2000), while studies have shown that in areas of high dog use these levels are ten times higher (Bonner and Agnew, 1983).

6.9 Nutrient levels in soil (particularly nitrogen and phosphorous) are important factors determining plant species composition and on heathland, the typical effect will be equivalent to applying a high level of fertilizer, resulting in a reduction in species richness and the presence of species typically associated with more improved habitats. Consequently a lush green strip is often evident alongside paths as nutrient enrichment can also lead to more vigorous growth and flowering (Taylor et al., 2006).

6.10 In a study on a heathland site frequently used by dog walkers, available soil nitrogen and phosphate was consistent with the spatial distribution of dog faeces which were most numerous within 1m from the path and correlated with a conversion from a heathy to grassy sward (Shaw et al., 1995). The same was also true for sand dunes at a site receiving a large number of dogs, where nutrient enrichment was observed alongside paths, a zone of rye-grass was observed and the typical flora remaining tended to be more luxuriant and flower more profusely (Taylor et al., 2005, Milwain, 1984). It must be noted however that trampling also has an impact on the floristic composition near paths and is therefore highly correlated with the occurrence of dog faeces, however it is thought that trampling exacerbates the problems that occur due to nutrient enrichment (Shaw et al., 1995).

6.11 Very little is known about the nutrient composition of dog urine and its impacts on habitats. It is however known that dog urine can scald vegetation and does provide some enrichment of soil nitrogen (Taylor et al., 2005). It is also known that urine does more damage on dry soils because the salts cannot disperse as easily. One study has shown that dog urine around the base of trees significantly alters the encrusting algal and lichen communities (Gilbert, 1989).

6.12 The persistence of dog faeces and nutrients in the soil will be subject to a number of factors, but primarily the soil type, soil water, weather and temperature. Dog faeces can take up to two months to break down, however if the weather is cold and dry this is likely to take longer, whereas if it is warm and wet it is likely to take less time (Taylor et al., 2005). The persistence of these nutrients in the soil is strongly influenced by the soil type. In one study it was calculated that phosphorous derived from agricultural fertilisers persist between 15 and 20 years in sandy soils, (Gough and Marrs, 1990). While the visual evidence of fouling only remains for a short time, the nutrients persist for far longer in the soil and therefore it can be considered that there is little seasonality in the vulnerability of a habitat to nutrient enrichment from fouling.

6.13 There is very little evidence of the extent of the problem of human fouling or the nutrient persistence in the natural environment. Problems, however, are likely to be highly localised, and the visual and nutrient persistence of human fouling is likely to be similar to that of dogs, however there is no evidence to confirm this assumption.

6.14 Another route by which enrichment through fouling can occur is from horses. It is likely that some impacts do occur as a result of soil enrichment by horse faeces (Newsome et al., 2004).

6.15 Liddle and Chitty (1981) compared soils from paths and areas away from paths at Chobham Common, a heathland site in Surrey. The paths were well used by horse riders. Path soils tended to have higher nutrient contents than un-trampled soils and their fertility was higher in relation to adjacent areas. The authors suggest that this may be due to dung deposited from horses, whose food is grown outside the heathland ecosystem.

6.16 The critical thresholds for the deposition of atmospheric nitrogen (in particular ammonia and nitrous oxides) which is likely to cause a change in the vegetation on heathlands range from 10 to 20 kg N ha-1 year-1., although figures as low as 5-8 kg N ha-1 year-1 have been proposed as the critical load for acid dune grassland (Emmet et al, 2011, Hall et al 2008, Remke, E. 2009) Nitrogen deposition leads to the gradual competitive exclusion of characteristic plant species by more nitrophilic (nitrogen-loving) plants, especially on poorer soils such as those underlying heathlands indicating that low levels of deposition can have a significant impact (Bobbink, et al 1998, Taylor et al., 2005). Nitrogen deposits from vehicles on adjacent heathland are closely correlated with the amount of traffic carried on the road and effects have been measured out as far as 200m on a busy double carriageway, but with far smaller distances on minor roads (Angold 1997)

Alien non-native introductions

6.17 Invasive non-native species are seen as one of the greatest threats to biodiversity (Williamson 1981) with an estimated 20-30% of all introduced species causing problems (Pimental et al 2001) and the number of non-native species increasing exponentially as a result of increased travel, transport, trade and tourism (Clout & De Poorter 2005). Species can hitch-hike on bags , rucksacks and clothing or footwear or through dumped waste material and can not only pose a threat to natural ecosystems and other species but can also have direct costs for eradication or control. It has been estimated that about £10 million is spent on control of non-native species for the benefit of biodiversity each year in England alone (Williams et al 2010).

6.18 There are few examples in the literature of alien species being introduced as a consequence of recreation, but rather there are some species whose spread is aided by recreation, mostly in aquatic environments. Edgar (2002) states that random fish introductions to ponds, i.e. those not associated with the purposeful stocking of fish for recreational or commercial fishing, dramatically increases in locations with public access. He describes the common practice of transferring fish from garden ponds when they become too big or the pond is to be in filled, to ponds in publicly accessible places, with the person transferring the fish believing they have ‘done the right thing’ for the fish. Alien species within the aquatic environment cause significant reductions in native aquatic animals, and in some cases can eradicate native fauna completely.

6.19 Beebee (1997) found that the introduction of goldfish to two ponds within his long term study of ponds within the Sussex chalk downlands resulted in the extinction of the great crested newt populations. Both frog and toad tadpoles as well as dragonfly nymphs and other aquatic invertebrates can also be consumed by introduced fish. Edgar (2002) notes that one of the most veracious predatory alien species is the terrapin, brought to ponds in publicly accessible places and released.

Terrapins will feed on juvenile and adult amphibians, and can therefore quickly eradicate a pond of its newts, frogs and toads.

6.20 On heathlands, there can be serious problems with rhododendron and *Gaultheria shallon*, as well as pirri-pirri bur on lighter sandy soils, and (Gynn & Richards 1985, Symes & Day 2003). Rhododendron is found on Cannock Chase around the former cemeteries and near Shugborough Park but has been much reduced by management, and Himalyan Balsam *Impatiens glandulifera* has invaded at Seven Springs (S. Sheppard pers. Comm).

6.21 Horse droppings can also serve to distribute seeds. Weaver and Adams (1996, cited in Landsberg 2001) recorded 29 plant species germinating from horse manure samples collected from horse trails in three national parks in Australia. An experimental study by Finnish researchers found that a number of introduced species were able to establish themselves in study plots treated with horse manure. Moreover, there was an interaction between horse manure treatment and humus removal treatment indicating that the non-native species were more likely to establish themselves in protected areas when the vegetation and soils are prone to trampling disturbance either by horses, hikers or other users. There is a lack of evidence on the extent to which horse droppings act as a dispersal vector for seeds within the UK. Lake (2002) found no evidence of seedlings germinating from pony dung on several lowland heathland sites grazed by ponies in southern England.

Disease

6.22 A group of microscopic fungal pathogens, *Phytophthora* ssp are responsible for tree deaths throughout the world (Brasier 1999) and can also affect a wide range of woody shrubs including heathland dwarf shrubs (Beales 2010.) These pathogens may be inadvertently transported by people or dogs (Defra 2008). A dramatic and worrying example is the recent appearance of the plant pathogens *P. ramorum* and *P kernoviae* , which causes death in susceptible species of trees and shrubs(and can also affect some dwarf shrubs, particularly European blueberry *Vaccinium myrtillus* (CSL 2005a, 2005b). Studies in the U.S. have found that *P. ramorum* more commonly occurred in soils on heavily used tracks compared to soil from adjacent areas off trails. Human-induced dispersal occurred within already infected areas and into areas lacking local sources of inoculum (Hall Cushman and Meentemeyer, 2008) and soil on car tyres, the feet of animals and hiker's boots have been implicated in the spread of the pathogen (Tjosvold et al 2002, CSL 2005 b).

6.23 On Cannock Chase, European blueberry was found to be infected with *Phytophthora pseudosyringae* in 2009 which spread quickly through the Blueberry population, possibly assisted by deer. A considerable effort has been made to contain the disease and research is ongoing to find an effective of control (Grout et al 2010)(Staffordshire County Council In prep). These three species of *Phytophthora* can all infect *Rododendron ponticum* which is main sporulating host. There is concern that the disease may spread to other species, particularly ancient trees at Cannock. *P. kernoviae* and *P. ramorum* are both known to infect a range of tree

species, but in Cornish woodlands, the removal of the Rhododendron resulted in no newly infected trees in the following two years, and removal of Rhododendron in historic gardens has also been shown to prevent new plant infections (Scottish Government 2008)

Trampling

6.24 Trampling can lead to soil compaction and erosion, resulting in changes to the structure and character of the soil or its removal down-slope. These changes can have effects on the soil flora and fauna, which may be temporary or more permanent, positive or negative. Erosion is a natural process and the contribution of recreational activities can damage ecosystems and affect amenities and landscape at a local scale.

Compaction

6.25 In general, trampling can result in the destruction of vegetation, the break-up and dispersal of litter and loss of organic soil layers, and on light soils, erosion of the top layer of the subsoil as well as compaction of the remaining layers. Soil compaction increases soil bulk density by reducing the volume of soil pores containing water and air resulting in a reduction in the suitability of the soil to support living processes. Compaction is greatest in fine grained soils containing clay and least in coarse soils such as sands and gravels. Wet soils compact more easily than dry soils. Loss of air from the soil leads to low oxygen levels and higher levels of carbon dioxide. Compaction reduces the free passage of water down through the soil and can lead to water standing on the surface resulting in run-off, which can cause erosion. Compaction of soils can reduce water absorption to as little as 3% of that in un-trampled soils (Cole 1992). Compaction is greatest in the top 15cm of the soil.

6.26 The physical action of hooves, feet or wheels may also loosen or displace some particles, and this together with the reduction in plant cover, leads to soil erosion. This can be accentuated by the fact that rainfall cannot easily penetrate the compacted soil and hence a greater proportion flows over the soil surface.

6.27 Compacted acid soils tend to become more alkaline while compacted alkaline soils tend to become more acid, both stabilising at about pH 5.5. Nutrient levels may also change, but can increase as well as decrease. Compaction can also contribute to widening temperature ranges with compacted soils being warmer by day and colder at night. Moore (1974) found that the removal of vegetation and soil compaction resulted in an increase in daytime temperature of 9°C and an increase in night time temperatures of 1°C.

Erosion

6.28 Soil erosion affects both the donor and the receptor site. At the donor sites, erosion can remove the most biologically and nutrient rich surface layers, including seed banks and litter. At receptor sites, eroded sediments can cover vegetation and pollute or block drainage channels and watercourses. Eroded soil can transport nutrients, minerals, pollutants and propagules of both plants and animals.

6.29 Soil erosion is caused by rain splash, overland water flow, which can cause rill and gully erosion, subsurface flow and wind. Erosion from water is greater on slopes, and wind erosion is greater on features which lie in line with the predominant wind direction. Light, sandy soils are most liable to wind erosion, including sandy heathland soils. Erosion is initiated in most cases by rainfall energy. Erosion rates are primarily from run off, the speed of which is largely determined by the slope of the ground and the intensity and periodicity of precipitation. However, erosion rates are also dependant on the availability of sediment at the soil surface, the availability of which is affected by vegetation cover, which varies seasonally (Ceballos et al 2002). In addition, run-off is greater, and begins sooner, from compacted than from un-compacted soils, and from wet soils than from dry. Erosion can also be increased where trampling has turned a wet soil into a liquid (Liddle 1997, Deluca et al 1998, Green 1998).

Damage to vegetation

6.30 Trampling causes damage to and loss of plant parts, and the effects on and responses by individual plant species will differ. Grasses will often tolerate higher levels of trampling than dwarf shrubs. (Lake et al. 2001). The impact of wear is least in the growing season (Liddle 1997).

6.31 In a comparison of trampling damage to grassland and heathland in Southern England, Harrison (1981) treated plots with 400 passes/week for five weeks in summer and 100 passes for four weeks in winter. She recorded recovery levels at seven weeks after summer trampling, at the start of the winter treatments in February/ March and six weeks later. She found that cover was reduced in all plots by 50% after the first week of summer trampling (400 passes), and that after the fourth week, this had dropped to less than 10%. Seven weeks after the summer passes, the unmanaged acid grassland plots had recovered to at least 50% live cover, but the managed acid grassland (mown annually) and *Calluna* heathland showed least recovery.

6.32 All plots had recovered further by late winter except the heathland, and Harrison suggested that Calluna was poorly adapted to recover during winter from trampling the previous summer. Winter trampling eliminated the grass cover on the acid grassland plots, but did the least damage to the heathland. All plots showed recovery in spring except the Calluna heath where the live cover continued to decline. Harrison concluded that the vulnerability to trampling was related to soil structure and drainage in winter, and to plant biology in the summer. Nutrient poor, coarse textured inorganic soils were affected more than fertile organic soils.

6.33 A study in central Norway looked at the effects of visitor trampling over four years on dry, damp and mesic grasslands on brown earth and peat soils and wet and dry heathland (Arnesen 1999). The trampling pressure varied between 300 passes per annum on the mesic grassland and dry heath, to 1800 on the dry grassland. By year four, a large proportion of species (on average 43%) had been eradicated except on the dry heath and mesic grassland where trampling levels were lowest. Vascular

plant species declined by 34% but liverworts declined by 73% and mosses by only 16%. The greatest loss in field layer cover took place on the dry heathland (95% by year four), with a reduction to 19% in the wet heath and 37% in the grasslands. Some vegetation types, notably those of bogs, and those with a high frequency of lichens are intolerant of high trampling intensities (Anderson & Radford 1992, Arnesen 1999).

Studies of experimental trampling of heathland in summer after periods of dry and wet weather, and in winter, in Brittany, France (Gallet & Rozé 2001, 2002, Gallet et al 2004), were summarised in the previous report on Cannock Chase by Liley et al (2009). The overall conclusions from these studies by Gallet et al were that:

- Dry heaths are more resistant to trampling damage than wet heaths
- Dry heaths are more resistant in winter than summer
- Damage to wet heath is greater in dry conditions than wet, but recovery is quicker when damage is caused in dry conditions
- Recovery from winter trampling is greater on wet heath than dry.
- Gorse is more resilient to winter than summer trampling
- Bell heather is most resilient to summer trampling in dry conditions
- There is less damage from trampling after a single event than from repeated trampling where the total number of passes was the same in both treatments

6.34 The authors suggest that trampling pressures on heathland should be reduced by about 30% after wet days in summer compared to periods after dry days, and that trampling levels overall should be about 50% less on mesophilous than on dry heath. At Cannock there are areas of dry heath and humid heath with the response of the latter to trampling possibly more akin to that of wet than dry heath.

6.35 On neutral grassland in Russia, Rogova (1976) noted that at 14 tramples a day the total vegetation cover declined to 50% within 20 days but at 350 tramples a week it reached the same level in under ten days. He also found that trampling at weekends only allowed some re-sprouting but that trampling throughout the week at 50 tramples/week allowed no recovery.

6.36 Recreational use can affect soil texture, aggregate stability, shear strength, water absorption properties and organic and chemical content of soils, all of which affect its vulnerability to erosion. The removal of vegetation through trampling can initiate soil erosion, which can become significant by the time 30% of the vegetation cover has been removed (Liddle 1997). Recreational paths, trails and tracks can provide a ready-made route for gully erosion, and human activity on slopes can accelerate soil creep. On chalk rubble in woodland, Speight (1973), found there was a six-fold increase in the downward creep of chalk rubble where visitors had walked or scrambled on the slope. Watson (1985) reported that on slopes of 15°, there were repeated foot slippages on disturbed ground with the rate of slippage increasing to 80% on slopes above 29°. Foot slippages increased the loosening of the soil and

vegetation. Erosion increases with the intensity of use and continues after the use has finished (Kuss 1983, 1986).

6.37 Soils can be protected against erosion by vegetation, with protection between 100 to 500 times greater than for unprotected soils. Woodland with a ground layer is probably most effectively protected, followed by grass cover, litter cover and scrub cover. Even open scrub can be an effective inhibitor of erosion. A gorse scrub cover was found to be very efficient in retaining sediment even under a high rainfall event (Gonzalez-Hidalgo et al 2004).

6.38 Vegetation can also protect the ground from daytime temperature extremes. Liddle (1987) found that in chalk grassland, trampled paths were frozen to a depth of 3-4cm after severe frost whereas under taller vegetation, soil temperature was above freezing. These differences can have effects on over-wintering invertebrates.

Different users

6.39 Erosion will also occur both during and after recreational activity (e.g. Kuss, 1983). Different types of user will exert different pressures on the ground depending on a range of circumstances. However, the downward force exerted by a pedestrian is generally far lower than from a horse and rider or vehicle (Liddle 1997; see Table 1).

Table 1: Total weight, area in contact with the ground, and calculated stationary pressure exerted on the ground in association with a range of outdoor recreational activities. Adapted from Liddle (1997)

Source of pressure	Average weight (kg)	Contact area (cm^2)	Static pressure (g cm^2)
Man wearing boots	80	388	206
Woman wearing boots	57	356	160
Unshod horse and rider	613	478	1282
Shod horse and rider	613	140	4380
Motorbike (Trail bike)	229	114	2008
Four-wheel-drive Toyota, empty	2 100	1355	1550
Four-wheel-drive Toyota, with four people and gear	2 500	1483	1686

6.40 It is apparent from the table that the pressure from a shod horse and rider is many times greater than a pedestrian and about twice that of a motor bike and 2.5 times that of a fully loaded four wheel drive vehicle. The effects of different users has been comprehensively covered in the earlier report by Liley et al (2009).

6.41 The reduction in cover of grassland vegetation caused by mountain bikes is estimated to be twice that caused by walkers and approximately half that caused by horse riders. Compared to human access on foot, motor-bikes create between one and 16.6 times more bare ground (Liddle, 1997). Wilson and Seney (1994) identified a similar pattern, but showed that lighter and low-powered bikes had less track impact potential than motorbikes.

6.42 In a study in the USA (White et al., 2006), the extent and severity of damage to trails varied between regions. The authors suggest environmental features such as soil

type and vegetation cover, variations in the intensity of use and user behaviour as possible explanations. Damage increased with slope at three of the five regions.

6.43 A number of studies show that the short-term impacts of mountain biking and hiking (when compared at similar intensities of use) may not differ greatly (Thurston and Reader, 2001; White et al., 2006). The immediate impacts of both activities can be severe but rapid recovery should be expected when the activities are not allowed to continue.

6.44 While track damage has consequences for other users and management of the site it is difficult to link such damage to nature conservation. Where there are key species associated with bare ground or track sides then trampling and cycling may be an issue. For example Edgar (2002) describes tracks at Canford Heath, Dorset as rendered unsuitable for sand lizards due to the activity of cyclists, and Miles (2003) notes that galloping horses can destroy sand wasp nests especially in winter. On the other hand, some ground disturbance can create suitable conditions for annual and ruderal heathland plants (Lake et al 2001) and for many bare ground invertebrates Key 2000

6.45 Detailed monitoring of paths in D'Entrecasteaux National Park, Western Australia was conducted by Newsome and Philips (see Newsome et al., 2002). The relative frequency of plant species, percentage vegetation cover, vegetation height and soil depth were recorded along experimental transects subject to trampling intensities of 0, 20, 100, 200 and 300 passes by a horse and rider. Horse riding changed the relative frequency of plant species by causing a decline in the native herbaceous plants and the percentage of bare ground increased from 5.2% (0 passes) to 31% (300 passes). There was also a rapid reduction in percentage vegetation cover following 20 and then 100 passes. The greatest amount of decrease in vegetation cover was 34% between 20 and 100 horse passes with the most significant rate of decrease (15.4%) in the percentage of vegetation cover occurring between 0 and 20 horse passes. The greatest amount of change in vegetation height (56.5 mm) occurred between 0 and 20 passes, the level of intensity that also produced the greatest reduction in soil depth (8.1mm). It is not known to what extent such results are applicable in different countries, however they do provide evidence that horse riding impacts can occur at relatively low intensities of use.

6.46 Compared to human access on foot, horses create between 1.7 and 4.4 times more bare ground (Liddle, 1997). Impacts vary according to habitat. For example, erosion caused by horse riders on forested trails in Finland (Siikamäki et al., 2006) was lowest in the driest forest type with a lichen-rich ground flora, compared to forest with a dry heath under-storey or moist forest characterized by a bog myrtle dominated ground flora.

6.47 The act of repeated trampling on existing vegetation creates new paths and tracks and these, together with the creation of firebreaks, results in the fragmentation of the heathland habitat. This could be particularly important for those invertebrates which show limited dispersal abilities (Mader, Schell, & Kornacker 1990), with

smaller heathland fragments and edge permeability being two of the main determinants of invertebrate diversity and movement (Webb 1989)(Stamps, Buechner, & Krishnan, 1987). However, as this impact study has shown, where the fragmentation is within the heathland footprint, it is likely that the loss of heathland habitat will be more significant than the fragmentation effects.

Fire

Introduction

6.48 A distinction needs to be made between a controlled fire and a wild fire. A controlled burn is a deliberately started fire, with the intention of burning off excess or old vegetation in a controlled or managed way in a defined area (Gimingham, 1992, Webb, 1997). A wild fire is a fire which is not controlled and can spread in an unpredictable way until it goes out or is put out. Such wild fires may be caused accidentally from discarded cigarettes, by sparks from a campfire, BBQ or from burning a dumped or stolen car, from fireworks, as a result of a controlled fire getting out of control, from discarded bottles in strong sunlight, from children playing with matches or similar, and from deliberate arson (Anderson, 1997, Tucker 2003). A study or recreational fire rings used for cooking found that these tended to be near streams, away from forest roads and close to open spaces in the forest (Hegetschweiler, 2008)

6.49 Based on 217 questionnaires from a sample of lowland heaths in Dorset, Kirby and Tantram (1999a) found that 61% of fires were caused by arson, 8% from management fires getting out of control, 7% from bonfires and the remainder from camp fires, burning refuse, vehicle fires, property fire and sparks from a railway. The only natural cause of fire was from lightning. A number of studies have linked the incidence of fires with areas used by the public. In the Peak District National Park during 1970-1995, 84% of 324 recorded fires were next to roads, paths or within areas of open access, and many burnt areas on Exmoor are close to public roads. Murison (2007) noted that wildfires occurred more frequently on those heaths attracting a high number of visitors; they usually originated near areas of human activity such as access points and paths; and were regularly started in areas adjacent to paths.

6.50 Kirby and Tantram (1999a) found that during the period 1990-1998, wildfires could occur at any time of year but were most common between April and August. Fires were more likely to occur at weekends than weekdays (a finding also noted by Anderson (1986) in the Peak District), during school holidays than term time, and during the afternoon and early evening than at other times of day. A possible explanation for this latter finding is that this is the period when children come out of school and working parents have not yet come home. In another study on heaths Murison (2007) found that 77% of wildfires occurred between April and September, with the peak wildfire frequency in April with 23% of the fires. Fires on the higher moorlands away from urban areas do not share this daily occurrence pattern due to

the greater effort and time needed to access them, and the predominance of daily visits by recreational visitors rather than school children.

6.51 A further analysis of these data, and a further data set for lowland heathland for 2003 by Rose and Clarke (2005) showed that the number of wildfire incidents varied widely between years. Fires were more common in the summer months than winter months and there was no evidence that fires were more or less common in 2002-3 than in 1993-8. They also found that generally there were fewer fires between Tuesday and Thursday than between Friday and Monday and that the median start time for fires was between 16.00 and 17.00 hours whether or not it was term time.

6.52 Fires can result in medium or long-term damage to ecosystems. The effect of a fire depends on its intensity, which is determined by the heat generated and the period of time the heat is applied. A hot fire moving slowly over the ground can cause far more damage than a superficial fire moving quickly. Factors which influence the intensity and extent of a wild fire are the pattern, quantity and combustibility of the vegetation, the prevailing weather conditions particularly relative humidity, sunshine, ambient temperature and wind direction and the topography of the site (Kirby and Tantram, 1999a, Tantram et al., 1999). They suggested that the risk was high when, in a given 10/11 day period, the number of sunshine hours reaches 100, cumulative relative humidity is<600% and there has been <5mm of rainfall overall. Anderson (1986) recorded that the number of fires in the Peak District National Park were nearly 80 times higher in the very dry year of 1976 than in the wetter year of 1973. She also found that on the moorlands, compared with lowland heathland, the incidence of fires increased substantially after a month of below average rainfall, and with concomitant high temperatures.

6.53 In the UK, most studies on fire have been carried out on lowland heath or moorland. This is because fire has been a standard management technique on these habitats for centuries and is still practised for commercial reasons, and much of the vegetation is therefore fire adapted. Many of the studies concern managed winter fires. In practice, as vegetation is usually drier in summer than winter, summer wildfires may consume more of the vegetation than would normally be burnt in a controlled winter fire. Summer wildfires can be hotter and more intensive than controlled winter fires, removing litter, destroying vegetation and burning down into organic soils.

6.54 In Dorset, between 1959 and 1998 the record strongly suggested a reduction in total areas burnt over the previous 30 years (Webb, 1997, Webb and Haskins, 1980, Webb, 1990, Rose et al., 2000). A reduction in the number of fires (58) was also recorded on Yateley Common to Castle Bottom Common in Hampshire by (Liley, 2004), compared to an earlier survey (76 fires) by Hall (Hall, 1996). The median size of fire at Yateley in 2004 was 0.0009ha with only five fires above 0.1ha, and two above 1ha and no obvious proximity of fires to car parks. In studies in Dorset, (Rose and Clarke, 2005) reported that, of 203 fires in 2002/3, only six burnt more than 1ha, 83% of fires were smaller than 0.1ha, and one fire, of 60ha represented 62.1% of the

total burnt area, and Murison (Murison, 2007) found that average wildfire size was 0.81 ha with 96% of burns covering less than 0.5 ha and only two of 103 fires exceeding 10ha in size. All these studies point to the fact that most wild fires are very small but occasionally a much larger fire occurs.

6.55 In the Peak District National Park Anderson (1997) recorded the numbers of annual fires 1970-1995 between 1 and 79, ranging from less than 0.1 ha to 1210 ha in size. There was no apparent reduction in average size or numbers of fires over the period despite considerable efforts to control this. McMorrow in Glaves et al (2005), noted that there were more uncontrolled fires in the Peak District in April (35) than September (9) during 1971-2000. A similar pattern has been reported for Dartmoor (Kirkham in Glaves et al 2005). February to June are the driest months in the Peak District, and combined with higher temperatures later in spring would account for this pattern.

6.56 The heat and variability of the temperature in a fire is partly a function of the age and structure of the vegetation which can determine the fuel load (e.g. dry grasses, scrub, heather *Calluna vulgaris* and other woody plants). Following a fire, regeneration will depend on the character of the pre-burnt vegetation. As the structure and composition of the vegetation affects its flammability, previous management that removes vegetation such as cutting or grazing, will affect fire temperature, intensity and spread.

6.57 A normal, controlled fire in upland heath will reach an average temperature of between 400-600°C, which will be sustained for about two minutes as the fire passes through the vegetation (Mallik and Gimingham, 1985) In grassland, average temperatures were higher, particularly in tussocks at between 560-805°C, and lasted about one minute except where tussocks were dense (Lloyd, 1968). Apart from the mean temperature of 360°C on lowland dry heath measured by (Allchin, 1997), in most fires a maximum fire temperature of about 8-900°C was attained regardless of habitat. Fires can also back burn and change direction with wind eddies, or small scale changes in the flammability of the vegetation, thus providing significant variation within a single event. Fires can, therefore, re-burn areas, and penetrate down into the peat, possibly burning here for days or weeks. Where there is a considerable quantity of inflammable material fires can be very intense with flames reaching 10m in height in gorse fires, and 5m in reed fires (George, 1992).

6.58 Temperatures at the ground surface can be as high or higher, than in the canopy of heather, but normally, 1cm below the soil surface, the temperature will remain below 100°C (Hobbs and Gimingham, 1984b). The effectiveness of the litter layer as an insulator will depend on its thickness and moisture content (Valette et al., 1994).

6.59 On dwarf shrub heath, heather regenerates from stock or seed after fire to form a low carpet of young plants, the 'pioneer' phase, before increasing in height and covering the ground during a 'building phase'. In due course, the heather achieves almost complete dominance, the 'mature phase', before starting to collapse,

opening up the canopy and with a mosaic of dead, dying and still healthy plants; this is the 'degenerate' phase (Watt 1947).

6.60 The temperature of fires in each stage from pioneer to degenerate heather generally increases and becomes more variable, particularly in the degenerate phase (Hobbs et al., 1983, Hobbs and Gimingham, 1984b) and on wet heaths (Currall, 1981). Fire intensity (heat released per unit area), will be determined primarily by the fuel load consumed, and this will normally be greater in older stands. The temperature and rate of spread of a fire will be affected by wind speed and fuel distribution (Hobbs and Gimingham, 1984b), air temperature (Brown and Davis 1973 in Allchin 1997) and relative humidity, which will influence moisture content of vegetation, litter and soil (Trollope, 1984).

6.61 On lowland heathland, the main study on fire temperature was carried out by Alchin (1997) on sites in Dorset and Devon. She generally found that fire temperatures in experimental winter fires in the vegetation were similar to those recorded in the uplands, but with lower temperatures at the litter surface than those above ground, a reversal of the situation in the uplands. Allchin concluded that the fire intensities in her lowland heath fires were not high enough to remove all litter, so seed bank and rootstocks were protected from high temperatures.

6.62 The main semi-natural habitats to be affected by wildfires are moorland and lowland heathland, due to the inflammable nature of the vegetation, the large areas involved which are often relatively inaccessible to the fire services, and the proximity of people.

6.63 There is a considerable literature on the effects of controlled fires which are mostly conducted on upland moors for summaries see (Tucker, 2003, Glaves et al., 2005) but few recent studies have been carried out on the effects of wildfires. By contrast, on lowland heathland, reviews of, and research into, controlled fires is sparse but see (Alchin, 1997). There is, however, a substantial literature on wildfires on UK lowland heaths, detailing the causes of fires, the size of areas burnt and the diurnal and seasonal frequency of fires (Rose et al., 2000, Hearn and Gilbert, 1977, Webb, 1997, Tantram et al., 1999, Rose and Clarke, 2005), Other studies have examined the subsequent effects on vegetation communities, invertebrates, reptiles and birds(for a review see Underhill-Day, 2005). No studies could be found on the medium and long term effects of repeated fires (except at upland sites in Scotland), or the differences between the effects of a controlled fire in winter and a wildfire in spring or summer.

Soils

6.64 Soils are protected from 'cool' burns by litter. Some of the fine ash particles may be washed into the soil pores, reducing infiltration rates, and increasing water retention and phosphorus levels (Mallik et al., 1984, Anderson, 1986) Water repellence on the surface of the soil may also increase in the short term after hot fires (Mallik and Rahman, 1985).

6.65 Relatively cool fires can partially sterilise the soil surface, disrupt biochemical processes increase pH slightly, and lead to nutrient loss (mostly nitrogen) through smoke and subsequent ash dispersal (Allen, 1964, Anderson, 1986). At temperatures above 300°C, nutrient loss in smoke increases rapidly (Evans and Allen, 1971)

6.66 In most cases, the main nutrients (potassium, calcium, magnesium), but not phosphorus and nitrogen, will be replaced on lowland heaths, through atmospheric inputs within a few years. Serial burning was associated with higher manganese, potassium, magnesium, sodium and pH on moorland at Tayside, while unburned sites had higher levels of organic matter, moisture content, nitrogen and available calcium (Stevenson et al., 1996). Burning can remove up to 30-35% of the accumulated nutrients (Hardtle, Niemeyer et al. 2007).

6.67 A number of studies have found increasing leaching rates after burning, threatening nitrogen pollution of heathland watercourses (Niemeyer, et al. 2005; Pilkington, Caporn et al. 2007). Leaching of bases such as calcium and magnesium can also increase after fire leading to increased acidity (Mohamed, Hardtle et al. 2007).

6.68 Disturbance by fire can also subsequently increase erosion rates through removal of vegetation and the exposure of the peat surface (Tallis, 1987, Phillips et al., 1981). In these circumstances, the soil surface is exposed to the direct effects of the sun, rain, frost and wind, and erosion will decline as the vegetation re-establishes (Tucker, 2003).

6.69 Where a severe fire has removed all vegetation and litter and surfaces are severely charred, and are susceptible to erosion by wetting-drying, heating-cooling and freezing-thawing, in the absence of vegetation, these processes would continue until the entire peat mass is lost (Maltby et al., 1990). Where peat soils are relatively shallow, ignition can be complete and the soil reduced to a layer of ash on top of the mineral substrate. After severe fire extensive areas of bare peat can still be found after ten yeas or more (Legg et al., 1992, Tallis, 1973, Yeo, 1997).

Vegetation

6.70 The recovery of heathland vegetation after a fire is a function of the composition of the plant community, the age of the plants since the last fire, the composition of the seed rain onto burnt areas and the characteristics of the fire itself (Hobbs and Gimingham, 1984b, Hobbs and Gimingham, 1984c, Hobbs et al., 1983, Marrs, 1986, Gloaguen, 1993.) As heather ages, there are fewer stems and flowers and the ability of the plants to re-sprout after a fire declines after about 12 years (Miller, 1970, Mohamed and Gimingham, 1970). Berdowski and Siepel (1988) found that 90% of stems sprouted from five-year old Calluna, but this figure declined to 10% in stands that were 20 years old.

6.71 Where fire kills the established plants, many species will persist through seed germination, although this takes longer initially as germination can lag behind re-sprouting regeneration by 1-2 years. Thus, burning of old stands of heather can kill most of the established plants and leads to seedling regeneration, which takes

longer. Fire temperatures of 500°C or more, lasting over a minute will kill the stem bases of heather, and a temperature of 200°C will kill heather seed, with short exposure to 40-60°C stimulating germination and higher temperatures and exposure times progressively reducing it (Whittaker and Gimingham, 1962, Whittaker, 1961) Most of the seed bank in heathland lies within the top 2-3 cm of soil (Legg et al., 1992).

6.72 A review of a rigorous sample of studies on burning on wet heath and bog found that although results were mixed; burning tended to promote the dominance of a few species; encouraged a move from dominance of ericoids to graminoids; increased the proportion of bare ground and resulted in a decreased abundance of key species (Stewart et al., 2004a). In all cases the burnt areas were within grazing blocks and the effects of grazing after burning were not assessed. Generally there were no consistent changes in species composition following burning but a trend towards an increase in bryophytes and the promotion of dominance of *Calluna vulgaris*, *Eriophorum* spp and *Molinia caerulea*, The review found that there had been only one study of rotational burning and few studies examined vegetation structure (Stewart et al., 2004a).

6.73 The review also found that there was no significant effect of burning on heathland plant diversity overall but that the effects of a single burning cycle can reduce biodiversity in old stands. Stevenson et al (1996) found that serially burned sites on dry heath were generally more heterogeneous floristically than unburned sites, which were generally dominated by ericaceous dwarf shrubs and bryophytes. Plant species richness varied with the time elapsed since the last burn and was generally better in burnt than in un-burnt stands, except in mature stands where it was higher in the absence of burning. Too frequent burning may encourage fire resistant species such as purple moor-grass and debilitated heather because it is burnt off too frequently (see Grant et al 1963; Miles 1987).

6.74 After a fire where temperature and intensity are more moderate, vegetation recovery will be largely influenced by the vegetation composition before the fire, although subsequent management, particularly grazing and trampling, will modify regeneration pathways. The less palatable or better-adapted species may be favoured by grazing, so that, for example, cross leaved-heath and the more unpalatable graminoids may benefit initially at the expense of heather. Burning of old stands of heather on a dry Scottish moorland resulted in initial colonisation by wavy hair grass *Deschampsia flexuosa* (Hobbs and Gimingham, 1984a). On wet heath, fire led to dominance by a range of graminoids that were not supplanted by dwarf shrubs for about 15 years (Currall, 1981). Where mat grass *Nardus stricta* dominance resulted from burning after an uncontrolled fire, heather had resumed dominance after nine years (King 1960). Stevenson et al (1996) found that two serially burnt stands of dry heath aged more than 19 years when burnt had lower species richness than un-burnt controls.

6.75 In Dorset, comprehensive heathland surveys in 1978 and 1987 allowed an assessment to be made of vegetation recovery rates and patterns following a severe fire in 1976 (Bullock and Webb, 1995). This found that the proportions of broad habitat types present before the fire were the same 11 years later after recovery. In scrub areas, however, there was evidence of some replacement of gorse by birch, and some increase in bracken cover.

6.76 Following fires on dry heath, initial colonisation by short-lived bristle bent grass *Agrostis setacea* peaked after four years and was replaced by heather, while on wetter areas, purple moor-grass initially increased but then gave way to heather. However, on dry, humid and wet heath, neither the extent nor composition showed any effects of the fires by 1987.

6.77 On southern heathlands in Brittany, following wildfires, the initial recovery and colonisation by bryophytes and grasses can delay recovery of dwarf shrub vegetation and it may take up to 20 years for heath to return, while on the better soils, and where there is no grazing, fire may encourage the regeneration of birch woodland (Clement and Touffet 1990; Gloaguen 1990). However, occasional burning may also remove litter and slow nutrient build up, and thus help to prevent the replacement of nutrient-poor conditions dominated by ericaceous shrubs with richer, grass-dominated communities (Aerts 1990; Berendse et al 1994). However, fires to achieve this aim would be less damaging to other features if carried out intentionally and in a planned way in winter.

6.78 Marrs et al (2004), found that burning reduced *Molinia* vegetation height but there was rapid recovery after two years, after which vegetation was higher than on unburnt areas, with little effect in reducing *Molinia*.

6.79 There is little information on rates of recovery following fire at different times of year, although heather regenerated more successfully in autumn than in spring in experimental fires in Scotland (Miller 1970). Where fires are severe, causing charring and damage to the peat surface, initial re-colonisation where the soils or surfaces are stable may be by crustose lichens, which can inhibit regeneration to a heathland vegetation (Legg et al., 1992). Often colonisation is by bryophytes, possibly with a succession from smaller cushion species to the larger *Polytrichum* species, and can last for a decade or more (Maltby et al., 1990, Anderson, 1997).

6.80 Repeated or hot fires are also likely to encourage bracken invasion, particularly in older stands of heather (Tucker, 2003). However, a study by (Nimes, 1995) found that in the Quantock Hills in Somerset, bracken was more likely to have replaced a dwarf shrub community if the ground had remained un-burnt during 1938-1987 than if it was burnt at least once during that period. This contrasts with (Anderson, 1986) who recorded a significantly higher rate of spread of bracken into heather moorland after a wildfire in the Peak District than in an unburnt control area.

6.81 On peatlands, plants with growing points at or below ground can have a competitive advantage over those, such as the heathers where growing points are above ground.

This can encourage the former including purple moor grass (whose shoots are above ground but protected by sheathing leaf bases), deer grass, cotton grass and purple small-reed grass *Calamagrostis canescens* to spread after fires. Bryophytes such as *Polytrichum* ssp., *Aulocomnium palustre*, and *Campylopus introflexus* can increase after fire on peatlands, helped by the release of nutrients by fire (Rowell 1988).

6.82 Summer fires can lead to a reduction in crowberry *Empetrum nigrum* (Hobbs, 1984, Anderson, 1986). The effects of burning on Sphagnum spp. appear to be variable, may be less damaging where water tables are high and fires are cool, and are not always detrimental, although both mosses and lichens are likely to be damaged when fires are hot (Shaw et al., 1996, Macdonald, 2000, Tucker, 2003). On acid grassland, large scale burning, under low intensity grazing can lead to purple moor-grass dominance and substantial areas of uniform, even-aged and species-poor habitat (Tucker, 2003).

Birds

6.83 There is a substantial literature on the effects of both controlled and wildfire in North America, Australia and the Mediterranean on individual species or groups, but few studies in the UK.

6.84 Any wildfire during the bird breeding season will normally destroy nests and eggs together with unfledged young within the burnt area, and in a severe fire, possibly adult birds which can get sucked into the fire by fierce air currents generated by the heat.

6.85 On lowland heathland only one study has looked in depth at the effects of fire on a bird species in the UK (Murison, 2007). The study looked at the effect of heathland fires on Dartford warbler Sylvia undata, a small passerine, largely confined to heathlands and strongly territorial at all times of year except in severe weather. Thus where a fire has impacted a Dartford warbler territory, the birds will continue in occupation if enough habitat has survived within or adjoining the territory to allow survival, even if breeding is not possible.

6.86 Murison found that generally Dartford warbler pairs affected by fire had fewer broods and raised fewer young overall than unaffected pairs although clutch size and nesting success was unaffected. This could partly be caused by a delay in the start of breeding as has been found for passerine species on Australian heaths where this was attributed to a lack of materials for nest building and inadequate food for egg production(Brooker and Rowley, 1991). Murison also found that Dartford warblers continued to make use of burnt territories provided some unburned patches remained. If less than half a territory was burnt then 83% of such territories would be occupied by a territorial male the next season dropping to 50% occupancy if more than half were burnt, 25% occupancy with 90% burned and absence if the whole territory was burnt. Some 45% of birds enlarged their territories to take in adjoining un-burnt ground.

6.87 Overall, there was drop of 41% in Dartford warbler breeding density in sites affected by wildfires in the following year, similar to a figure recorded for Dartford warblers after fire in Mediterranean scrubland (Pons et al., 2003).

6.88 Overall, in a study of Australian heathland birds 81% of the species previously breeding were still able to nest despite the fire, mostly using only sprouting plant species as nest sites (as opposed to plants regenerating from seed), and with one species using unusually high sites in trees for two years after the fire). But in one species post-fire breeding productivity was severely depressed due to increased predation (Brooker and Rowley, 1991).

6.89 In Mediterranean scrub, bird abundance and species richness increased rapidly after the first year for five years after a fire with the community continuing to support open-space species as well as an increasing abundance of scrub nesting species (Herrando et al., 2002), although it has also been reported that open-space species which have colonised burnt areas can show a marked decrease in density after only two years (Pons, 1998)

6.90 These studies suggest that that:

- Fires that cause substantial damage to the vegetation can lead to a severe initial decline in bird populations depending on habitat and species, but even small patches of surviving vegetation can be enough for some species in heathland and grassland to persist and breed.
- After a fire in a scrub grassland mosaic, open ground species such as larks and pipits can move in and persist for some time with the recovering populations of scrub species
- Where fire damage to the ground or shrub layer vegetation is patchy, strongly territorial species will stay on their territories and can breed successfully
- After a fire, many species will stay in their territories if resources permit and will make use of remaining features for nesting where these would not normally be used in un-burnt habitat
- Birds breeding in burnt areas produce fewer young than birds in un-burnt areas due to later breeding and fewer broods rather than lower clutch and fledged brood sizes or lower nest success.
- Declines in breeding bird populations could be greater in later successional stage vegetation such as woodland than in early or arrested successional stages such as heathland or grassland.
- Recovery of pre-fire levels of abundance and richness in bird populations of scrub, heathland and grassland species can be rapid (4-6 years).

Reptiles

6.91 There are numerous examples of the effects of fire on reptile populations, with direct mortalities as a result of fire and subsequent predation of the survivors in the aftermath with an absence of cover and food (Nature Conservancy Council, 1983).

Little work has, however been carried out to estimate mortality levels and recovery rates. After a large heathland fire on an area with an estimated pre-fire population of 700-1050 smooth snakes *Coronella austriaca*, only nine adults and two broods of young (five and eight) were discovered during a search after the fire, together with 30 sand lizards *Lacerta agilis* whose pre-fire population would been substantial (Spellerberg, 1977). There could presumably be a similar mortality of adders and common lizards after a fire on Cannock Chase. It is suggested that the rate of recovery of reptile populations after fire will be affected by the extent of open habitat after fire, the speed of recovery of important plant species and the more gradual accumulation of leaf litter and dead wood (Driscol and Henderson, 2008).

6.92 Fire is seen as a major threat to reptile populations and causes the most damage during the reptile active season (March – October). Fires are particularly devastating to reptile populations because of their specific habitat requirements and restricted home ranges. Depending on the intensity of the fire suitable hibernation sites for reptiles could also be lost.

6.93 Most of a population of common lizards *Lacerta vivipara* on an area of about 1 ha of heathland at Strensall Common in Yorkshire were killed when this was severely burnt. However, repeated surveys found that the population had recovered its estimated numbers after three breeding season, with recolonisation largely by young first year individuals coming from an un-burnt adjoining heath (Simms, 1969).

6.94 In summary:

- Reptiles are particularly susceptible to incineration by fire as they are slow moving and largely live above ground and have a limited home range
- Where ground cover has been removed reptiles are at an increased risk of ground and avian predation as they are largely active in daytime. With the loss of ground cover there is little or no prey availability for the surviving reptiles.
- Where patches of vegetation survive fire these can act as sanctuaries for reptiles
- In smaller fires, burnt areas will be re-colonised by reptiles from adjoining un-burnt habitat within a few years, but large fires can suppress population for a considerable time or cause local extinctions particularly in a fragmented landscape.

Invertebrates

6.95 There have been few studies on the effects of fire on invertebrates of heathland or moorland and with those studies that have taken place often limited in scope, based on specific collection and sampling methods and without controls (Tucker, 2003). Generally the consensus from research studies is that almost all above ground invertebrates are destroyed by fire whether these are ‘hot’ or ‘cool’ fires. However, provided adjoining, undamaged habitat is present, then these can serve as refugia and re-colonisation can take place (Merrett, 1976, Ghandi et al., 2001, Harper et al., 2000, Tucker, 2003). Burning also reduces the populations of soil dwelling

invertebrates in dry habitats (Buffington, 1966, Rickard, 1970, James, 1988, Ahlgren, 1974) but not those of wet habitat (Ditlhogo et al., 1992)

6.96 Following a fire, as the vegetation develops, the mix of invertebrates changes from early successional species of bare ground habitats to those species characteristic of the greater diversity of structure of more mature vegetation with its associated litter layer (Merrett, 1976, Usher, 1992, Usher and Smart, 1988, Gardner and Usher, 1989, Andersen, 1991, Brian et al., 1976). However the greatest diversity of invertebrates can be on the pioneer and degenerate phases of the heather communities on upland moors (Gimingham, 1985, Barclay-Estrup, 1974)

6.97 Recovery of the full community of unburnt areas can take as little as two years in grassland to 20 years in heathland habitats (Panzer, 2002, Bell et al., 2001) Some species and communities can benefit from the open conditions following a fire or in regularly burned sites (Johnson, 1995, Joy, 1995, Delettre, 1995, Cadbury, 1992a, Cadbury, 1992b) while others can be seriously depleted or even eliminated (Kirby, 2001) .

6.98 Where fires are extensive, whole populations of invertebrates can be destroyed and large fires may cause local extinctions in less mobile species. Invertebrate groups which are most vulnerable to fire in open habitats are those present in the litter as eggs or larvae in spring when many fires take place, species with only one generation per annum and sedentary or flightless species or groups. These include molluscs, leafhoppers, grasshoppers and some butterfly and moth species (Panzer, 2002, Kerney, 1999).

6.99 In general, burning is seen as particularly harmful to invertebrates where fires are severe or cover large areas (Kirby, 2001, Tucker, 2003, Aked, 1984).

6.100 In summary:

- Soil invertebrates are more vulnerable to fire in dry than in wet habitats but there have been few recent studies
- In a number of habitats, especially those adapted to fire management such as heathland invertebrate communities recover quickly from small fires
- Some invertebrate species benefit from fire management, either immediately or in the medium term
- Following fire, invertebrate communities follow a successional path related to the decline of bare ground and recovery of the vegetation, and a mozaic of habitats of different ages following fires provide a range of suitable conditions for these communities
- Large fires can be very damaging, delaying re-colonisation and threatening extinction to more vulnerable species
- Species with low vagility (dispersal abilities) or those with a life cycle vulnerable to a disturbance effect such as a fire are most at risk

Disturbance

Introduction and definitions of disturbance

6.101 Disturbance can be defined as any human activity that influences an animal's behaviour or survival. By far the majority of the literature (and there are thousands of studies), focuses on birds (for general reviews on pedestrian access and heathland birds see Sidaway and Ramblers' Association., 1990, Whitfield et al., 2008, Woodfield and Langston, 2004, Lowen et al., 2008). Disturbance can also affect mammals, herptiles and invertebrates (for general reviews see Edgar, 2002, Lowen et al., 2008,). The range of studies is potentially bewildering, demonstrating a range of different impacts, in different circumstances, to different species. For example, Ficetola et al. (2007) show strong differences in the response of different species to the same source of disturbance. There is still contention about the applicability of some methods of study and the actual impacts on populations (Gill, 2007).

6.102 The presence of humans in the landscape can cause animals to flee and can also result in impacts such as increased predation (for example because the adults when flushed betray the presence of a nest) or direct trampling (of invertebrate burrows or nests). Disturbance can also result in an increase in stress levels, reduced feeding time or the avoidance of otherwise suitable habitat.

6.103 Although most disturbance events are not intentional, it is important, to highlight that deliberate disturbance of some species is illegal. The offence of intentionally disturbing protected species occupying places used for shelter or protection was first introduced in section 9 of the Wildlife and Countryside Act 1981 ('WCA') and applied to species listed on Schedule 5 to the Act. A similar but slightly wider offence was introduced by the Conservation (Natural Habitats &c.) Regulations 1994 ('the Habitats Regulations'), which prohibited deliberate disturbance of a European Protected Species wherever it occurred. Section 9 of the WCA was later amended by the Countryside and Rights of Way Act 2000 to include both intentional and reckless disturbance.

Mechanisms: the types of activity that can cause disturbance

6.104 Studies have shown disturbance effects for a wide range of activities besides simply people's presence in the landscape, for example traffic (see Reijnen et al., 1997 for a review) and dogs (Banks and Bryant, 2007, Lord et al., 2001). Some types of disturbance are clearly likely to invoke different responses. In very general terms, both distance from the source of disturbance and the scale of the disturbance (noise level, group size) will both influence the response (Beale and Monaghan, 2004b, Delaney et al., 1999). Studies that have compared different types of disturbance usually show a weaker behavioural response to:

- vehicles than to people on foot (Pease et al., 2005, Rees et al., 2005, Taylor et al., 2007);
- people without dogs rather than people with dogs (Lord et al., 2001, Taylor et al., 2007, Banks and Bryant, 2007)

- slower moving than fast moving sources of disturbance (Ronconi and St. Clair, 2002, Eason et al., 2009)
- smaller groups rather than larger groups of people (Beale and Monaghan, 2005, Beale, 2007, Fernandez-Juricic et al., 2002, Taylor and Knight, 2003, Townshend and O'Connor, 1993)
- people following regular routes/trails rather than wandering randomly (Fairbanks and Tullous, 2002, Pearce-Higgins et al., 2007)

6.105 There is conflicting evidence on the disturbance effects of horses. One study (Lafferty, 2002) found that birds were more likely to take flight from horse-riders compared to people on foot. In contrast Burger (1986) suggests people on horseback do not seem to threaten birds, even though horse riders frequently moved rapidly. Three studies have compared people on foot to people on bicycles and there is conflicting evidence with one study showing a stronger response than to hikers and another no difference between bikers and pedestrians (Gander and Ingold, 1997, Taylor and Knight, 2003). In both cases the studies involved large mammals.

Seasonality and temporal variation

6.106 Disturbance has different impacts at different times of year for all taxa. During the breeding season individuals will usually be tied to specific locations and young may be particularly vulnerable to trampling or predation. During the winter individuals will be free of the constraints associated with breeding but disturbance issues may interact with the weather, and the energetic costs of disturbance may be more severe in cold weather, particularly for groups such as shorebirds or reptiles.

6.107 The bird breeding season ranges from January for species such as crossbill through to August for some species (such as nightjar or ringed plover). For mammals there can be similar variations, for example Harbour seals' breeding and moulting season lasts from June to August whereas badgers give birth between mid-December and April). It is species for which the breeding season coincides with the 'peak' tourist and recreational season (i.e. July and August) that disturbance may be a particular issue, especially those that occur in habitats such as beaches that tend to be particularly busy in the summer. .

Particular Species or Species Groups

Mammals

6.108 When compared with the wealth of research relating to human disturbance of birds, there are few studies of mammals in the UK and disturbance. A number of terrestrial mammals are protected from intentional or reckless disturbance under the Wildlife & Countryside Act 1981 ('Schedule 5 species') and / or the Habitats Regulations 1994 ('European Protected Species'), including all species of bats, and red squirrel. The only species of mammal included in the SAC and SSSI designations are bats (five species) red squirrel (no longer present) and fallow deer.

Bats

6.109 Excessive disturbance is likely to cause bats to abandon a site or possibly be a cause of mortality, but there is little documented evidence or examples, probably due to the level of legal protection afforded, which would prevent a large number of experimental studies. However there is also increasing evidence that disturbance without contact can also have a negative effect upon bats and their reproductive success. Disturbance to bats during their hibernation period can be particularly harmful, with light, temperature changes and noise all causing bats to be aroused from their hibernation. This causes energy loss during a time when conserving fat stores is criticalMaternity roosts are also particularly sensitive to disturbance, and with bats only raising one young per year, the consequences of maternity roost disturbance on population levels can be significant (Mann, Steidl and Dalton 2002). Disturbance to bats can also occur when they are actively foraging. Lighting can cause disturbance to bats and has been shown to disrupt flight patterns (Stone et al., 2009).

Deer

6.110 There are two deer species present at Cannock, roe deer Capreolus capreolus and the introduced fallow deer Dama dama. Deer respond to disturbance and there is evidence that their distribution, physiology, breeding success and survival can all be affected by disturbance (e.g. Mitchell et al., 1977, Yalden, 1990). Domestic dogs can chase (and sometimes kill/maim) deer (see Taylor et al., 2005 for review).

Birds

6.111 The enormous volume of literature on disturbance to birds means that there is evidence for disturbance effects for a wide range of species yet few studies place the disturbance in any kind of population context or identify whether disturbance is actually a conservation issue.

6.112 During the non-breeding season, the main impacts of human disturbance on birds is interruption to foraging and, to a lesser extent, roosting (Woodfield and Langston, 2004). There is a body of research suggesting that responsiveness to disturbance is a species-specific trait (e.g. Yasué, 2005). The extent to which disturbance affects the actual distribution of individuals within a site will vary according to the species involved, the availability of other resources and the individuals' own state. If under stress, for example during cold winter weather when food resources are scarce, birds may be less easily disturbed than at other times (Burton, 2007, Stillman and Goss-Custard, 2002a), they may simply not be able to afford to stop feeding.

6.113 There may also be seasonal variation within a species' responsiveness to disturbance, as individuals alter their threshold in response to shifts in the basic trade-off between increased perceived predation risk (tolerating disturbance) and the increased starvation risk of not feeding, i.e. avoiding disturbance (Stillman and Goss-Custard, 2002a). Towards the end of winter, migratory birds need to increase feeding rates to provide energy for migration to breeding grounds. As winter progresses, Eurasian oystercatcher energy requirements increase and their feeding conditions deteriorate. To survive they spend longer feeding and so have less spare

time in which to compensate for disturbance. Later in winter, birds approach a disturbance source more closely and return more quickly after a disturbance. Their behavioural response to disturbance is less when they are having more difficulty surviving and hence their starvation risk (avoiding disturbance) is greater (Stillman and Goss-Custard, 2002a). It is thus important to measure subtle behavioural changes in foraging rates along with key ecological variables in order to assess the true impact of human disturbance on migratory shorebirds (Yasué, 2005).

6.114 There are a suite of breeding bird species associated with lowland heathland – nightjar, woodlark and Dartford warbler – for which there is a strong body of evidence for disturbance effects. These have been summarised in Liley *at al* (2009) and will not be repeated in detail here. Suffice it to say that disturbance effects have been found to be related to nest failure in nightjars, later breeding and lower breeding productivity in Dartford warblers and failure to establish breeding territories in woodlarks. (Mallord 2005, Mallord *et a*l 2007, Liley *et al* 2006, Murison 2006, Murison *et al* 2007, Clakre, liley & Sharp 2008, Liley and Clarke 2003). Heathlands are also important in winter when sites may be used by roosting raptors.

Reptiles

6.115 Edgar ranks the adder as the second most vulnerable reptile (after the sand lizard) to impacts from recreation. He draws on anecdotal evidence to suggest that adders can be surprisingly sensitive to the presence of humans. Disturbance can result in adders being flushed from basking locations and can force them to expend energy in cold weather. Edgar also documents evidence for direct mortality as a consequence of people's fear of a poisonous snake.

Invertebrates

6.116 For many invertebrate species it is difficult to untangle the importance of access levels in modifying habitats (discussed in the damage section) from the direct impacts of trampling and disturbance. Disturbance and direct mortality from trampling are however clearly issues for some species or particular groups and we highlight these below:

- Deadwood invertebrates: On sites with public access, bark stripping and breaking up rotten wood can do considerable damage to the invertebrate fauna (Kirby, 2001). Removal of deadwood and dead and rotting trees is a major threat to saproxylic (deadwood) invertebrates (Alexander et al., 2005f, Alexander et al., 2005g, Alexander et al., 2005h, Alexander et al., 2005i, Kirby, 2001). This micro-habitat is often removed for health and safety reasons and also by the public for camp fires etc. Anderson (1992) discusses the consequences of the removal of deadwood for camp fires for woodland invertebrates.

- Species associated with trackways and paths: Access has been shown to impact on behaviour for tiger beetles in Turkey (Arndt et al., 2005). Arndt et al. looked at three different dune areas with varying levels of human activity. The activity of adult tiger beetles diverged during the tourist season, decreasing markedly

with increased disturbance. Larval activities showed similar trends, with first and second instar larvae practically absent from the heavily disturbed section. For diurnal, surface-feeding species that occur on bare ground(such as paths and tracks) disturbance can clearly be an issue. Trampling may also result in direct mortality. Observations of *C. hybrida* in France noted a high mortality of adults on a well-used cycle track across dunes, due to crushing by bike tyres (Alexander et al., 2005b). Liddle noted 10 times fewer invertebrates and a much smaller number of species on trampled dunes (with only 50 tramples per week) compared with adjacent un-trampled areas. Anderson (1992) discusses the implications of trampling in woodland habitats upon soils, with a decrease in soil nitrifying bacteria and effects upon soil dwelling invertebrates. Bayfield (1979) undertook a specific study on the effects of trampling on *Molophilus ater*, a peatland cranefly, finding significant effects upon the species, mainly due to physical crushing having the potential to kill a high proportion of larvae within the peat. Lower numbers of larvae were found by Bayfield along pathways as a consequence.

Summary

Some of the impacts described in the literature will be the principal concerns at Cannock Chase while others are of more limited concern.

Of principal concern for the interest features of the SAC are trampling, fire, nutrient enrichment and disease with more limited concern on litter and alien non-native introductions.

Disturbance is of limited relevance to the interest features of the SAC but will affect wildlife, especially breeding birds. These include Annex I species Nightjar, woodlark and Dartford warbler with nightjar in nationally important numbers.

The effects of trampling on Cannock Chase are to cause soil compaction, erosion and deposition and damage to vegetation. An increase in paths, tracks and the need for firebreaks can all increase fragmentation at least for some sedentary invertebrates, and can damage or destroy significant areas of lowland heath. However, some invertebrate populations benefit from the resultant bare ground.

The trampling effects from horses and cyclists are particularly evident at Cannock and it is clear that these users are not keeping to the designated bridleways but are accessing the whole are where ever there are paths, tracks and fire breaks.

The impact of Phytophthora has been serious and could become catastrophic for some flora and fauna, although it is unclear to what extent human access and recreation has contributed to its introduction and spread.

Heathlands are very vulnerable to increased nutrient levels and the impacts of animal waste at Cannock, particularly dogs but to a lesser extent horses, are widespread.

Fire is always of major concern on any lowland heath, but has had limited impacts on Cannock in recent years. Most fires are small and inconsequential with faster reporting and more effective control measures. Unfortunately fire break systems have to be maintained to guard against the occasional large and very damaging fire, the risk of which is always present.

The actions of the site staff have maintained a largely litter free environment and the impacts from alien introductions are low.

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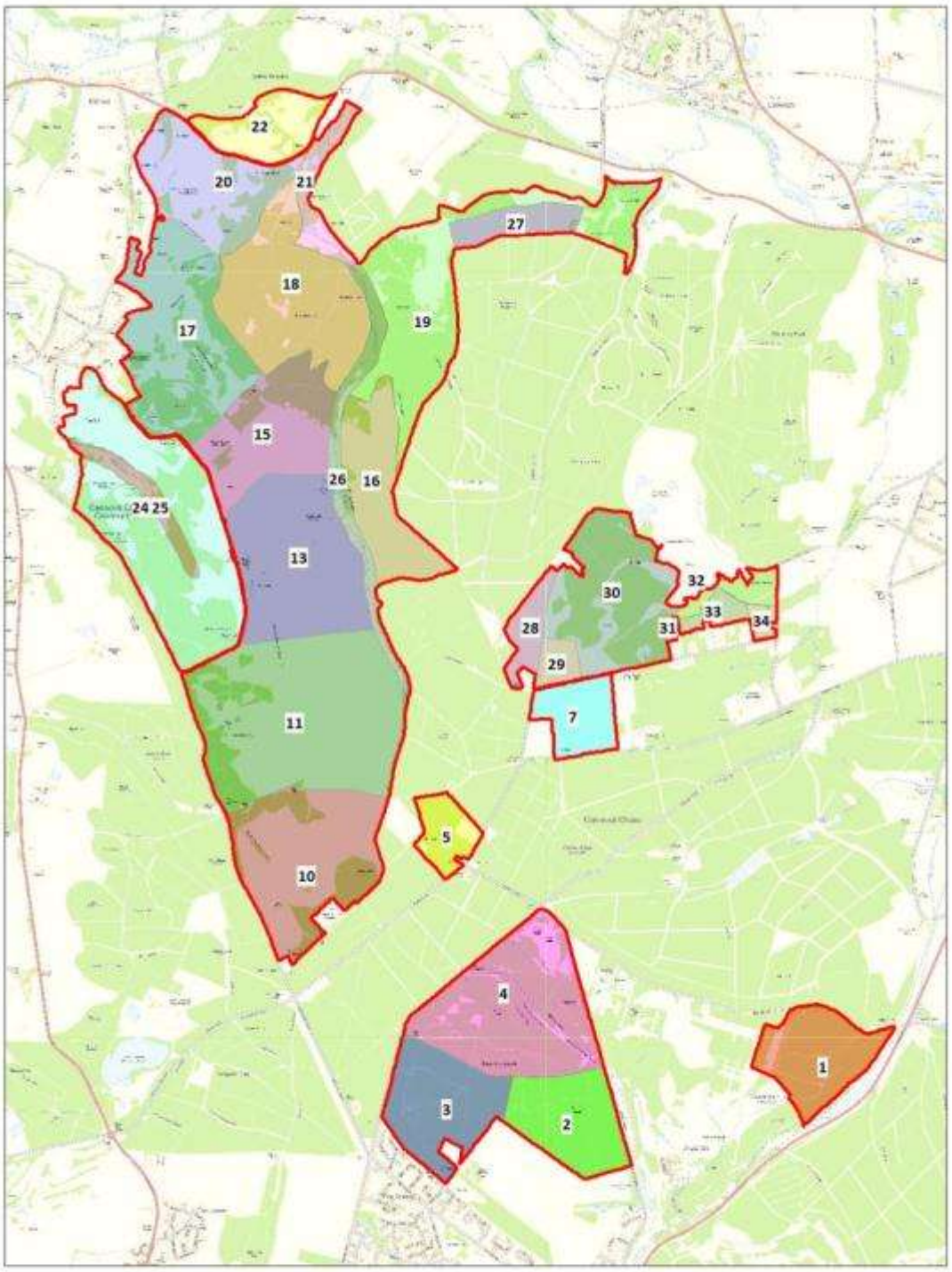
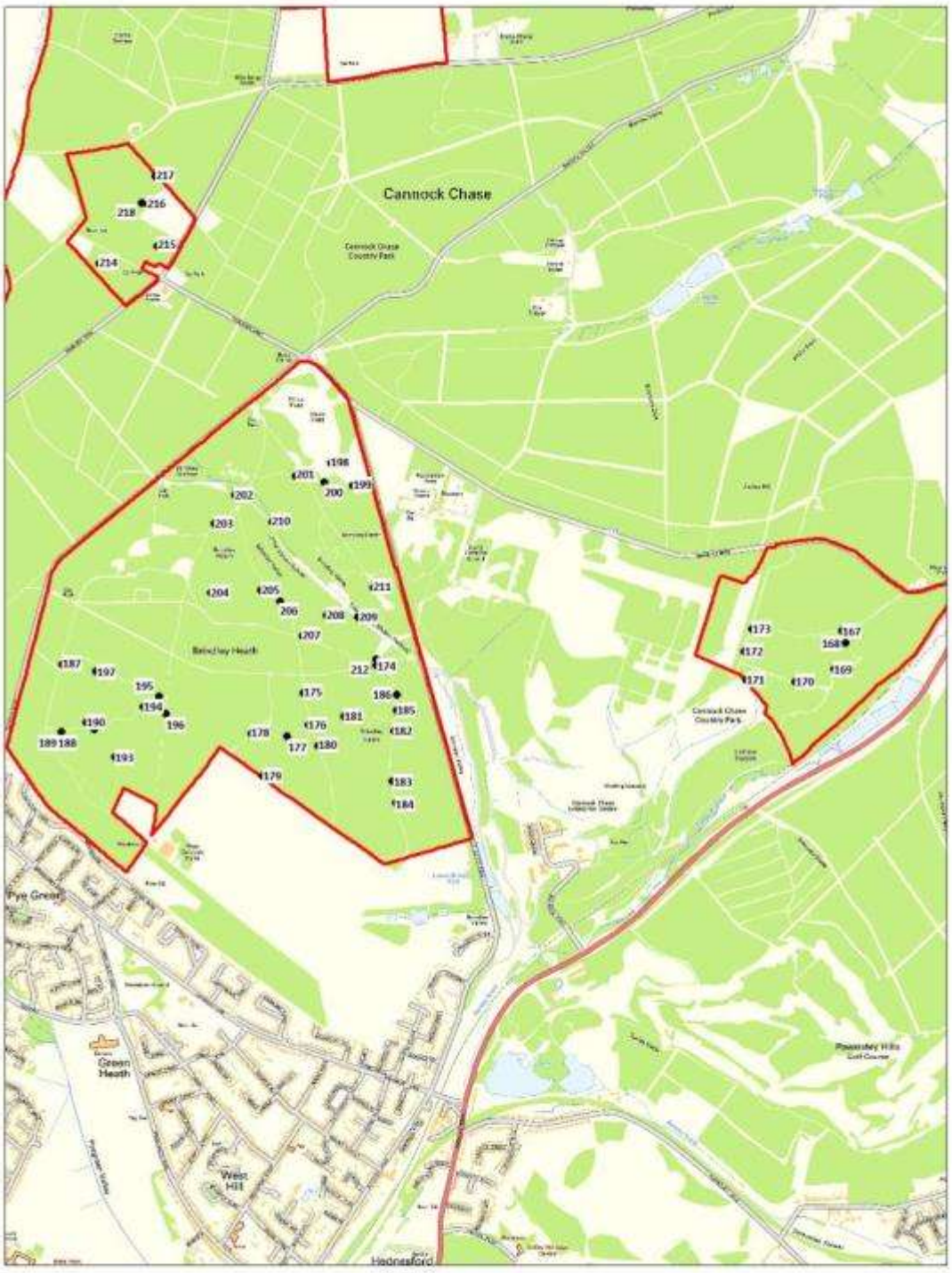


Map 1: SAC and SSSI Units
(numbers on map are SSSI units)

SAC



Map 2: Target Note Reference Numbers (Southern part of SAC)

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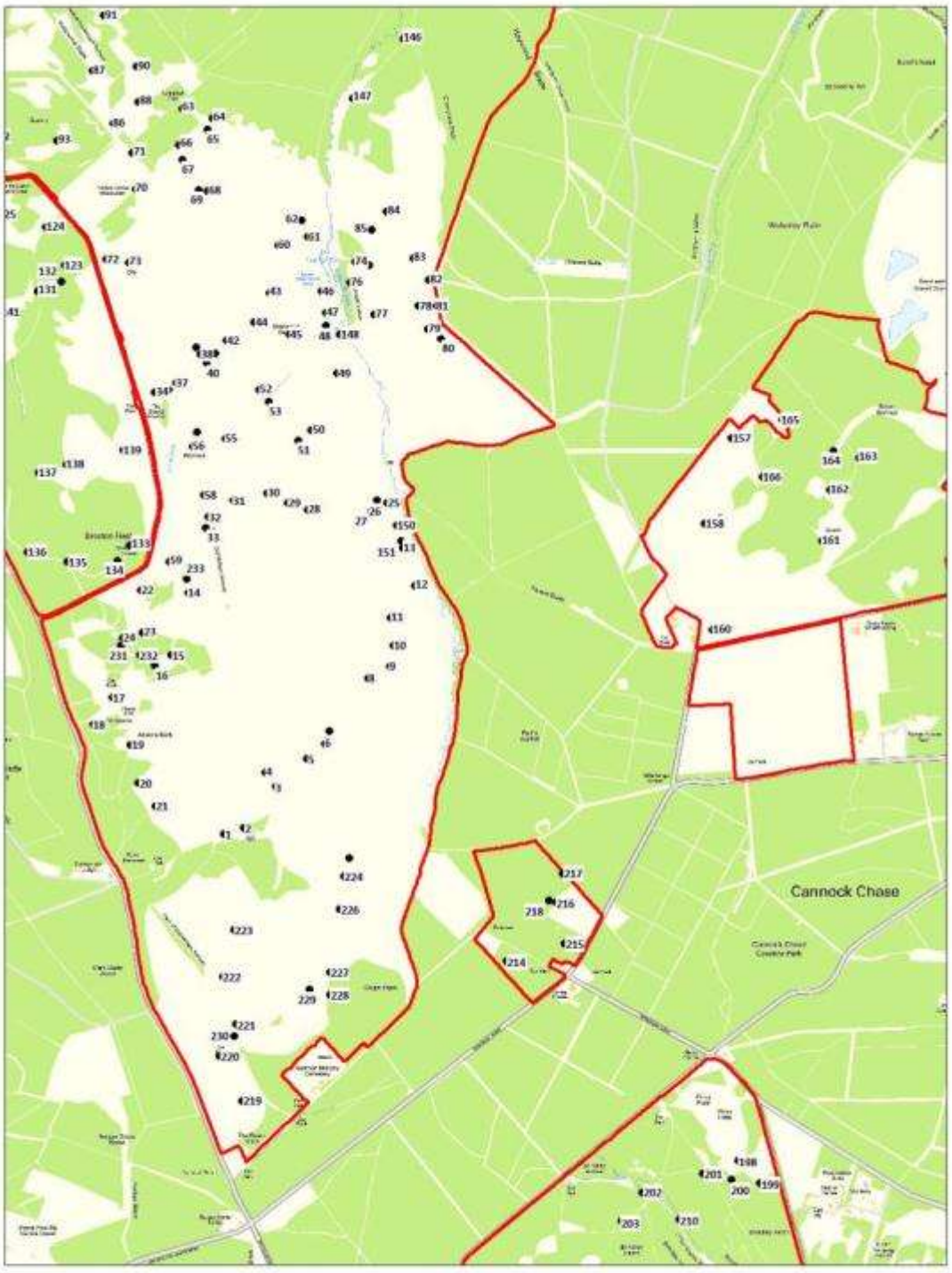
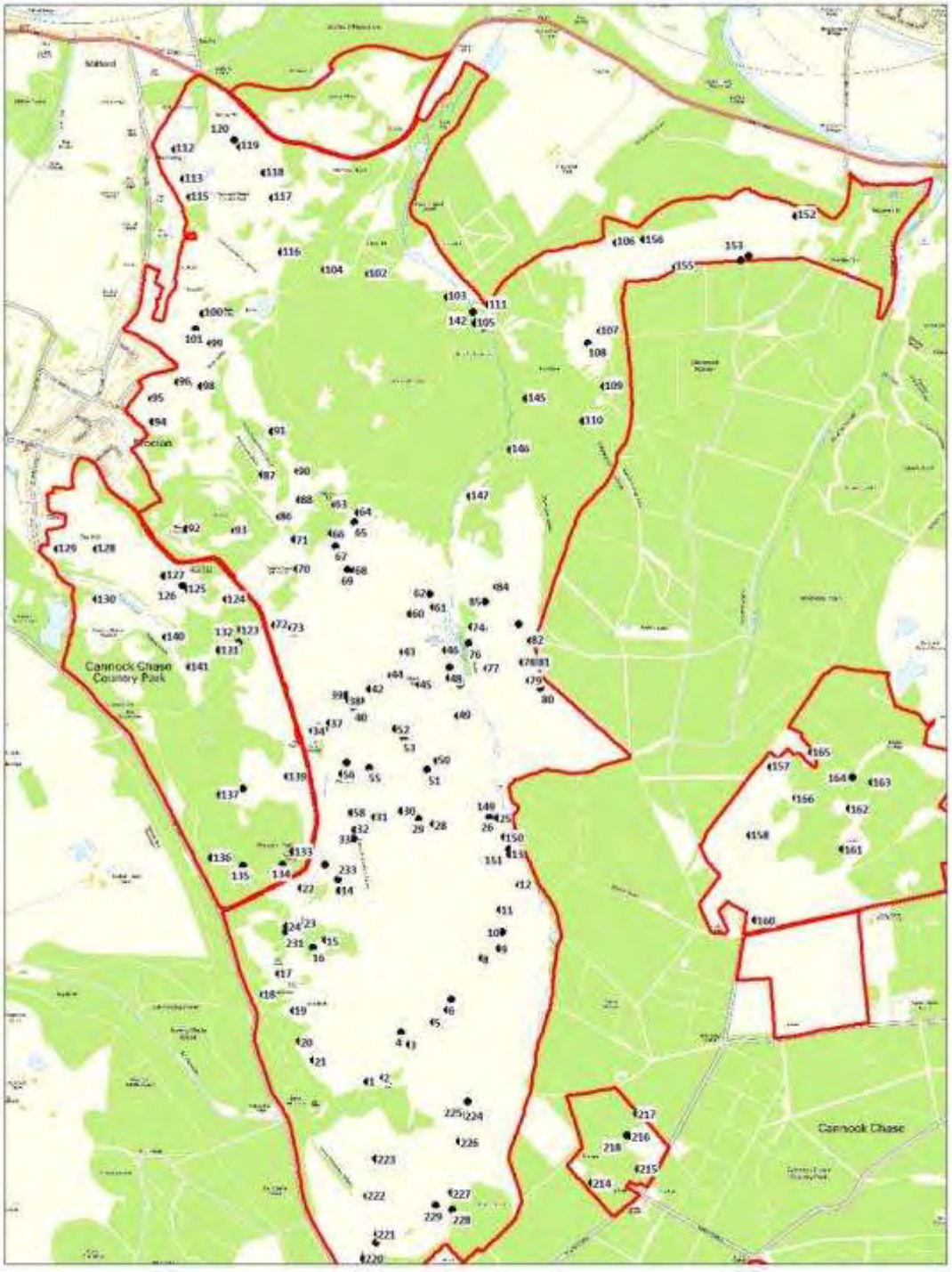
SAC



Map 3: Target Note Reference Numbers Middle part of SAC)

SAC



Map 4: Target Note Reference Numbers Northern part of SAC)

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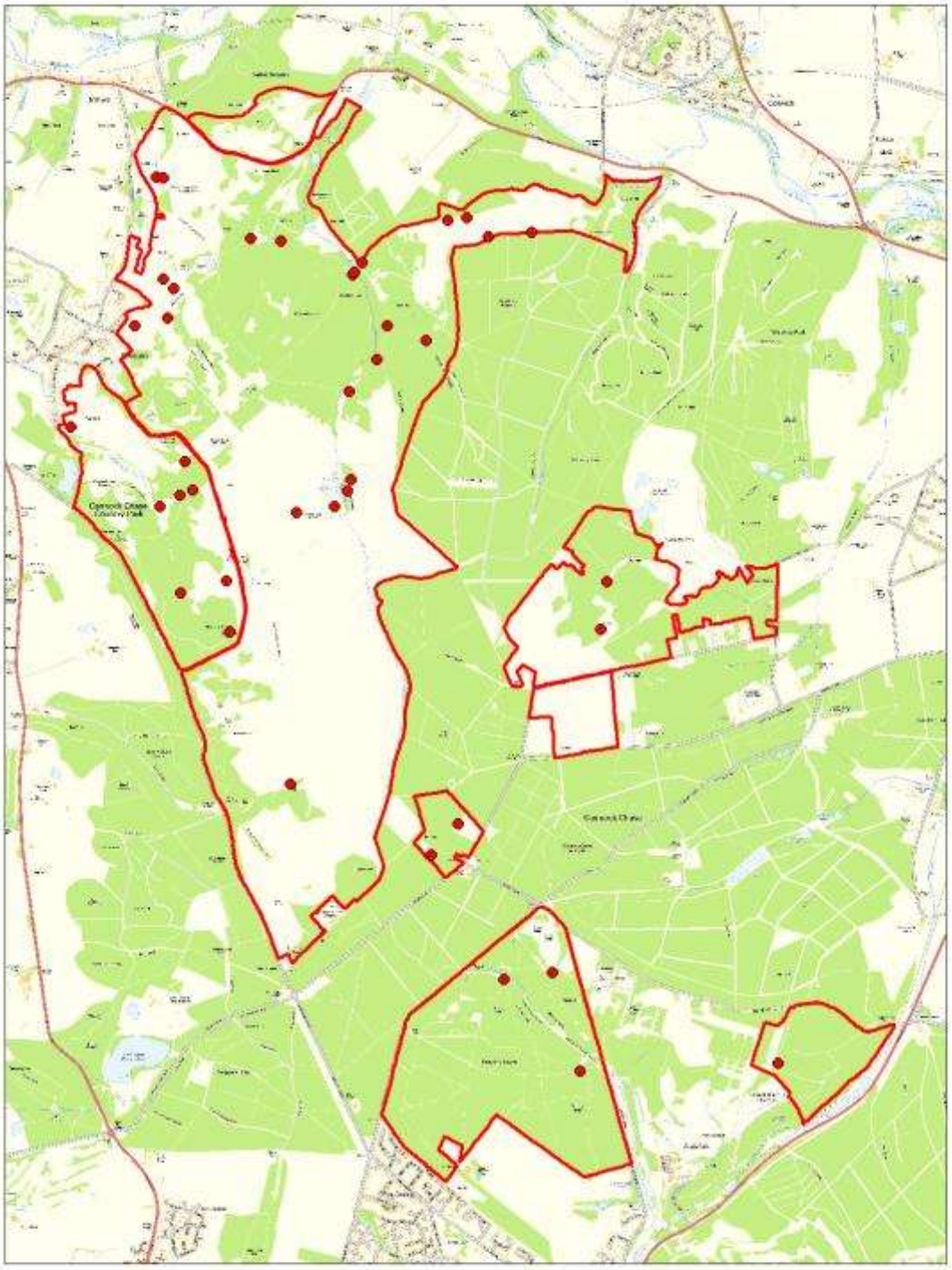
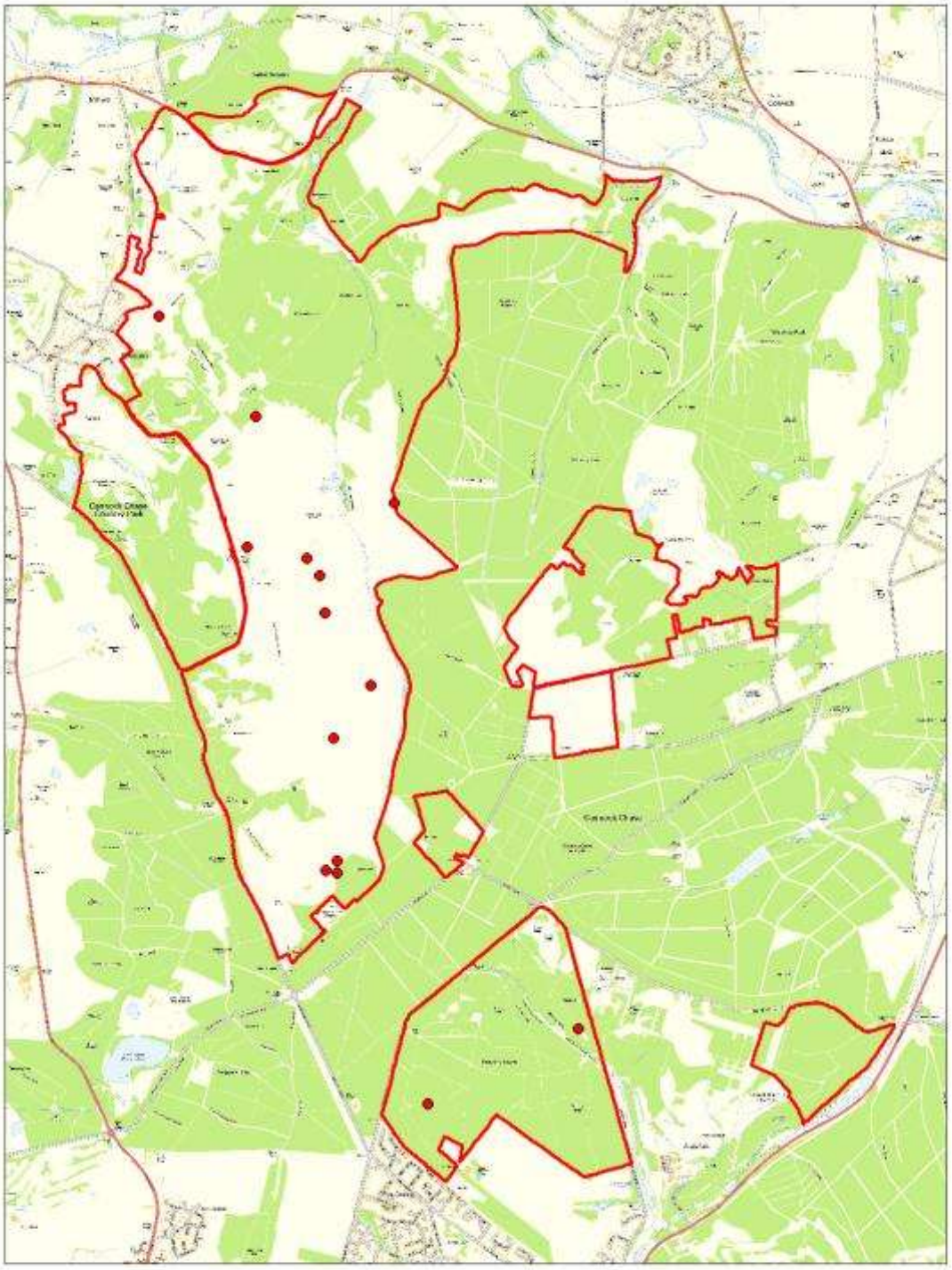
SAC



Map 5: Selected examples of impacts relating to cycling

Particular impacts relating to bikes (40)

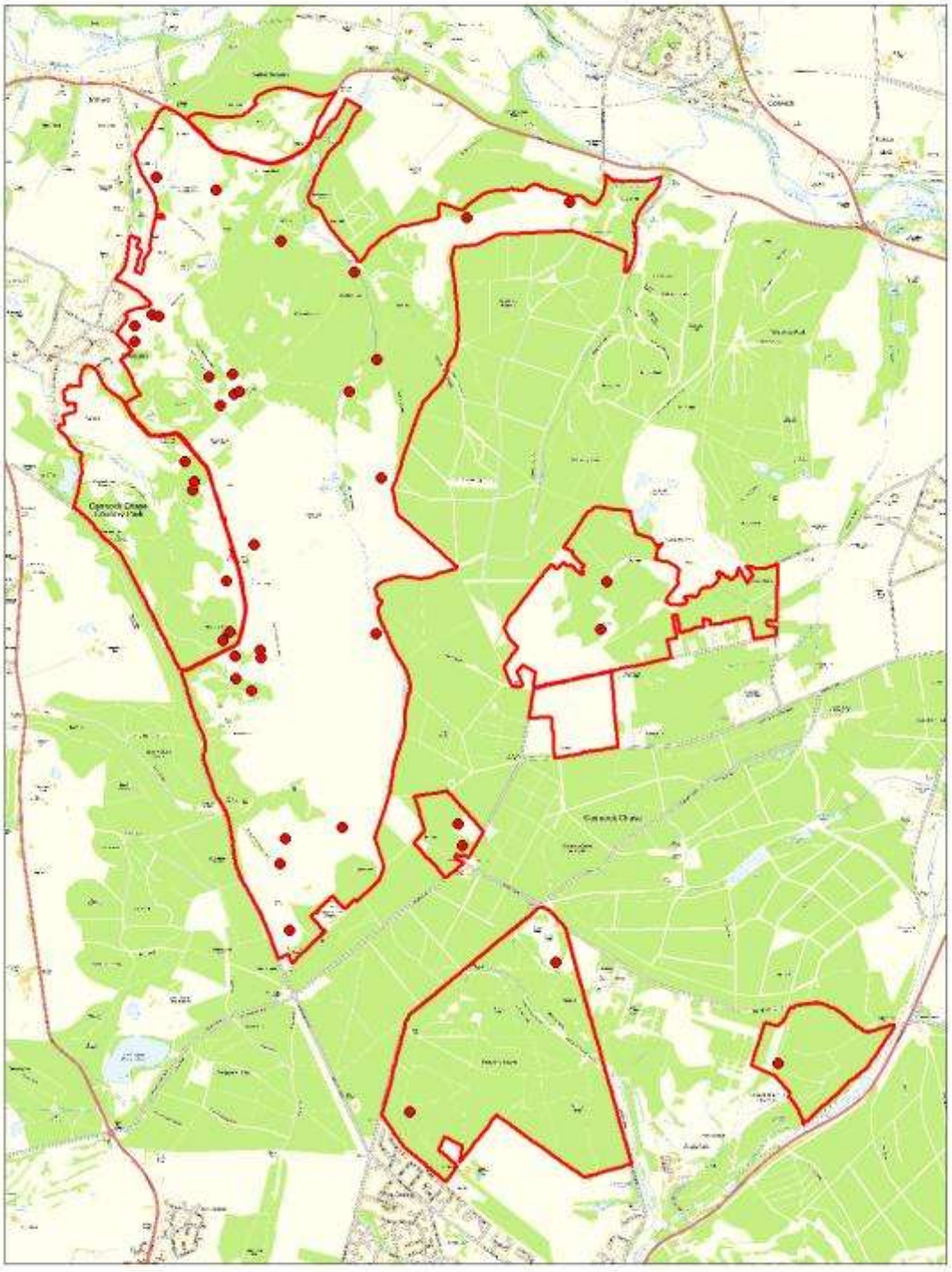
SAC



Map 6: Selected examples of path expansion

Instances of path expansion (14)

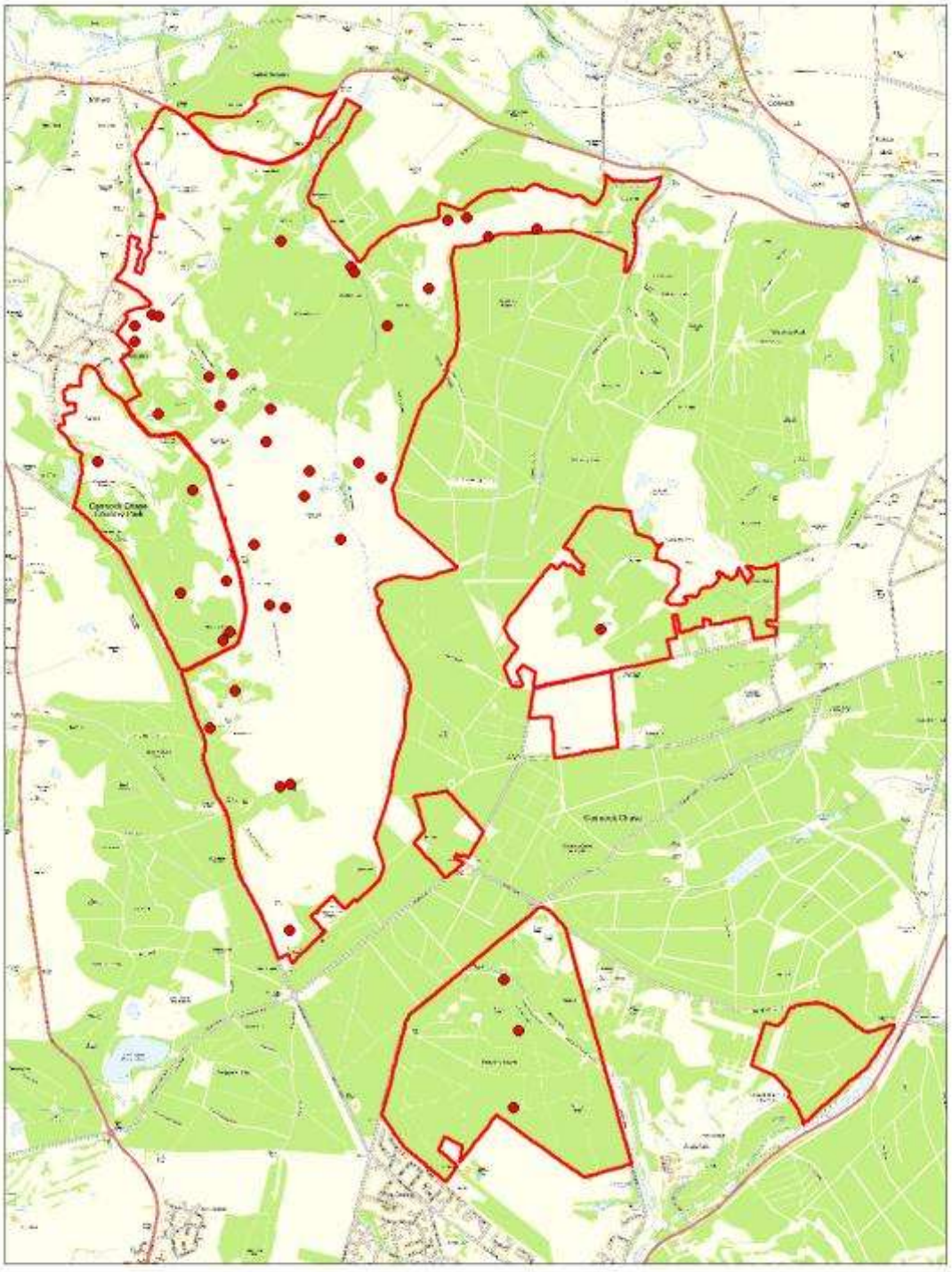
SAC



Map 7: Selected examples of impacts relating to dogs

Particular impacts relating to dogs (42)

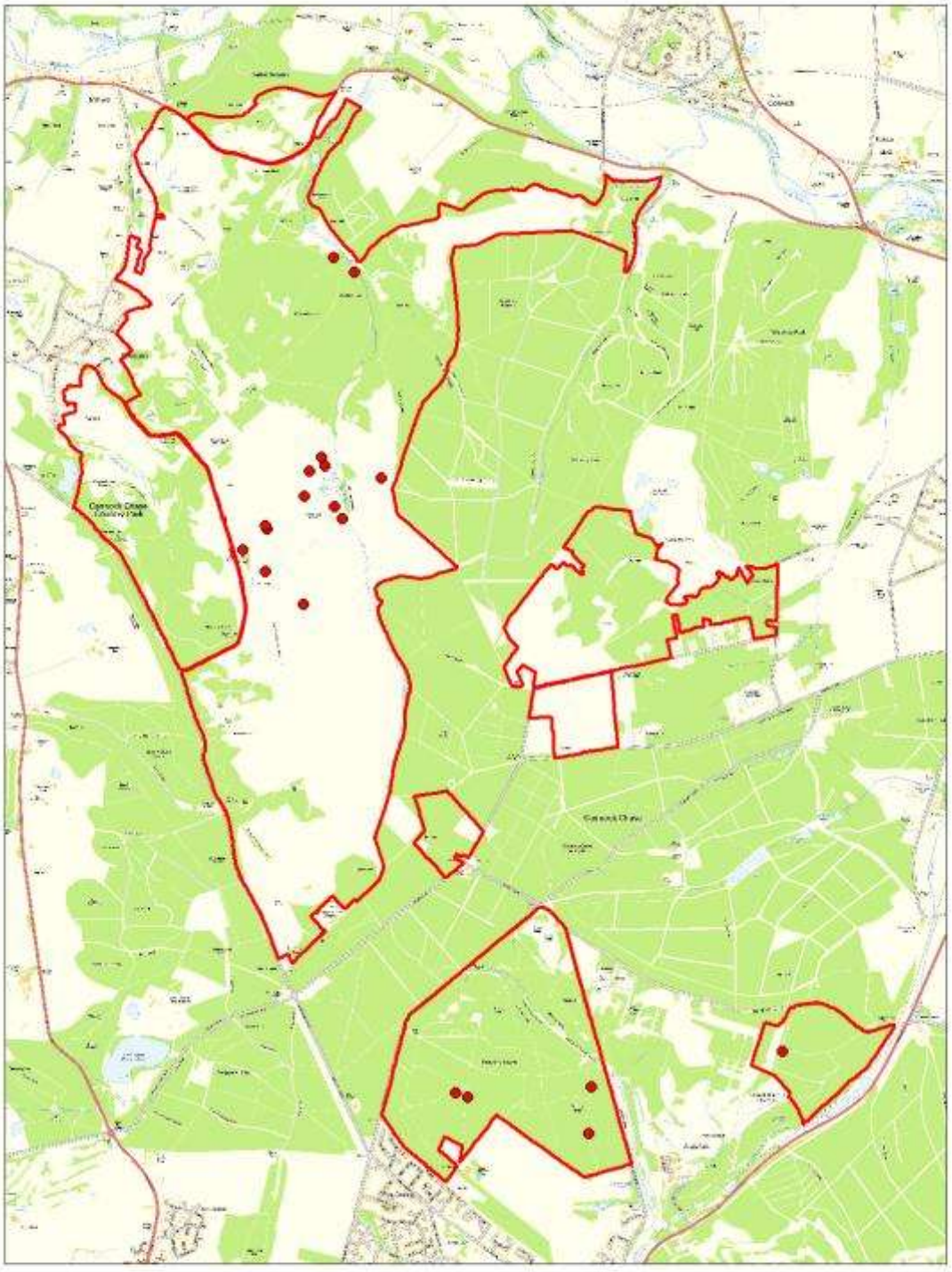
SAC



Map 8: Selected examples of impacts relating to horses

Impacts relating to horses (42)

SAC



Map 9: Selected examples of enrichment

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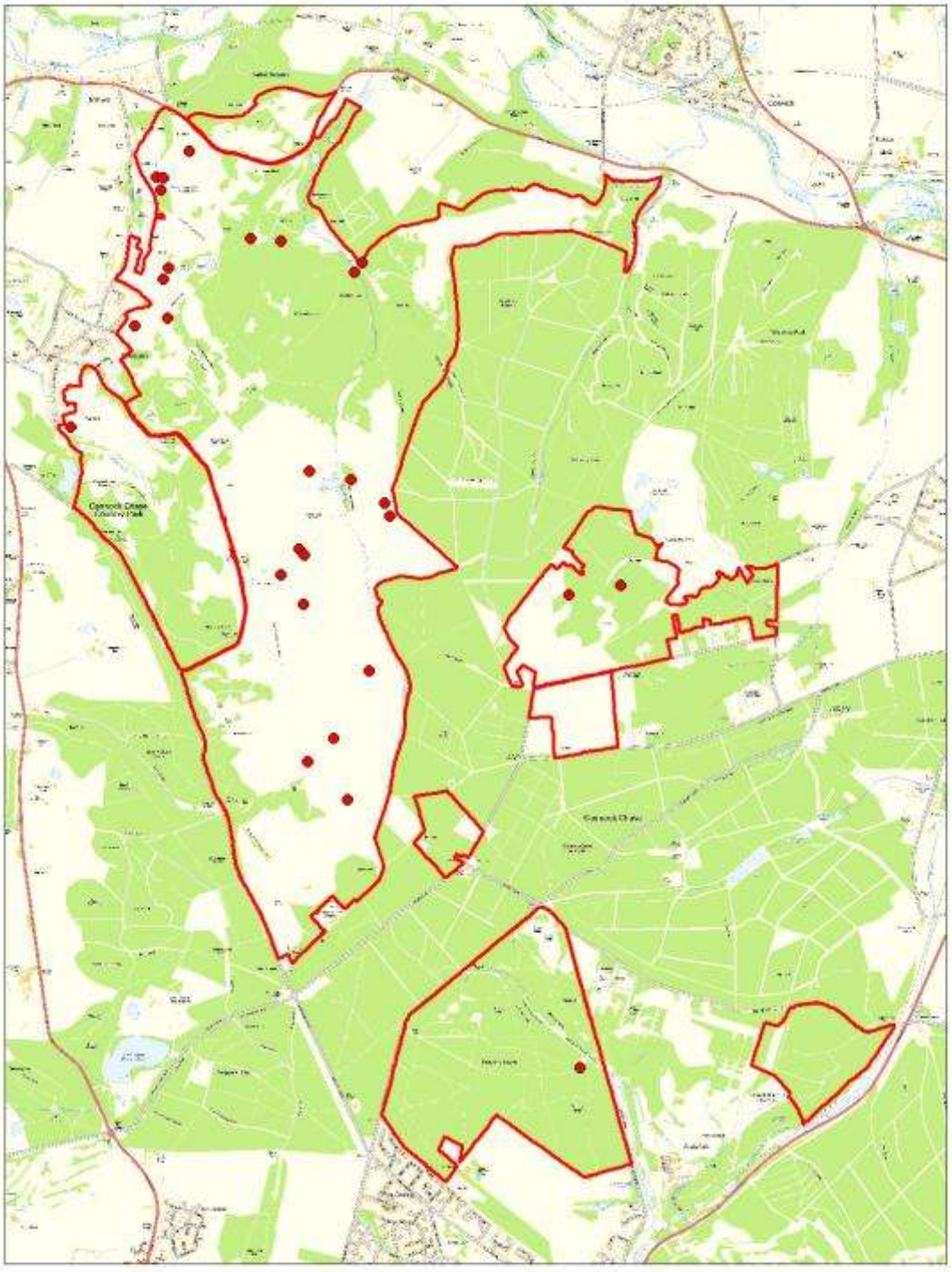
Locations where enrichment observed (19)

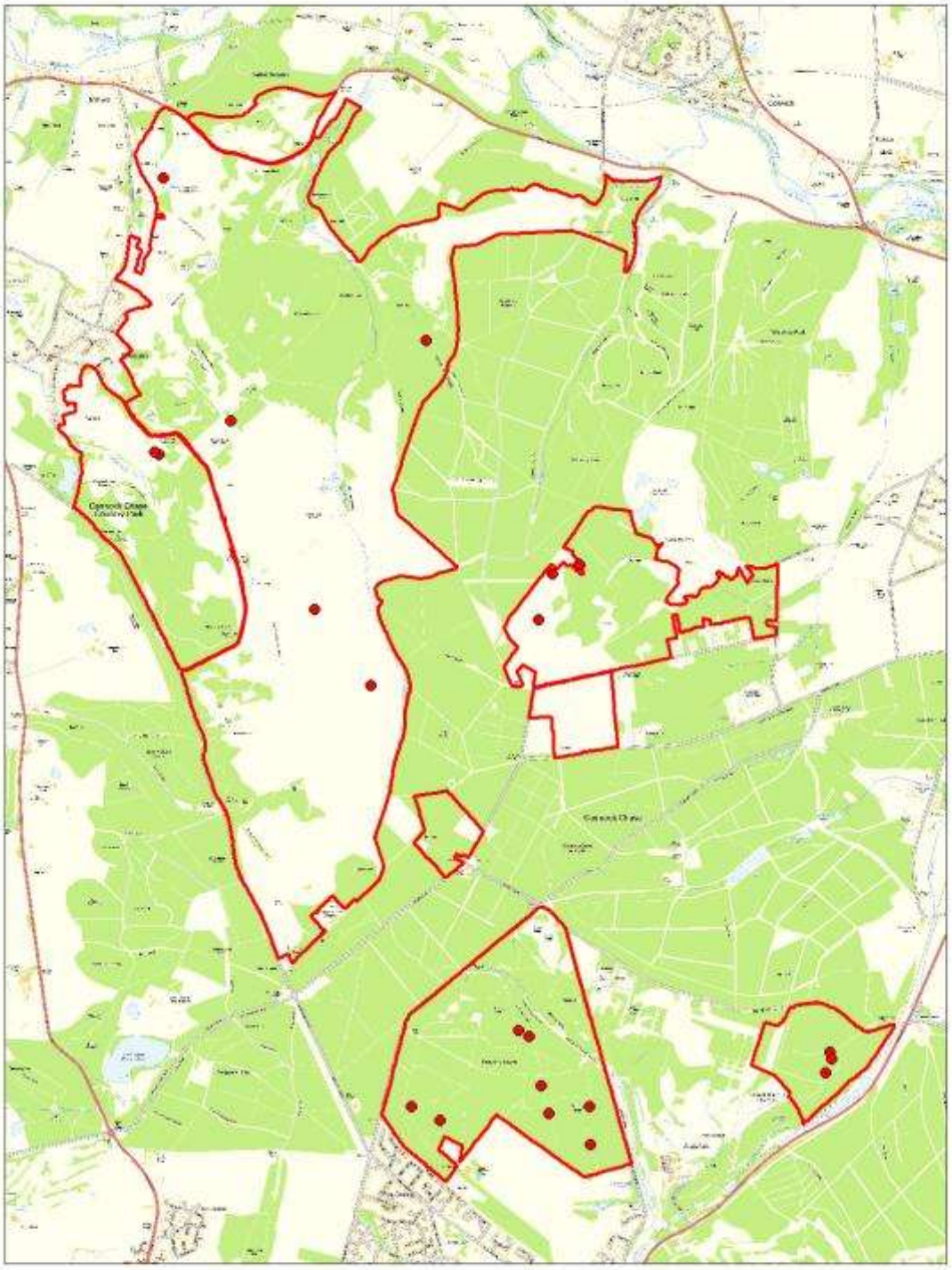
SAC



Map 10: Selected examples of erosion

Particular instances of erosion (28)

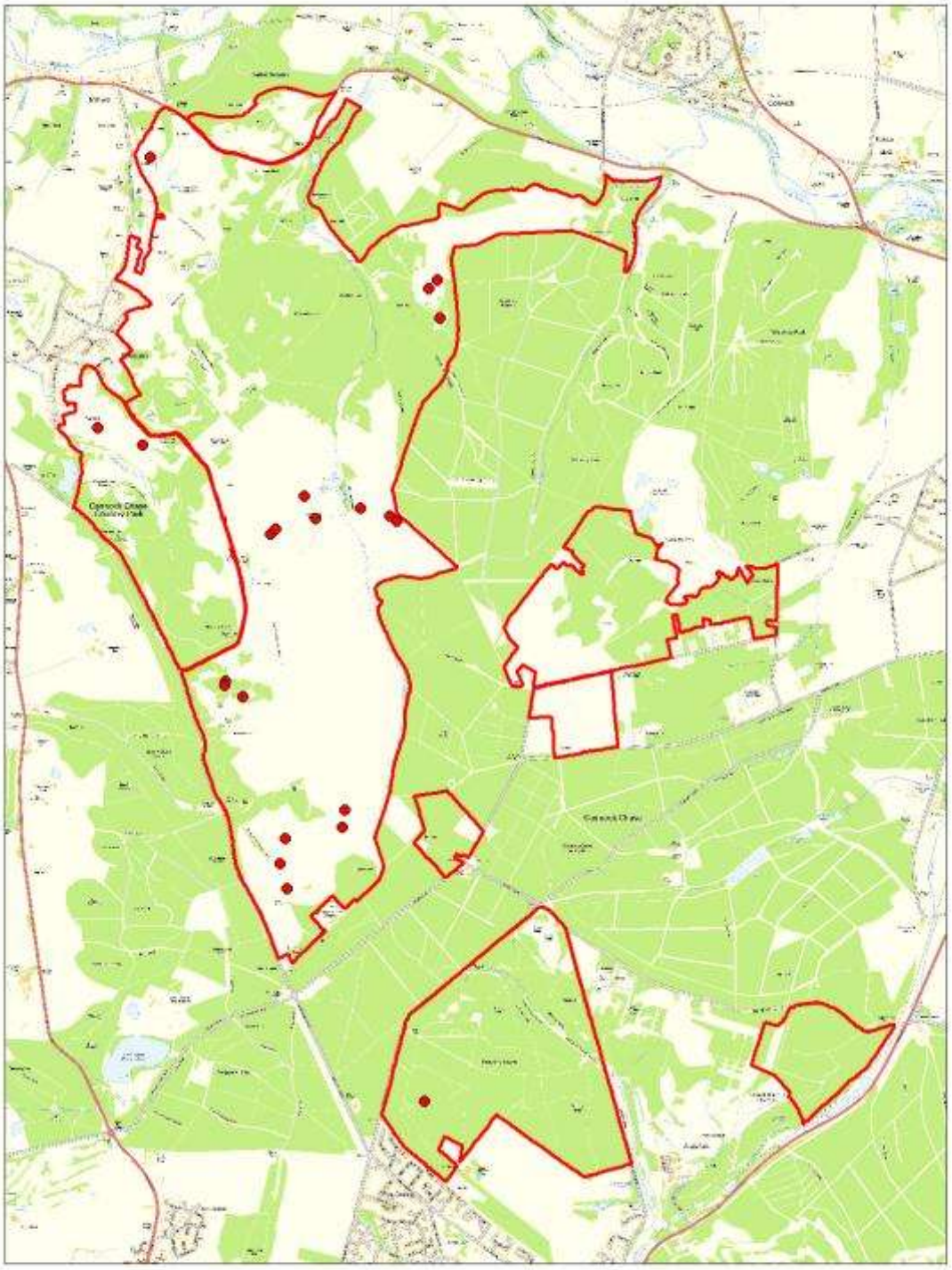
SAC



Map 11: Selected examples of impacts relating to vehicles

Impacts relating to vehicles (21)

SAC



Map 12: Selected examples of path widening

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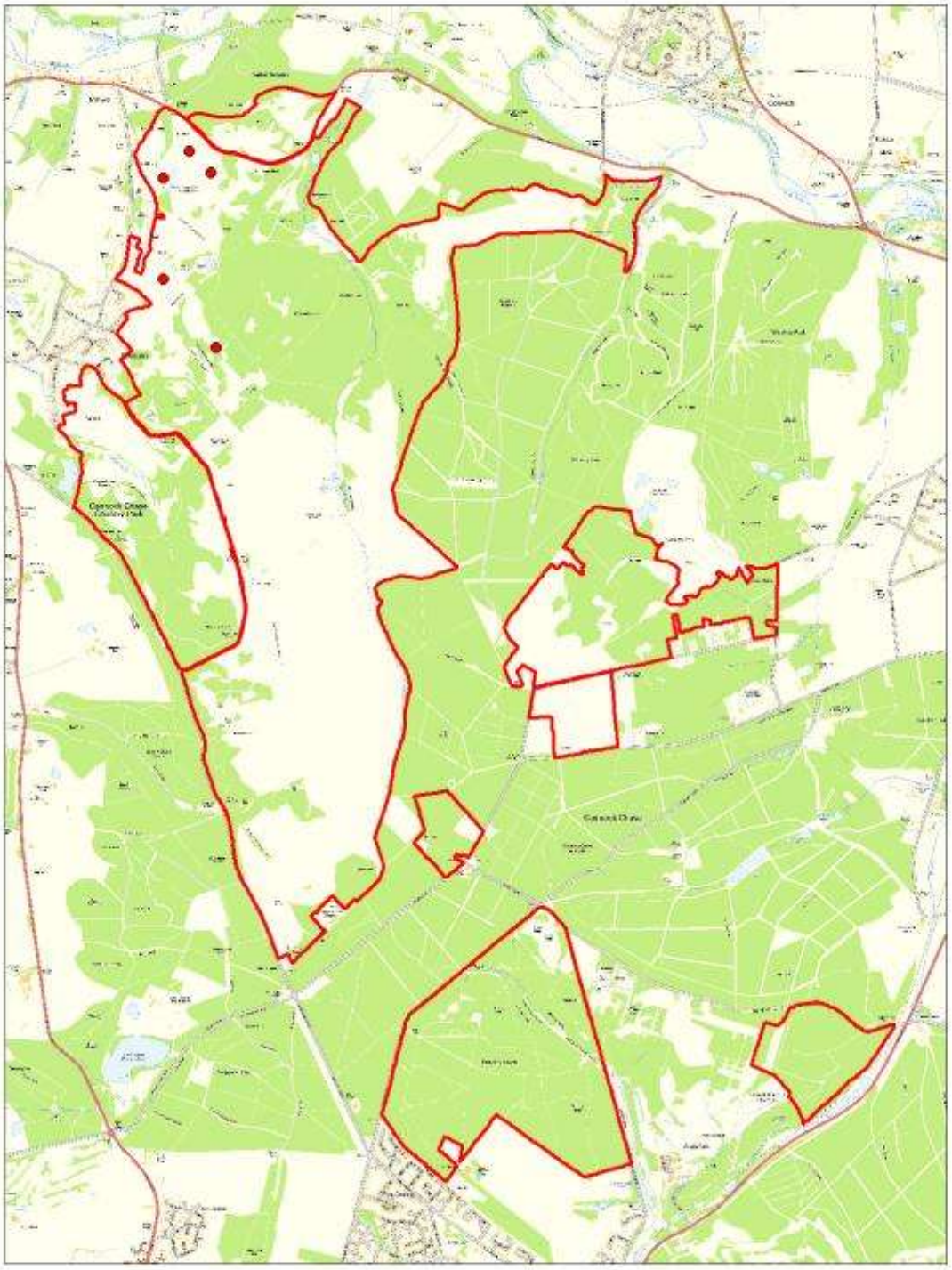
Particular instances of path widening (22)

SAC

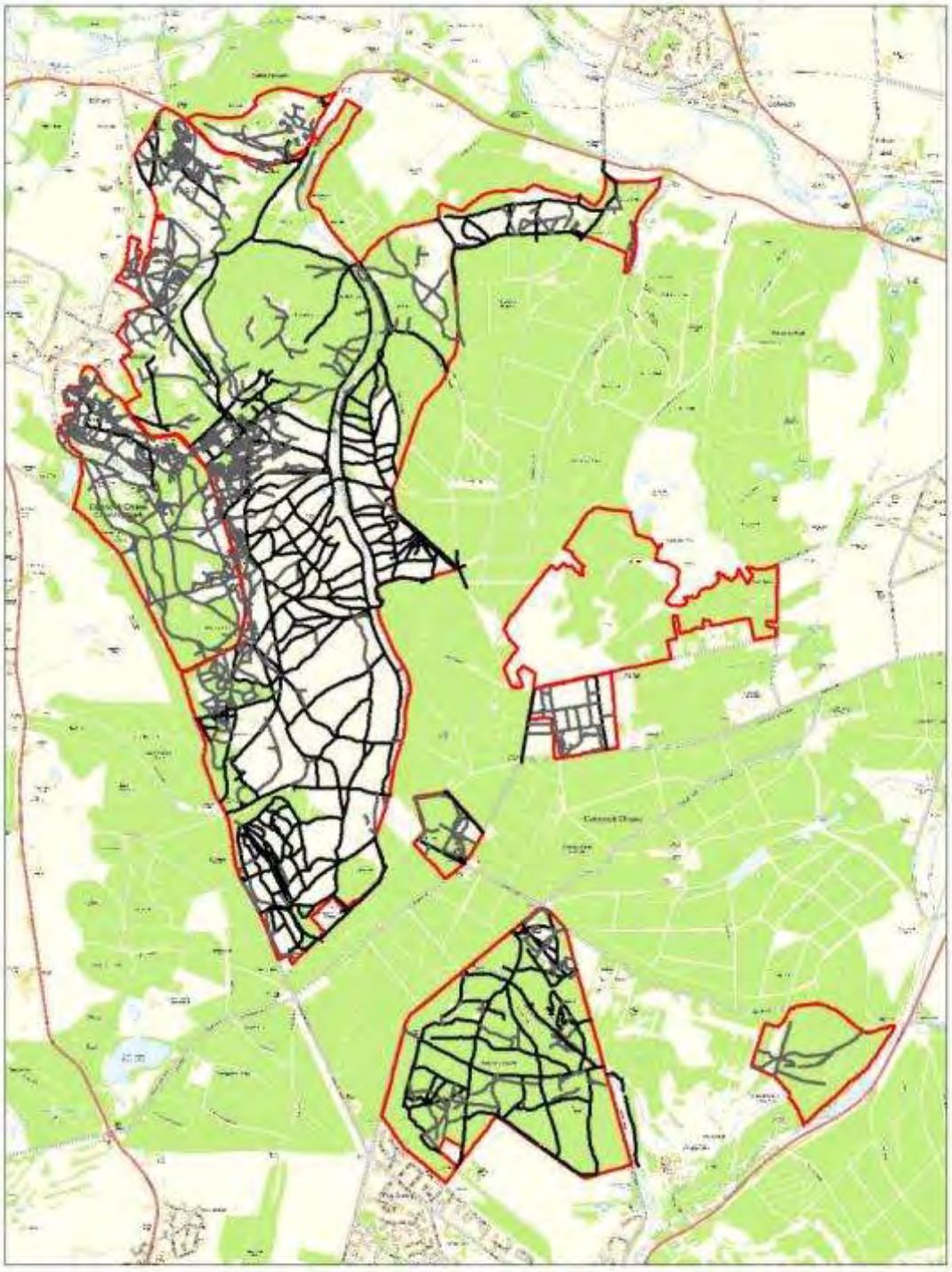


Map 13: Selected examples of fires

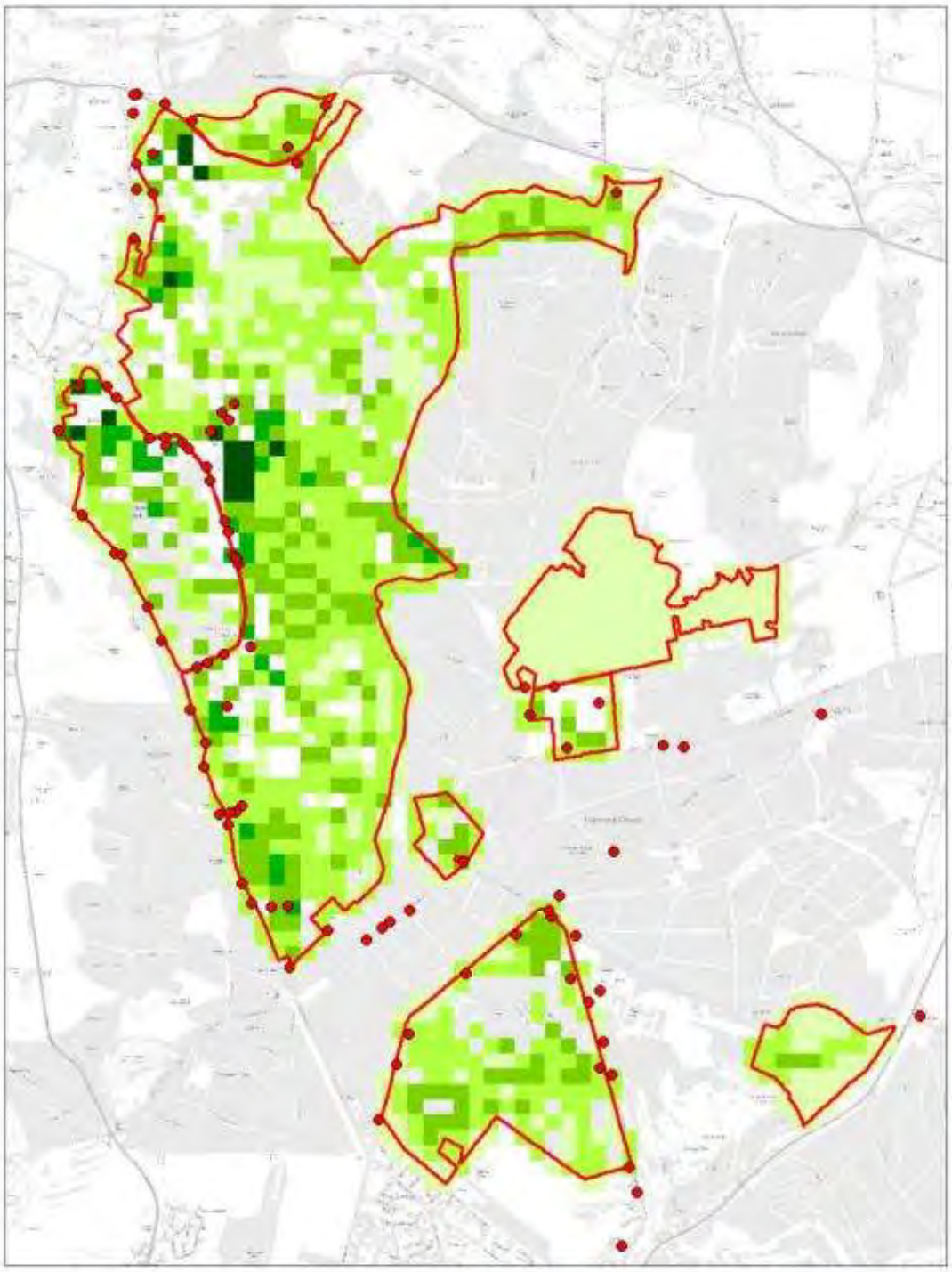
Particular instances of fires (5)

SAC

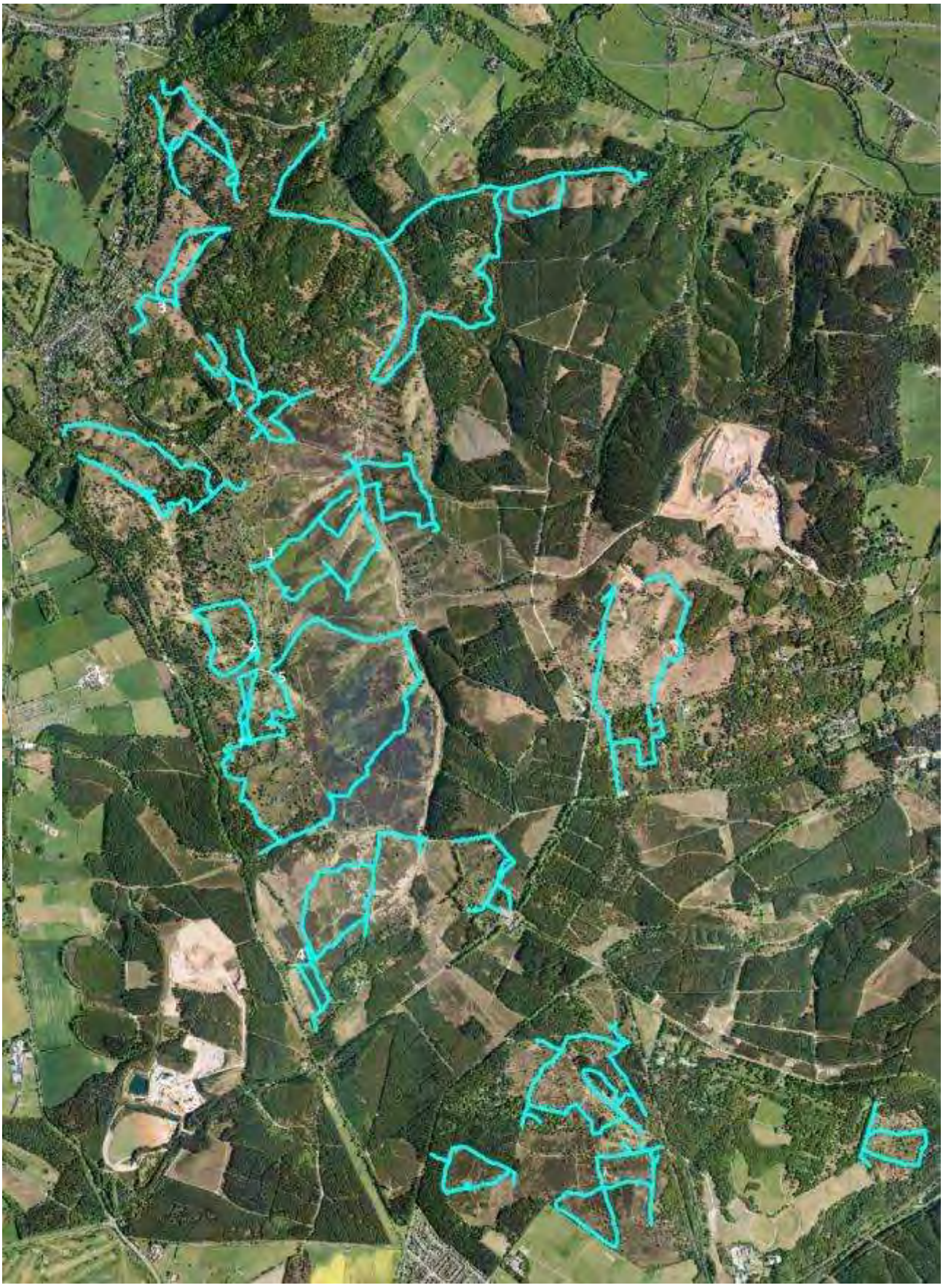
Appendix 2: Path network



Map 14: Digitised Path Network



Map 15: Path Network within 100m grid
Length of path/track within each (non-wooded) cell



Map 16: Path network walked in this study. Numbers 1-5 show locations of detailed sampling described in Appendix 4. Aerial photographs provided by Stafford County Council (dated 2011)

Appendix 3: Target notes for site visit/impact assessment

The following contains target notes relating to particular impacts or observations made during the site visits. The first column provides a number that allows cross-reference with the maps. The columns indicating types of impact (cycles, expansion, dogs etc.) contain a "1" where the particular impact occurs. These columns are used to generate the additional maps in Appendix 1.

MapID	Unit	Date Visited	Cycles	Expansion	Dogs	Horses	Enrichment	Erosion	Vehicles	Widening	Fire	Target Notes
167	1	05/08/2011							1			Ground disturbance by contractors' machinery. (Photo 1120614)
168	1	05/08/2011							1			Only slight traces of cycles on path – mostly machinery.
169	1	05/08/2011							1			Little visitor pressure on this path; recent use by machinery (Photo 1120617,19,20).
170	1	05/08/2011										Mown 'firebreak' on top of ridge (Photo 1120621).
171	1	05/08/2011										Perimeter path with apparently moderate visitor use (Photo 1120628).
172	1	05/08/2011	1		1							Path along western edge of heath – surprisingly well used given its distance from car parks. No stoning; up to 1m trampled. (Photo 1120629, 31-34)
173	1	05/08/2011					1					C50m strip, clearly caused by enrichment washing from higher areas (Photo 1120632).
174	2	05/08/2011	1									Track going W-E, widened 1.5m over whole length. Stony 'main line; Used by bikes (Photo 1120676-8). Nardus and D flexuosa worn out on edge.
175	2	05/08/2011							1			Path between cross-roads not so heavily used; apparently widening is more from machinery/vehicle use.
176	2	05/08/2011										About 30m length where track edge is being used in preference to stony main track (Photo 1120681).
177	2	05/08/2011										Double path on track edge (Photo 1120682).
178	2	05/08/2011				1						Track down hill not badly affected. Used by horses.
179	2	05/08/2011										Track expanding slightly but not affecting good heath.
180	2	05/08/2011							1			Heather driven on on W side (c50m length) – 1m wide path has become 2m wide with vehicle passage (Photos 1120687, 9).
181	2	05/08/2011										Eastwards of 37, less used than previous – 3 lane has become one lane....a bit further on: back to 3 lanes
182	2	05/08/2011							1			Going south, vehicle ruts
183	2	05/08/2011					1					Wet hollow, enriched particularly on E side of track which takes most run-off from it (Photo 1120696-7).
184	2	05/08/2011							1			Further on, bad damage by vehicles; effect of limestone surfacing noted on edge vegetation in one place.

MapID	Unit	Date Visited	Cycles	Expansion	Dogs	Horses	Enrichment	Erosion	Vehicles	Widening	Fire	Target Notes
185	2	05/08/2011										Going north, more stoning noted (Photo 1120702)
186	2	05/08/2011					1					High nutrient hollow (about 10m equilateral triangle) (Photo 1120704) at top of slope on E side of track plus narrow path coming through heather to it (a short-cut from car park that initially comes through woodland, Photo 1120706).
187	3	05/08/2011										A little up the perimeter track from car park exit through woodland : 50m three-tier use here. Main track on right (2m?) coarse gravel, on a slight shelf another stone path and left of this, trampled heath grasses. c1m extra affected all the way along. Photo 1120707.
188	3	05/08/2011			1							Carrying on along the edge of the site, horse use apparent but fairly minor. C 0.5m enriched and trampled.
189	3	05/08/2011							1			The start of this path has been doubled in width probably by vehicle use but recreational path use low and the bare ground looks like good habitat (photo 1120708-9).
190	3	05/08/2011								1		A link between paths – cut heather.
191	3	05/08/2011		1								Too many paths. Paths have expanded but don't appear still to be doing so.
192	3	05/08/2011										Good invertebrate habitat on track.
193	3	05/08/2011							1			Two lager cans!
194	3	05/08/2011					1					Minor nutrient sump – 10x10m
195	3	05/08/2011										Junction of paths (T junction). Heavily used here – corner-cutting. Photo 1120713
196	3	05/08/2011					1					Track widened in bottom and 1mx50m+ enriched fringe with bramble, tall oat, rb willowherb etc.
197	4	05/08/2011										Wide mown grassy firebreak; no significant recreational pressure. Width 7-8m. Photo 1220635.
198	4	05/08/2011			1		1					Close to car park there is a concentration of dog faeces.
199	4	05/08/2011										Track heading west to junction, mainly through heathland restored from tree-cover. Photo 1220636.
200	4	05/08/2011	1	1								Minor edge damage, as 3. A bit of evidence of cycle use at wm16.
201	4	05/08/2011								1		Path originally through woodland, going up westwards to car park. Now heath on S side. Widening mainly on N side at wm18 – photo 1120641.
202	4	05/08/2011	1			1						Quite heavy cycle use; horses too. Photos 1120642-4.
203	4	05/08/2011										Paths in trees with hard surfacing; woodland edge no surface– not heavily used.
204	4	05/08/2011		1								Path forks; north branch look newish.

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205	4	05/08/2011				1			1			Machinery/vehicle ruts along this track. Horse dung but use doesn't appear heavy.
206	4	05/08/2011							1			Edge affected by vehicles; path not very heavily used.
207	4	05/08/2011		1								New path c 2m wide – worn turf: Photos 1120650/2
208	4	05/08/2011										Fairly well used track but 'ditch and 'bank' constrain widening – photo 1120655.
209	4	05/08/2011		1								Ponds and bridge plus a network of paths involving viewing platform – looks like some newish ones in woodland eg NW of the pond– photo 1120657-72.
210	4	05/08/2011								1		Path edges mown – about 1m over-widened
211	4	05/08/2011		1								Cut-through here being widened.
212	4	05/08/2011	1	1				1				Erosion on steep slope next to southern boundary – cycles? – photo 1120673-75. A 'bypass' has been formed to avoid it.
214	5	04/08/2011	1									Cans and plastic bags under beeches. 10mx10m affected. Photo 1120569. Quite a few small paths used by bikes in scrubby heath/grass to south of bridleway – photos 1120566, 70-71.
215	5	04/08/2011			1							Marked 'X-Y' on map, 20 deposits of dog mess along this length of path
216	5	04/08/2011	1		1							Path across heath – desire line which looks as though it is being increasingly used. Widened on average by 0.5m over single file use. Dog walker plus 3 dogs and 4 mountain bikes seen in 10 minutes. Bikes apparently use it as a cut-through from car park to FC land. Photos 1120588-93, 1120604-5
217	5	04/08/2011										Path along NE side. Section 'A-B' on map, widened up to 1m with people opting to walk/ride on grassy edge rather than stony path in middle – photos 1120581-6. Joins wider path on N side – photos 1120578-80.
218	5	04/08/2011										Newish narrow path – short cut – joining NW boundary path further NE than 3. Photo 1120587, 601-3.
219	10	05/08/2011			1	1						Near German cemeteries, firebreaks 5m wide, grassy (photos 1120752, 74,75): some mown areas of heather near road have come back grassy. Some useful bare ground on firebreaks. Used by pedestrians and equestrians but not at a high level in this part.
220	10	05/08/2011										Metalled road to Aspen car park has lay-bys for extra parking
221	10	05/08/2011								1		One of several paths from car park - a c 5m wide fire break, recently widened.
222	10	05/08/2011			1					1		Newly widened fire breaks (photos 1120754-5). Level of recreational use varies but trampling and dog fouling is spreading into the available space where mowing has happened (photo 1120764).
223	10	05/08/2011			1					1		Generally, fire break cutting is excessive – here 7m! (photo 1120756) and apparently similar over most of this compartment
224	10	05/08/2011								1		Junction of largely bare tracks but also recently further widened (photos 1120759, 63).

MapID	Unit	Date Visited	Cycles	Expansion	Dogs	Horses	Enrichment	Erosion	Vehicles	Widening	Fire	Target Notes
225	10	05/08/2011						1				Path becoming stony/eroded on slope (photo 1120762)
226	10	05/08/2011			1					1		Widened track with full width being used by walkers (photos 1120765-7).
227	10	05/08/2011		1								Multiple paths developing (photo 1120769)
228	10	05/08/2011		1								Vegetation growth on original path causing diversion (photos 1120770,1)
229	10	05/08/2011		1								Not widened by cutting but stony surface encouraging extra path to form Photos 1120772,3)
230	10	05/08/2011										70m section of path recorded as sample (see separate note)
1	11	16/08/2011				1						Track from Katyn Memorial car park 2m wide plus 1 extra metre of equestrian use. Phytophthora-affected bilberry on north side (photo 1120868-9); other side there is a former car park - (photo 1120870) with lichen later identified by JW as Umbilicaria cylindrica – an upland species probably on the edge of its range.
2	11	16/08/2011	1			1						Apparently new path taking off from N side of track onto heath (photos 1120871-3); signs of cycling and horse-riding on it. Fire on west side then both sides. Grayling?
3	11	16/08/2011						1				Steep eroded double path
4	11	16/08/2011										Track apparently surfaced with limestone.
5	11	16/08/2011										Cross-roads; good path for invertebrates – not heavily used; about 3m wide in all.
6	11	16/08/2011		1				1				Down slope, path widened into 5 tracks because of stoniness on more eroded lines (photo 1120877). Still aculeate holes in suitable patches (photo 1120878).
7	11	16/08/2011										Track up hill which looks as if use is increasing on it. Molinia flattened and trampled (photo 1120879).
8	11	16/08/2011										Down slope, good bare ground on path with Deschampsia flexuosa/Nardus and bramble on edges.
9	11	16/08/2011										T junction. A more heavily used N/S path with stoning on slope.
10	11	16/08/2011		1					1			Multiple tracks on slope down (photo 1120885). Sweep of vehicle rutting.
11	11	16/08/2011						1				Gully erosion to cross-roads (photo 1120886-8).
12	11	16/08/2011										Path downhill mostly vegetated; no major erosion. Deep gully at edge saves path from erosion (photo 1120889).
13	11	16/08/2011			1							Sump effect on edge of track – wet and enriched - Trifolium repens, Agrostis capillaris, Juncus effusus.
14	11	16/08/2011			1							Various surfacing of track. Significant effect of dog fouling – for 200m+ - Agrostis, Dactylis, Cirsium vulgare etc. (photo 1120931-2) Sample site with photos (1130275-7).

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15	11	16/08/2011			1							Turning right, this path is not as affected by dogs but still evidence along it. A good path for bare sand (photo 1120912).
16	11	16/08/2011								1		Minor path off 12 – mown!
17	11	16/08/2011										Near car park there are grassy patches. Lots of paths (photos 1120915-16). Many fewer dogs near this car park – not used much by dog walkers – other activity!
18	11	16/08/2011				1						Horse track – narrow, unvegetated (photo 1120917).
19	11	16/08/2011										Sandy, quite well-used path going to car park (photo 1120918). It appears that this area was once more important for recreation – bits of old 'furniture'.
20	11	16/08/2011										Worn path going NW. NE/SW path less well used than 15.
21	11	16/08/2011										Next NE/SW path doesn't have heavy pressure and has useful bare ground. Leads back to track from Katyn car park (photo 1120918).
22	11	16/08/2011			1							Stoned path going from Chase Road Corner car park southwards. Looks like old military origin – stoning underneath. Quite a lot of dog fouling but not as much as 11 (photo 1120922).
23	11	16/08/2011			1							Minor path taking off from main one – grassy and only slightly worn in the middle. Probably no horses but certainly dogs.
24	11	16/08/2011								1		Mown path – reason for mowing unclear.
231	11	16/08/2011								1		Mown path – reason for mowing unclear. (photos 1120926-9). In one place, virtually dead gorse both sides. A scraped bank where cutter has run aground (photo 1120929).
232	11	16/08/2011				1						Grassy track - a couple of horseriders using it.
233	11	16/08/2011			1							Left hand fork from Chase Road Corner car park. Less used by dog walkers than 11 and thus less affected and surface less worn but still a wide area of Agrostis-dominated fringe with bramble locally.
25	13	16/08/2011										Wide splay junction above stream.
26	13	16/08/2011										Newish track uphill; could erode (photo 1120896).
27	13	16/08/2011										Path up hill; one track. (light lines on airpic are in fact lines of Molinia, possibly marking depressions caused by past use – this goes for locs 4 and 5 too).
28	13	16/08/2011		1								Very new expansion? Both sides of E-W track.
29	13	16/08/2011							1			Further up, old? vehicle use shows – lots of lines.
30	13	16/08/2011					1	1				Centre of track has loose stone (photo 1120903 ; foreign stone has been put in with Terram. Edge vegetation apparently affected – white clover, Agrostis and bramble.
31	13	16/08/2011				1						Another stoned track. We saw galloping horses on this a little bit later.
32	13	16/08/2011										Railway route

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33	13	16/08/2011										Newish desire line developing (photo 1120907)
34	13	16/08/2011					1					Glacial boulder surrounds – heavily modified vegetation – Arrhenatherum etc. Cutting for railway? next to this.
35	13	16/08/2011		1								Wide path; 5m plus 1m trample; edges used for softer walking (Photo 1120935).
36	13	16/08/2011										Exit onto main track from NE with a cut-through showing increasing use (Photo 1120937-8)
37	13	16/08/2011			1	1						2m extended to 4m with recent cutting into heather etc (Photo 1120939) (sampled later). Already horses using new mown sides and dog fouling on them too.
38	13	16/08/2011					1					Junction of tracks with a nearby 'sump effect' – an area of slightly enriched bracken/grass/bramble plus Holcus and Agrostis.
39	13	16/08/2011					1					Very narrow but well-worn track from junction (may be strongly eroded in wet weather). Turns a sharp right angle down slope where it is marked by bracken – enrichment? (photo 1120946).
40	13	16/08/2011								1		Over-mown firebreak; from junction runs south2.5 m track originally with 1.5m mowing on one side and 0.5m on the other (photo 1120947).
41	13	16/08/2011								1		Over-widening lower down – Extra 1.5m recently added to main path (photo 1120949). Seems to have happened in 2 stages – first path developed on shelf; then another 0.5m added by cutting.
42	13	16/08/2011										Path off 17 – 1m, extended 1.5m either side into heath.
43	13	16/08/2011				1	1			1		Overwidening here – 5 paths on terraces. Photo 1120962. Enrichment from horse droppings mid pic will wash into heath Photo 1120963 shows bracken and bramble below track, some distance from it.
44	13	16/08/2011	1									Heading SSE of junction, path grassy – 2m main track plus 1m extra, recently added; little used but cycle track noted.
45	13	16/08/2011								1		3m path with 2m widening
46	13	16/08/2011										Junction with bottom track where path goes down steep bank shows this path without firebreak widening (photo 1120973).
47	13	16/08/2011	1				1					Short cut across loop of main path (junction of Units 13 and 26). A narrow one-lane path , enriched at entrance (photos 1130012-16 – in Unit 26 folder). Heavy use by cycles.
48	13	16/08/2011										Hydrocotyle, Triglochin, Anagallis tenella, Carex panicea in wettest bit.
49	13	16/08/2011				1						Very minor path, no more than 1m wide, mown into a 'firebreak' 4m wide; horses using it . Photo 1130018. We took left (southern) option at fork which is more worn at top end.
50	13	16/08/2011										Heather line along probable old path, perhaps 0.5m wide, apparent on airpic plus other similar areas nearby, seen on facing slope – photos 1130019-20.
51	13	16/08/2011		1								Successive stages of path widening with mown areas giving potential for further paths.
52	13	16/08/2011						1				Eroded steep path on opposite slope – photos 1130021-25

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53	13	16/08/2011						1				Stony eroded paths with expanding use
54	13	16/08/2011		1								Small bypass outside mown path width, on slope -photo 1130026
55	13	16/08/2011						1				Gully being eroded
56	13	16/08/2011										New desire line towards pond
57	13	16/08/2011					1					Enriched lawn/hollow below track
58	13	16/08/2011				1						Horses using softer edges of track here
59	13	16/08/2011										Grassy ground near car park with what appears to be recent motor bike damage (photo 1120911 - Unit 13).
60	15	17/08/2011				1	1	1				Confined path surfaced all across with fine grey stone. A bit of erosion in the south; signs of horses; some enrichment on edge – Agrostis/composites; natural drainage ditch to the side. Photo 1130010.
61	15	17/08/2011					1					Bottom path; more gullying and enrichment – thistles, grasses, yarrow, tall oat.
62	15	17/08/2011					1					Granite-covered path –just Plantago coronopus at bottom; some patches of surfacing. Enrichment on edges where drainage takes it; c40% vegetated overall. Photo 1130011
63	15	17/08/2011										Grassy track from Coppice Hill car park. Looks like part of old military installation. Close rabbit-grazing. Photo 1130042
64	15	17/08/2011										Path along top of slope – SW/NE. Modest use NE-wards. Vehicle width with one rut worn through and the other not quite. Has old horse droppings. Photo 1130043.
65	15	17/08/2011				1						Path off 5, heading SE downhill, has strange enriched areas at top (may be old military use) – grassy and unworn (Photo 1130046). More wear further down Photo 1130047). Some horse use.
66	15	17/08/2011		1								Top path, pushed out here by plantation trees (Photo 1130049).
67	15	17/08/2011										Light pressure on path down slope. Path grassy and c3m wide. No extra firebreak width put on here. Aculeate holes on side track.
68	15	17/08/2011										Meets other path – similarly constrained in width.
69	15	17/08/2011				1						Spot-spraying of birch along track edge has cause a fair amount of by-kill of heather (photo 1130051). Horse use but they may prefer softer alternatives – eg 8.
70	15	17/08/2011										Grassy path through old camp; heath a little way back from path so not affected by enrichment. Original track c3m with 1m grassy rabbit-grazed banks each side
71	15	17/08/2011							1			Broken pole barrier at Frieda's Grave car park.
72	15	17/08/2011										A lightly used desire-line through modified heath – grassy with scattered hawthorns and birches (photo 130055).
73	15	17/08/2011										Looks as though deer have caused/are maintaining these bare patches – odd! (photo 1130056).

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74	16	17/08/2011	1					1				Probably mostly in Unit 26 – network of tracks, many on steep slopes for cycling excitement (photo 1120979).
75	16	17/08/2011										Track up hill is contained in a cutting.
76	16	17/08/2011	1									Bottom track. Uses appear primarily cycle and pedestrian – path constrained by slope on left and bank on right (photo 1120980).
77	16	17/08/2011								1		5m wide freshly cut firebreak, probably widened by 0.5m each side this time (photo 1120983).
78	16	17/08/2011						1				Erosion on steep slope of upper track (photo 1120987-8).
79	16	17/08/2011						1		1		Firebreak -7m wide with a badly eroded gully (photo 1120990); 4m added recently to the original 3m, apparently..
80	16	17/08/2011								1		Mown firebreak; same features (photos 1120991-2)
81	16	17/08/2011		1								Top firebreak/track. 5-7 parallel paths! (photo 1120993-4)
82	16	17/08/2011										Grassy intersection – Agrostis, Cynosurus, Plantago, Prunella and composites.
83	16	17/08/2011			1	1	1					Track going E from intersection; 'original path appears to be about 2.5m wide; another metre added more recently on terrace (photo 1120998). Useful invertebrate habitat on very edge but too trampled on path (photo 1120996-7.) Quite a lot of evidence of dogs and horses (photo 1120999) and enrichment on down-slope side.
84	16	17/08/2011										Steep firebreak, very loose on top of slope but fortunately not used much.
85	16	17/08/2011				1						Horse use down slope, avoiding stony bits.
86	17	18/08/2011			1	1						Stony track away north from Freda's Grave car park. In cutting here, so impacts contained. Bracken side banks mown (incl heather).
87	17	18/08/2011			1	1						Hardened track over stone with grass cover and several smaller grass paths off through bracken. Heath strip along SW edge. Some dog walking
88	17	18/08/2011			1							Small path off NW corner of Coppice Hill car park. Clips small patch of heath. Quite narrow and slightly worn (photos 1130122-3).
89	17	18/08/2011			1							Metalled track N from car park. At c30m grassy path curves off west forming grassy triangle junction (photos 1130125,7). Agrostis, Holcus, Trifolium, Composites. Lots of dog mess .
90	17	18/08/2011			1	1						Firm path with natural stony base, across heath patch. 2.5m wide with 50% each of grass and stone. Impact mainly contained by edge growth of heather/grass. (Heather rather degenerate and succeeding to grass).
91	17	18/08/2011									1	Same 2.5m path, stone/grass, through bracken with heather beneath. Small burnt patch – 2 years ago – in birch/bilberry (20m x 20m approx - photo 1130129,31).
92	17	18/08/2011				1						Large patch of heather in quarry (photos 1130134-6 –Q1). Single 3m wide track along east side (by fence). Some short grass and moss and firm stony/sandy base - 60% bare.

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93	17	18/08/2011										Another heath patch within fenced area of quarry. Heath appears to be invading grass. No obvious access now (photos 1130114,16,38 – Q1).
94	17	18/08/2011			1	1						Heath/acid grass at Brook Lane. A few single width paths up heath slope from houses, to join upper wider grassy track. Some wear and dog mess/horse dung (photos 1130139-43).
95	17	18/08/2011	1		1	1		1				Typically track (nr rowans) 2.5m wide and mainly grass, but some erosion with turf starting to get worn. Several 'personal' paths cut across heath to houses. (photos 1130144-7).
96	17	18/08/2011			1	1						Junction of paths (photos N,W,S,E: 1130149-52). Sample * done on path heading west. 3m wide mainly grassy path, 30% bare. Dog and horse poo.
97	17	18/08/2011		1	1	1						30m east from cross junction of paths through heath patch. Excessive widening of path with 3 clear lines now cut into heath. No obvious reason – not stony or wet. 60% bare (photo 1130155).
98	17	18/08/2011	1					1				Wide junction of 5 paths (photos 1130157-60). Grassy but worn to stone on slope. Much cycle use. Eroded on SE side. Northern track eroded as it rises to join main E/W track (photo 1130156, 61).
99	17	18/08/2011	1									Newish cycle route, with 3 clear lines and spreading, down very steep bracken slope (from Sundial hill) to join E/W track(photo 1130162). Further new cut (cycles) 25m east.
100	17	18/08/2011						1				Heather/acid grass (Nardus/Agrostis)/bilberry around hilltop pines. Main cross path 2.5m worn grass, more eroded on slope. Other minor paths lead into heath. (photos 1130164-6).
101	17	18/08/2011	1					1			1	Bonfire site in trampled grass alongside Millenium Sundial. Steep eroded paths climb onto this site and link to loc.12. (photos 1130170,71).
102	18	18/08/2011	1		1	1		1				Wide stony track between Brocton Coppice and Shugborough woodlands. Footways created each side of track, especially Unit 18 side, presumably to avoid stony surface. These cut through acid grass/bracken/heath. Some erosion of slope and in places 2 or 3 such tracks. Active cycle use seen using these small tracks // to main track. On main track down to this point (the boundary of Unit 20) at least 5 bags of dog mess discarded. (photo 1130195-97).
103	18	18/08/2011					1					Enriched hollow beside track – the result of run-off from track. Vegetation modified to be dominated by Rubus and Juncus.
104	18	18/08/2011	1					1				N tip of Brocton Coppice at track junction near large bracken 'clearing'. Eroded soil and torn turf across grassland at foot of slope and clear evidence of cycle use down the steep slope, through Brocton Coppice oaks (photo 1130206).
105	18	18/08/2011	1									Along track SW of Stepping Stones, where stream close to this side, a cycle path (with tracks) cuts down through steep bracken slope to the main track – boundary with Unit 26. A further such track c 100m closer to Stepping Stones, by concrete structure in stream. This one with less heavy use but several clear tyre ruts.
106	19	19/08/2011	1			1						Corner cut at NW corner of Unit 27. Separates heath of Unit 27 from this small heath patch in 19. Foot access but also clear evidence of cycle and horse use. (photo 1130234).
107	19	19/08/2011								1		Firebreak/track crosses heath. Recently cut 1m on each side of 3m break (photos 1130235).
108	19	19/08/2011				1				1		Large grassy/flowery junction of breaks in heath block (photo 1130236-8). Breaks very recently widened 2m+. Little visitor use – rides fully vegetated but some horse use (photos 1130241-2).

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109	19	19/08/2011								1		Mowing of grassy glade in bracken 20m+ wide in places (photo 1130243). Cut in flower, reducing nectaring opportunities in otherwise extensive bracken stand.
110	19	19/08/2011	1						1			4m track along valley bottom. Agrostis across track (photo 1130244) – some vehicle use and light pressure on flat but cycle erosion down to stone on slope (30 % bare, more on slope). Heath edge here, before bracken starts, with good heather – as yet uncut and providing local good nectar source
111	19	19/08/2011	1					1				Just north of Steeping Stones, a steep cycle track down to main track and Stones, through bracken/birch. Deeply rutted and eroding (photos 1130270-1). Further similar cycle path at Unit 27 junction.
112	20	18/08/2011								1		Small grassy paths south of Sister Dora car park. Little damage here and surface mostly unbroken, though trampled turf. Heathy grass each side (photos 1130173-4).
113	20	18/08/2011	1		1			1				Stony track curving around heath/grass slope. Trampled alongside (to avoid loose stones?). Several desire lines across grass/heath. Stones and soil spilling off down slope side from wash/cycle scuffing, and enriched turf resulting – Holcus. Dog poo bags left in grass! (photos 1130175-8).
114	20	18/08/2011	1					1	1		1	Wide worn steep track across heath slope, 5m wide and all eroded with very trampled grass edges grading into heather (photo 1130180,82). Lots of litter on back of steep heather hill and bonfire and much litter in valley below (E) of hill – cans, papers etc (photo 1130184).
115	20	18/08/2011						1				Worn and eroding path up steep grass/heath slope from vehicle track. Loose sand/stone and worn grass (photo 1130183).
116	20	18/08/2011										2m firm stony path, 80% bare. Light use. Heath/grass edges. Very small, scarcely used narrow path off through heather to hill-top pines (photos 1130185-6).
117	20	18/08/2011			1							Small slightly worn path 0.5m, through heather. Divides heath. Relatively new? Some dog mess (photos 1130187-8).
118	20	18/08/2011									1	Bonfire site ca 1.5x1.5m, in grass track near junction (photo 1130189).
119	20	18/08/2011										Old but still effective constructed steps down steep slope (photo 1130190).
120	20	18/08/2011						1			1	Steps up opposite slope to hill-top tumulus, but overhanging gorse/scrub has encouraged an alternative path to form, causing erosion of heath, cutting into side of tumulus (photo 1130192). BBQ patches burnt in grass on tumulus bank.
123	24	17/08/2011			1							Modified heath, probably the result of intensive restoration – bits of Deschampsia flexuosa, Calluna and Nardus; a lot of bramble, foxglove, bracken, some rose. Paths fairly well used, dog fouling in places. Photo 1130058.
124	24	17/08/2011	1		1							Paths well used by bikes, worn to stone; 0.5m wide but additional lanes in many places. 2 cyclists, much dog fouling,; a network of paths.
125	24	17/08/2011							1			A contractor's track off main track; may be being adopted for recreation (photo 1130059).
126	24	17/08/2011							1			Contractor damage on path side (photo 1130060).
127	24	17/08/2011								1		Path is currently two discrete paths but shows expansion outwards (photos 1130063-5).

MapID	Unit	Date Visited	Cycles	Expansion	Dogs	Horses	Enrichment	Erosion	Vehicles	Widening	Fire	Target Notes
128	24	17/08/2011								1		When there is nothing to constrain it, the path widens to take up all space – softer walking on grass (photo 1130066). Here path is very broad.
129	24	17/08/2011	1					1				Evidence of increasing bike use here. (photos 1130069-72). Slope with erosion scarred now being bypassed (worn Deschampsia and humic layer) and beginning to create another route.
130	24	17/08/2011				1						Path along N side of Unit 25. Modest pressure; bit of expansion to avoid stones; some horse use.
131	24	17/08/2011	1									Track used by cycles but not heavily affected (one cyclist seen)
132	24	17/08/2011	1		1	1						Path through trees rather worn but use apparently quite modest (photo 1130073, 78)
133	24	17/08/2011	1		1	1						Path from Chase Rd Corner meets another larger path and becomes 2 worn lines. Wide grassy triangle at junction. Some enrichment in zone near road – Arrhenatherum and Rubus extend 20m into heath (photos 1130082).
134	24	17/08/2011			1	1						Path west 2m wide, grassy, 10% bare, becomes 3m wide and has 3-4 worn tracks with grass strips between. Veg – Nardus, Juncus squarrosus, Calluna. 30% compacted sand surface (photo 1130087).
135	24	17/08/2011										Junction. Grassy with J effusus. Small single width path to north. 3-4m wide track links south to road. Worn 1m into heath edge, with mainly grassy base. (4 views S,E,N,W – 1130087-90)
136	24	17/08/2011										West path mainly grassy with 3 – 4 trampled lines providing compacted sand. Small single path northwards (photo 1130093).
137	24	17/08/2011	1			1						Junction with island of Juncus and 4 paths off (photo 1130099). Pics taken of 4 tracks,-N,W,S,E – photos 1130095-8). Paths 3m wide grassy with 3-4 worn tracks and 40% bare. Path E steeper with some exposed sand.
138	24	17/08/2011										Minor path cuts across route of main path – new use?
139	24	17/08/2011	1		1	1						Junction with 4 paths (4 views N, W, S, E – photos 1130101-4). 3m wide, grassy with 2-3 worn tracks, 40% bare.
140	25	17/08/2011										Crossing point – minor path across valley. Marsh fern conservation nearby. (photo 1130075-6)
141	25	17/08/2011	1									Another crossing, quite restrained use but some cycling evident (photo 1130077)
142	26	16/08/2011				1						Stepping Stones. Heavily trampled vegetation on edge of stream – Agrostis canina, Molinia caerulea, Juncus squarrosus. Grades into less trampled wedge of Molinia/Calluna grassy heath beyond the trampled zone (photo 1130201). Some litter.
143	26	16/08/2011	1		1	1	1	1				Molinia/Calluna grass heath between stream and track. Evidence of enriched edge – Cirsium and Lolium replacing Molinia (photo 1130203)- wash off track and/or dog mess?
144	26	16/08/2011										Several informal log bridges up stream of Stones, but intense pressure declines in c200m.
145	26	16/08/2011	1			1						Boundary with Cpt 19. Small heathy patch at bottom of valley from Cpt 19. main track goes around but heath cut by several, smaller, 2m paths. Cycles appear to come down steep slope off Cpt 19 and straight onto smaller path

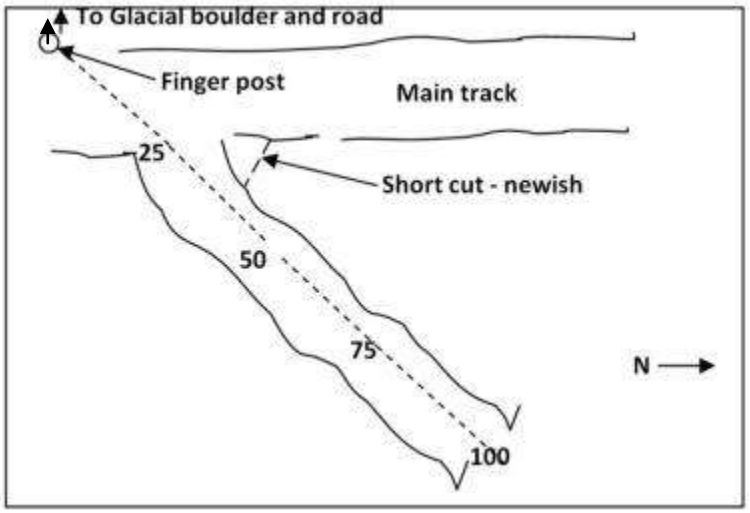
MapID	Unit	Date Visited	Cycles	Expansion	Dogs	Horses	Enrichment	Erosion	Vehicles	Widening	Fire	Target Notes
146	26	16/08/2011	1		1							Smaller 1.5m path parallel to main track, on edge of alders, with several links to stream. Main path used by cycles and dogs – widens variously where wetter. Log in stream to make informal crossing (photo 1130251). Walker with dog seen in alder woodland on streamside path
147	26	16/08/2011	1		1							Small streamside path between stream and main track, through alders and wet heathy grassland. Obvious cycle as well as pedestrian use (photo 1130259).
148	26	16/08/2011					1					Main, much-used track along west side. Evidence of enrichment affecting Cpt 26, from track – wash, dog/horse dung effect? (photo 1130017). Veg changed from grassy heath to Holcus and Cirsium.
149	26	16/08/2011										Path on east, FC side. 4m track on west side heavily used, incl by vehicles, but pressure fairly contained by slope and vegetation
150	26	16/08/2011										Path has diverted to avoid wet patch – (photo 1120894 – Unit 26)
151	26	16/08/2011										A little path through vegetation down to hollow (dry at present) in 'flood plain' (photo 1120893 – Unit 26).
152	27	19/08/2011			1							Much dog mess all along main track from Seven Springs car park towards Cpt 27. From bottom, hard gravel vehicle track, firebreak up bracken slop. Much dog mess on acid grass clearing (photo 1130212).
153	27	19/08/2011				1						Mown grass break in valley through bracken hills. Light trampling but as yet largely unbroken turf, but some cutting by horse hooves starting .
154	27	19/08/2011	1									Higher top main track has several 'link' paths forming, connecting to fire breaks (photos 1130217-8). Top track firm with some vehicle use – grassy on flat, or firm stone but broken surface on steep slope (photo 1130219).
155	27	19/08/2011	1			1						Firebreak curves with gradient at top with 2 link paths cut across through heath (photo 1130221).
156	27	19/08/2011	1		1	1						Lower path 3m, a stony vehicle track beside Cpt 19. Has 2m+ edge path, worn into heath veg – to avoid stones? (photo 1130233,73)
157	28	06/08/2011							1			Path strikes off through heath.Probably originally a vehicle track. Minor use but divides heath patch (photos 1120739-40).
158	28	06/08/2011							1			Old vehicle access over heath. Apparently not strayed from (photo 1120743).
159	28	06/08/2011										One-lane path through heath – minimal damage.
160	29	06/08/2011										Cut-through path to join bottom valley track- through bracken. (photo 1120747). Most of unit appeared to be bracken-covered.
161	30	06/08/2011	1		1	1						Around deep pit and pool, obvious biking as well as riding (across top) and dog walking (photos 1120725-7).
162	30	06/08/2011										A large amount of tree clearance has happened recently; still a lot of bracken to control – much sprayed bracken and Molinia (photo 1120728,33).
163	30	06/08/2011						1				Top of steep slope; erosion on track – used for machinery, now biking. Several wide former quarry tracks so present recreational use mainly confined to these (except for exciting biking –photo 1120731 – but we couldn't find a lot of recent tyre marks here). Is cycling being discouraged?

MapID	Unit	Date Visited	Cycles	Expansion	Dogs	Horses	Enrichment	Erosion	Vehicles	Widening	Fire	Target Notes
164	30	06/08/2011	1		1							Valley bottom track (photo 1120732) with dog walking and cycling
165	30	06/08/2011							1			Bare area – signs of wheelies – 4x4? (photo 1120734)(Outside cpt/SAC)
166	30	06/08/2011						1				Small 'quarry': Mountain bike runs on slopes but patches of good heath (if scrubby) in between (photo 1120735, 41)

Appendix 4: Notes of five path lengths sampled in detail

At five access points a length of path was sampled in more detail and notes and photographs taken at three or more transect points. These locations could be re-surveyed in future.

Sample point 1 in Unit 13, near Glacial Boulder**.** 17 August 2011 (photos 1130274-7)



Sketch to indicate location of sample length in relation to Glacial boulder

A 100m section of the track heading NE was sampled in more detail; measured from finger post to the west of main N/S track (photo 1130038).

From post, 25m NE: (photo 1130037)
3m wide central track comprising 3-4 pathways, 40% bare; worn turf with *Festuca tenuifolia, Nardus, Agrostis capillaris, Hypochoeris.* The outer 1m to the right of the worn path has *Agrostis capillaris, Molinia, Nardus, Festuca tenuifolia*.
The outer 1m to the left of the worn path has *Calluna, Molinia, Deschampsia flexuosa.*

From post, 50m NE: (photo 1130039)
3m wide central track comprising 1-2 pathways, 20% bare; worn turf with *Festuca tenuifolia, Nardus, Agrostis capillaris.* The outer 1m to the right of the worn path has *Molinia, Nardus, Deschampsia flexuosa, Calluna*. The outer 1m to the left of the worn path has *Calluna, Molinia, Deschampsia flexuosa.*

From post, 75m NE: (photo 1130040)
3m wide central track comprising 3-4 pathways, 70% bare; worn turf with *Festuca tenuifolia, Nardus, Agrostis capillaris.* The outer 1m to the right of the worn path has *Deschampsia flexuosa, Calluna, Vaccinium myrtillus*. The outer 1m to the left of the worn path has *Calluna, Molinia, Nardus, Vaccnium myrtillus.*

From post, 100m NE: (photo 1130041)
3m wide central track comprising 1-2 pathways, 50% bare; worn turf with *Molinia, Calluna, Nardus, Agrostis capillaris.* The outer 0.5m to the right of the worn path has *Deschampsia flexuosa, Calluna, Vaccinium myrtillus, Nardus*. The outer 1m to the left of the worn path has *Calluna, Molinia, Vaccnium myrtillus.*

The 100m length of path and its edges had 6 separate deposits of dog mess and 10 deposits of horse droppings.

Sample point 2 in Unit 24, near loc.11. 18 August 2011 (photos 1130107, 08, 09, 11)

A 100m section of the path leading north from the cross junction on the heath near Chase Rd Corner was sampled in more detail measured from the post (photo 1130112).

From post near junction point, 25north: (photo 1130107)
3m wide path with overall 50% bare. Worn turf has *Agrostis capillaris, Lolium perenne, Nardus stricta, Trifolium repens, Plantago major, Poa annua*.
No intrusion into heath edges.

From post near junction point, 50m north: (photo 1130108)
3m wide path, overall 70% bare, with worn *Agrostis capillaris, Lolium perenne, Plantago major.*

From post near junction point, 75m north: (photo 1130109)
Total width 3m with 80% bare. Worn *Agrostis capillaris, Lolium perenne, Plantago major*

From post near junction point, 75m north: (photo 1130111)
Total width 3m with 80% bare. Worn *Agrostis capillaris* mainly with some *Lolium perenne.*

The 100m length of path and its edges had 2 separate deposits of dog mess and 1 of horse dung.

Sample point 3 in Unit 17, near loc.10. 18 August 2011 (photos 1130150, 53, 54)

A 50m section of the path leading west from the cross junction on the heath patch at Brook Lane was sampled in more detail.

From centre of junction point, 25m west: (photo 1130153)
3m wide path with overall 40% bare. Trampled turf has *Agrostis capillaris, Nardus stricta, Rumex acetosella, Poa annua*.
On each side there is a 0.5m grassy strip before the heather dominates. On N side this grassy strip has *Agrostis capillaris, Rumex acetosella, Holcus lanatus, Rubus fruticosus.* On S side the strip has *Agrostis capillaris, Holcus lanatus, Pteridium aquilinum.*

From centre of junction point, 50m west: (photo 1130154)
2.5m wide path, overall 50% bare, with two discrete worn tracks forming a 'terracette'. The low bank between the tracks has *Agrostis capillaris, Nardus stricta, Calluna vulgaris, Sagina procumbens, Composites* and lichen of the genus *Peltigera.* The trampled part of the path has *Agrostis capillaris* and *Poa annua.*
The grassy strip on the N side of the path has *Agrostis capillaris, Nardus stricta, Rumex acetosella* and *Deschampsia flexuosa,* all rather trampled, before heather dominates.
The grassy strip on the S side of the path has *Agrostis capillaris, Rumex acetosella, Holcus lanatus, Digitalis purpurea* and *Pteridium aquilinum* before heather dominates.

The 50m length of path and its edges had 26 separate deposits of dog mess and 4 of horse dung.

Sample point 4 in Unit 10, near Aspens Car park. 19 August 2011 (photos 1130278, 79, 80, and 'transect' view 1130284-1130294)

A 70m section of the path leading north from the single small oak tree on the heath ca 30m north of Aspens car park was sampled in more detail measured from tree trunk (photo 1130112).

From oak tree, 25north: (photo 1130278)
3m wide path with overall 60% bare. 4 distinct tracks. Worn turf has *Agrostis capillaris, Lolium perenne, Festuca ovina, Plantago major, Poa annua*. The outer 1m on right side of the worn path (looking back south towards the oak) has *Agrostis capillaris, Lolium perenne, Festuca ovina, Plantago major* and *Prunella vulgaris.*
'Influence zone' to both heath edges. On right side this zone is 4m wide and has *Agrostis capillaris, Lolium perenne, Festuca ovina, Holcus lanatus, Deschampsia flexuosa, Cerastium.* On left side the zone is 1m wide with *Agrostis capillaris* and *Holcus lanatus*

From oak tree, 50m north: (photo 1130279)
3m wide path, heavily worn, overall 85% bare, with *Agrostis capillaris, Poa annua* and *Juncus squarrosus.* On right side edge of worn path is 0.5m trampled zone with *Agrostis capillaris, Holcus lanatus and Cerastium.* Beyond this is a 2m 'influence zone' with *Holcus lanatus, Agrostis capillaris, Cerastium , Molinia caerulea* and *Calluna vulgaris.* On the left of the worn path is 2m wide heath edge zone with *Molinia caerulea, Juncus squarrosus, Deschampsia flexuosa, Agrostis capillaris, Festuca rubra* and *Calluna vulgaris.*

From oak tree, 70m north: (photo 1130280)
Heavily worn/trampled path 4m with 75% bare. Worn *Agrostis capillaris, Poa annua* and *Juncus squarrosus.* On right side a 1m worn edge with *Agrostis capillaris, Festuca rubra* and *Rumex acetosella* and a further 2m 'influence zone' with *Holcus lanatus, Arrhenatherum elatius, Agrostis capillaris, Festuca rubra* and *Deschampsia flexuosa.* On the left is a 3m worn/influence zone with *, Molinia caerulea, Festuca rubra* and *Agrostis capillaris* that grades into *Calluna vulgaris/ Deschampsia flexuosa* heath.

The 70m length of path and its edges had 61 separate deposits of dog mess and 1 dumped bag of dog mess.

Transect showing vegetation across track at about 25m point

Sample point 5 in Unit 11, near Chase Road Corner Car park**.** 16 August 2011 (photos 1130274-7)

A 100m section of the right hand one of the two tracks from Chase Road Corner car park (leads SE) was sampled in more detail; measured from car park barrier).

From barrier, 25m SE: (photo 1130274)
4m wide path of which 1m bare (chippings etc – not useful); worn turf with *Lolium perenne, Trifolium repens*. The outer 3m to the right of the worn path has Holcus, Dactylis, Arrhenatherum, *Agrostis capillaris, Urtica dioica, Cirsium arvense, Rubus fruticosus (tr);* rank.
The outer 2m to the left of the worn path and has *Agrostis capillaris with Cirsium arvense, Arrhenatherum* and *Molinia.*

From barrier, 50m SE: (photo 1130275)
3m wide path of which 0.5m bare; worn turf with *Lolium perenne, Trifolium repens, Dactylis, Plantago major*. The outer 3.5m to the right of the worn path has dense Holcus, Dactylis, Trifolium repens. The outer 3m to the left of the worn path and has *Arrhenatherum, Holcus, Agrostis capillaris, Chameirion angustifolium, Dactylis.*

From barrier, 75m SE: (photo 1130276)
3m wide path of which 1m bare; worn turf with *Lolium perenne, Trifolium repens, Plantago major*. The outer 0.5m to the right of the worn path has dense Dactylis, *Agrostis capillaris,Festuca rubra, Chameirion angustifolium (tr)*. The outer 2m to the left of the worn path has dense *Agrostis capillaris, Dactylis, Cirsium arvense.*

From barrier, 100m SE: (photo 1130277)
3m wide path of which 0.5m bare (on gradient so pebbles with sand); worn turf with *Lolium perenne, Trifolium repens and Plantago major*. The outer 0.5m to the right of the worn path has *Agrostis capillaris,Festuca rubra*. The outer 2m to the left of the worn path has *Agrostis capillaris, Festuca rubra, Pteridium, Arrhenatherum (tr) and Cerastium glomeratum.*

The 100m length of path and its edges had 60 separate deposits of dog mess.