

Report to Estates and Buildings, University of Edinburgh

Biodiversity Baseline Review of the King's Buildings Campus, University of Edinburgh



**Dr Barbra Harvie MIEEM FHEA PCUT
CECS, School of GeoSciences, University of Edinburgh**

April 2009

Acknowledgements

John Turpin, Landscape Maintenance Officer, University of Edinburgh who, with his team, recorded the data for the horticultural (formal) beds and made an inventory of trees (species and location).

Colleagues at King's Buildings Campus (University of Edinburgh and Scottish Agricultural College) who contributed identification skills, species records and information on teaching and research uses.

In particular:

Faye Gibbins, Computing Officer, School of GeoSciences. University bee-keeper

Dr Alistair Hamilton, SAC. Information on teaching and additional species

Dr Colin Legg, CECS, School of GeoSciences. Hover fly species lists

Dr Graham Russell, CECS, School of GeoSciences. Bird species lists

Angus Currie, Fleur Rothwell and others from Estates and Buildings, University of Edinburgh for their support of the project.

Summary

Rationale

The information in this report is the first stage in the development of a biodiversity action plan for the King's Buildings campus and will contribute towards the University of Edinburgh's implementation of the Scottish Government strategy for the conservation and enhancement of biodiversity in Scotland.

Evidence

The biodiversity of the site has been assessed by auditing the native and naturalised vegetation on the campus and comparing this with the National Vegetation Classification of naturally occurring vegetation types. This information was augmented with records of non-native planting, birds, mammals, fungi and some invertebrates.

Conclusions

King's Buildings campus is diverse in both species and habitats. Managed grassland areas are varied and rich in plant species (including grasses). There are 124 different tree species including examples of 23 of the 33 native British trees. The formal, non-native planting provides extensive and varied ground cover for small animals (especially invertebrate species). In addition to adding to the biodiversity of Edinburgh the green space on campus has high amenity value and is important to the well-being of the 6,500 staff and students based in the College of Science and Engineering.

Recommendations

The diversity of green space should be retained when feasible during future development of the campus. Diversity can be enhanced by developing grassland areas into wild flower meadows, considerate grouping of new tree planting and planting with native species whenever possible.

The mosaic of large and small parcels of green space should be maintained to provide diversity of habitat for native animals, particularly those that visit from the surrounding countryside.

It should be recognised that the King's Buildings campus is not an urban site and that it provides a much needed buffer zone between the Local Nature Reserve and Edinburgh city.

Mitigation options

The University and Estates and Buildings have already stated that they have a commitment to maintaining and enhancing biodiversity and attaining BREEAM certification on building development. This could be supported by more direct communication channels within and beyond the King's Buildings:

- generally raising awareness of the importance of local biodiversity
- wider communication at all levels of land management
- keeping users of the campus informed of proposed developments
- enforcing contractual agreements with developers

TABLE OF CONTENTS

Acknowledgements	2
Summary	2
Introduction	6
Aims	6
The King's Buildings site	6
Methodology.....	7
Biodiversity audit	7
Existing management.....	7
Academic use	7
Results.....	8
Grass parcels	8
Formal beds	10
Tree species.....	10
Analysis of vegetation data.....	10
Mammal and bird species.....	13
Fungi	14
Invertebrates	14
Management	16
Academic use.....	16
Amenity use.....	19
Discussion.....	20
Diversity of species and habitat.....	20
Management	26
Academic and amenity use	28
Conclusions	30
Recommendations.....	31
References.....	32
Appendices.....	33
Appendix 1: Native and naturalised plant species	33
Appendix 2: Exotic species and horticultural varieties	36
Appendix 3: Tree species	40
Appendix 4: Phase 1 Survey Map.....	43
Appendix 5: National Vegetation Classification Map.....	44

LIST OF TABLES

Table 1: Parcel numbers not included in survey	8
Table 2: Area of each grass parcel surveyed and number of species recorded	9
Table 3: Phase 1 habitat types identified on campus with definition and map codes	11
Table 4: National Vegetation Classification types identified on Campus.....	12
Table 5: Mammal and bird species	13
Table 6: Fungi species.....	14
Table 7: Hoverfly species.....	15

LIST OF FIGURES

Figure 1: Number of species recorded plotted against area for each parcel..	9
Figure 2: Brown roll-rims.....	14
Figure 3: <i>Sphegina sibirica</i>	16
Figure 4: PhD project supervised by Dr G Jackson	17
Figure 5: PhD project supervised by Dr K Heal.....	18
Figure 7: Local Nature Reserve on Blackford Hill and the Hermitage of Braid	20
Figure 8: Spring beauty.....	24
Figure 9: Arum lily berries	24
Figure 10: Small-scale diversity in parcel 60.....	24
Figure 11: Rarely recorded species in parcel 58.....	24
Figure 12: Daffodils.....	24
Figure 13: Crew Building	25
Figure 14: Secluded seating	25
Figure 15: Silver birch grove	25
Figure 16: Non-natives provide food	25
Figure 17: Habitat for <i>Helix aspersa</i>	25
Figure 18: Habitat for rare mosses.....	25
Figure 19: Unnecessary damage to green space	27
Figure 20: Excessive loss of green space.....	27
Figure 21: Café culture at KB.....	29
Figure 22: Impromptu picnic site	29

Introduction

This report provides a biodiversity baseline review of the King's Buildings campus, University of Edinburgh based on a biodiversity audit that was carried out during the spring and summer of 2008. The review is the first stage in the development of a biodiversity action plan for the King's Buildings Campus and will contribute towards the University's implementation of "The strategy for the conservation and enhancement of biodiversity in Scotland" (Scottish Executive, 2004 and Scottish Government 2007).

Methodologies were adapted from the Environmental Association of Universities and Colleges practical guide to biodiversity on campus (EAUC, undated) and comply with the professional standards adopted by the Institute of Ecology and Environmental Management (IEEM, 2007).

Aims

The aims of the biodiversity audit of the King's Buildings Campus were to survey existing vegetation and assess the significance of the features found in order to facilitate the development of a biodiversity action plan with clear, long-term objectives and a timetabled programme for implementation.

The long-term objectives (adapted from Scottish Executive, 2004; Scottish Government, 2007) are:

- To increase awareness, understanding and enjoyment of biodiversity and to engage students, staff and visitors in the conservation and enhancement of the University environs in compliance with the strategy of the Scottish Government.
- To develop an effective management framework that ensures biodiversity is taken into account in all decision-making.
- To restore and enhance biodiversity through better planning, design and practice.

The King's Buildings site

The King's Buildings campus covers 20 ha (over 49 acres) and is bounded by West Mains Road to the north, Mayfield Road to the east and Craigmillar Park Golf Course to the south and west (RMJM, 2007). The site comprises 50 main buildings (with associated car-parks) linked by 6.4 km (4 miles) of roadway. In addition to the College of Science and Engineering, University of Edinburgh (5000 students and 1500 staff) the campus also houses the Edinburgh Scottish Agricultural College and the Scottish Micro Electronic Centre.

Most importantly the campus has over 6 ha (60,000 square metres) of green space divided into parcels of land ranging in size from 2 m² to 2435 m². Roughly half of the area (80% of the parcels) is managed as formal shrub beds and the remainder is managed either as mown lawns or as rough grass areas planted with bulbs. In addition there are more than 1000 native and non-native trees planted as specimens, in avenues and in semi-natural groves throughout the campus.

Methodology

Maps of the King's Buildings Campus (scale 1:500) were sourced through Estates and Buildings and each parcel of green space was numbered using an existing system operated by the Landscape Maintenance Officer (John Turpin). A total of 281 parcels had previously been identified: shrub (223 parcels), lawn grass (41 parcels) and rough grass with bulb planting (13 parcels).

Biodiversity audit

The whole campus was initially described using Phase 1 habitat survey classification (Nature Conservancy Council, 1990) to provide a broad overview of site. This is a subjective method of categorising and mapping habitats into woodland, grassland and miscellaneous (including buildings) categories.

Each parcel of land was then surveyed individually and the presence of plant species (including grasses and ferns) was recorded. Moss species were recorded in the lawn grass and rough grass parcels if they were a noteworthy component of the vegetation and records were made of wild plants growing in formal beds. An inventory of cultivars growing in formal beds and of individual trees was provided by John Turpin. Supplementary records were made of mammals, birds, some invertebrates and fungi as they were noted on the campus.

Plant species data resulting from surveying each of the lawn grass and rough grass parcels were analysed using Comkey version 2.0 (Legg, 2008), a computer software package that compared the lists of native and naturalised plant species recorded in each parcel with model lists representing the National Vegetation Classification (NVC) of natural type-specimen communities (Rodwell, 1991-2000). Comkey also described the likely habitat conditions, light, moisture, pH and fertility of the parcel based on the mean Ellenberg Indicator Values¹ for all species consistent with that community.

Existing management

A general account of current management was determined through personal communication with John Turpin (Landscape Maintenance Officer), from observation of construction works and building development during 2008 and from the King's Buildings Planning Framework (RMJM, 2007).

Academic use

Current and potential use of the campus for academic research and teaching purposes was provided by colleagues (lecturers, researchers and PhD students) in response to an email request for information and from personal communication with individuals.

¹ "Ellenberg's indicator values for British plants" (Hill *et al.*, 1999) is a set of ecological indicator values for the 1,791 vascular plant species that grow in the United Kingdom based on their range of tolerance to light (L), moisture (F), reaction (R; a measure of soil or water pH), nitrogen (N), and salt (S) compared with other species. Plant communities can be described in terms of the mean and range of indicator values allocated to individual species and from this the attributes of the physical habitat can be inferred.

Results

The biodiversity audit resulted in individual species lists for:

- Plant species recorded in grass parcels (Appendix 1)
- Plant species recorded in formal beds (Appendix 2)
- Tree species on campus (Appendix 3)
- Mammal species lists (Table 5)
- Bird species lists (Table 5)
- Fungi species lists (Table 6)
- Hoverfly species lists (Table 7)

Grass parcels

Fifty grassed areas (total area 24,137m²) were surveyed. Ten of the originally identified grass parcels were not included in the survey (Table 1) and two previously un-numbered grass parcels were allocated numbers 6a (600 m²) and 12a (884 m²).

A total of 126 native and naturalised plant species, including grass species and 5 key bryophytes were recorded (Appendix 1).

Table 1: Parcel numbers not included in survey

Parcel numbers correspond to numbers used in master map (Appendix).

Parcel numbers	Not included by reason of:
11,55,56	inaccessible due to construction and works access for the new Waddington Building, in the south east corner of campus
5, 27	no longer existed following extensions to existing buildings
2, 10, 28	replaced with gravel or bark mulch
65, 66	managed as units with adjoining parcels 32 and 33 respectively during the 2008 season

The number of plant species in each parcel was noted, including bryophytes if they were a major component of the vegetation (Table 2).

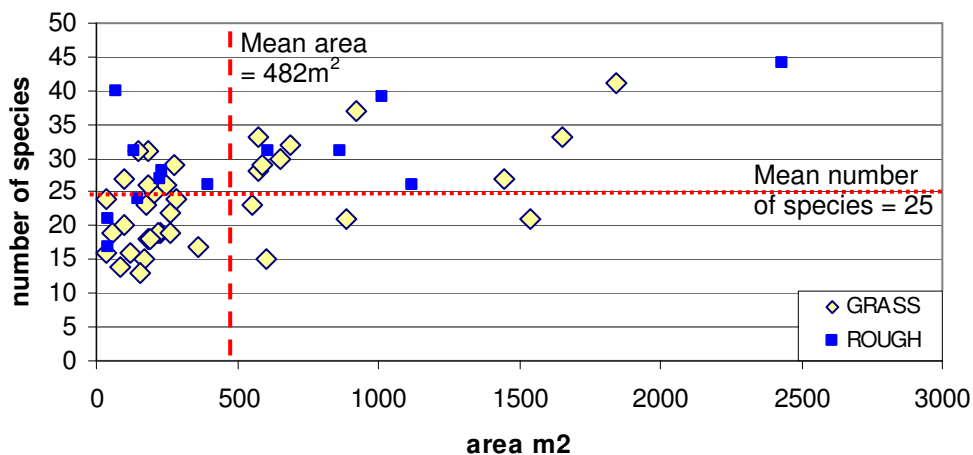
A small group of common species were recorded in more than 40 grass parcel; daisy, creeping buttercup, ragwort and white clover, and the grasses cocksfoot, yorkshire fog and rye grass (none of these was recorded in every parcel). Twenty-two species were each recorded in only one parcel including wild basil, field madder, wild strawberry, scentless mayweed and the grass false brome.

The highest number of plant species recorded in a single parcel was 44, recorded in parcel 67 a large area of rough grass opposite the Joseph Black Building. The lowest number of plant species recorded in a single parcel was 13, recorded in parcel 9 a medium sized area of mown grass opposite the Rutherford Building. The mean number of species recorded parcels was 25.

Table 2: Area of each grass parcel surveyed and number of species recorded

Parcel numbers correspond to numbers used in master map (Appendix 5). Parcels are listed consecutively (missing numbers are parcels no longer grassed over). Rough grass areas are shaded.

parcel number	area (m ²)	all species	grass species	parcel number	area (m ²)	all species	grass species
1	1536	21	4	30	365	17	5
3	173	15	4	31	34	24	7
4	120	16	4	32	592	29	7
6	227	19	5	33	919	37	6
6a	600	15	4	34	206	25	7
7	571	33	7	35	148	31	9
8	571	28	5	36	249	26	9
9	158	13	5	37	277	29	7
12	99	20	6	38	33	16	7
12a	884	21	4	39	185	26	6
13	652	30	7	40	285	24	7
14	184	31	4	41	84	14	7
15	1651	33	7	51	1013	39	11
16	223	19	5	52	607	31	8
17	1843	41	8	53	235	28	10
18	185	18	5	54	395	26	10
19	553	23	5	57	867	31	12
20	1450	27	6	58	41	17	6
21	263	22	7	59	1123	26	8
22	265	19	7	60	43	21	8
23	690	32	7	61	72	40	13
24	60	19	7	62	227	27	9
25	97	27	7	63	138	31	14
26	174	23	7	64	146	24	9
29	189	18	7	67	2435	44	13

**Figure 1: Number of species recorded plotted against area for each parcel**

Mean area (---) and mean number of species (....). There is no significant correlation between parcel size and number of species ($R^2 < 0.3$).

The number of species recorded in each parcel was plotted against the areas of the parcels (in m²) to test whether the variation in species numbers was linked the size of plot i.e. the larger the parcel the more species (Figure 1).

The graph shows that, regardless of area size, the rough grass parcels have consistently high numbers of species recorded. Ten of the 13 rough grass parcels have above average numbers of species (>25), the exceptions are parcels 58 and 60 to the south west of the Crew Building; they are also the two smallest rough grass areas (highlighted in bold Table 2) and area 64 adjacent and to the north of Crew Building. Only 15 of the 37 mown parcels have above average numbers of species.

Eleven small parcels in the top left hand section of the graph are identified as contributing most to vegetation diversity. These are rough grass parcels 53, 54, 61, 62 and 63 and mown grass parcels 14, 25, 34,35,36,37 and 39

Formal beds

Two hundred and sixteen formal beds were surveyed (30,285 m²) and a total of 419 species and horticultural varieties were recorded (Appendix 2). Of the 233 originally identified shrub beds 15 small beds (less than 100 m²) have been permanently lost to gravel or minor building work and 13 were empty at the time of the survey. In addition, six large beds (totalling 2,312 m²) have been permanently lost to construction work and 17 new parcels have been created.

No statistical analyses were carried out on the data collected from the formal beds although they have been mapped as introduced shrub (J 1.4) in the Phase 1 Survey of King's Buildings campus (Appendix 4).

Tree species

A total of 1209 individual trees representing 124 species were recorded on campus and their locations were mapped (Appendix 3). Five species, sycamore, scots pine, corsican pine, silver birch and lodgepole pine, represent almost half the trees (49.1%). Sixty-eight of the species (54.8%) are represented by only one, two or three specimens and account, in total, for less than 10% of the trees. Nine native species are among those recorded in these small numbers: alder, hornbeam, sweet chestnut, hawthorn, walnut, aspen, plum, goat willow and yew.

Analysis of vegetation data

Phase 1 Habitat Survey

The whole of King's Buildings Campus, including buildings and car parks, was categorised from Phase 1 Habitat Survey definitions and mapped using hierarchical alphanumeric reference codes (Nature Conservancy Council, 1990). Twelve designations were identified (Table 3 and Appendix 5).

The Miscellaneous phase 1 habitats follow the same boundaries as the parcels of land with formal planting (Introduced shrub, J 1.4), the hedges round the south, east and north campus boundaries (J 2.1.2) and the buildings (shaded black).

The Woodland phase 1 habitats cover several grassland parcels where trees have been planted and the habitat boundaries do not always follow the parcel

boundaries. The density of the trees determines whether the habitat is parkland (< 30% cover) or plantation (a generic term for all planted trees) and the species composition determines whether these are deciduous, conifer or mixed woodlands.

The Grassland phase 1 habitats are determined by a combination of management practices and named grass species that indicate soil type. Neutral grassland (pH 5.5 - 7.0) is usually enclosed, mown only once (occasionally twice) a year and is indicated by meadow fox-tail (*Alopecurus pratensis*), false oat-grass (*Arrhenatherum elatius*), crested dog's tail (*Cynosurus cristatus*) and cock's foot (*Dactylis glomerata*). This matches most of the rough grass areas on campus. Improved grass-land is species poor and is often lush and green because of fertilizers, herbicides and intensive grazing or mowing which matches most of the mown lawn parcels on campus. The dominant grass is rye grass (*Lolium perenne*) with white clover (*Trifolium repens*), sorrel (*Rumex acetosa*), dandelion (*Taraxacum officinale*), daisy (*Bellis perennis*) and buttercup (*Ranunculus* sp.). Several of the mown parcels however still retain traces of their neutral grassland origins with a wider range of species than improved grassland and these are categorised as poor semi-improved grassland². Some of the areas mapped have been allocated two Phase 1 habitat designations to indicate both the grassland and woodland cover.

Table 3: Phase 1 habitat types identified on campus with definition and map codes

A full description of each definition has been included with Appendix

Habitat	definition	Alphanumeric code	Lettered code
Woodland	Broadleaved plantation	A 1.1.2	PBW
	Conifer plantation	A 1.2.2	PCW
	Mixed plantation	A 1.2.3	PMW
	Parkland broadleaved	A 3.1	SBW
	Parkland mixed	A 3.3	SMW
Grassland	Neutral grassland	B 2.2	SNG
	Improved grassland	B 4	I
	Poor semi-improved	B 6	SI
Miscellaneous	Introduced shrub	J 1.4	IS
	Hedge	J 2.1.2	PH
	Building	J 3.6	No code – shade black

National Vegetation Classification

The lists of plant species recorded in each of the grass parcels were matched to the most similar National Vegetation Classification community using the Comkey computer programme (Legg, 2008). Ten different communities were identified revealing the extent of variability in vegetation type between the

² It could be argued that the improved and semi-improved grassland habitats on King's Buildings Campus should be defined as cultivated, amenity grassland (J 1.2) but the diversity of both grass and non-grass species suggests that this classification would not be appropriate and does not fully describe the areas.

grass parcels. The Ellenberg indicator values generated from the plant species recorded show similar variations in soil pH, nutrient availability, soil moisture and available light (Table 4).

The most commonly occurring vegetation types were: MG7e describing 18 regularly mown parcels of land, predominantly at roundabouts or adjoining rough grass parcels; MG4 (that corresponds with groups of plant species with the highest indicator values for soil moisture) describing 13 rough grass parcels, mostly large and round the perimeter of the campus.

Two areas of MG2 (with the lowest indicator values for light and pH) correspond to woodland areas with lime and sycamore trees, rough grass and unique spring ground cover. The single, small parcel of mown grass (outside Agriculture Building) corresponds with SD8 and has vegetation with the highest indicator value for light and lowest values for soil moisture and nitrogen. Three apparently unconnected parcels that are very different in appearance correspond with OV22 and vegetation with the highest indicator values for pH and nitrogen.

Table 4: National Vegetation Classification types identified on Campus

A brief description of each classification type and the number of parcels recorded. The mean Ellenberg Indicator Values for light (L), moisture (F), pH (R) and nitrogen (N) associated with each vegetation type are displayed with the lowest (blue italic) and highest (red bold) values highlighted.

NVC code	Community description	Number of parcels	L	F	R	N
MG 2	<i>Arrhenatherum elatius</i> – <i>Filipendula ulmaria</i> tall-herb grassland	2	<i>6.14</i>	5.60	<i>5.72</i>	4.37
MG 3	<i>Anthoxanthum odoratum</i> – <i>Geranium sylvaticum</i> grassland	5	6.96	5.32	5.86	4.28
MG 4	<i>Alopecurus pratensis</i> – <i>Sanguisorba officinalis</i> grassland	13	7.10	5.74	6.12	4.52
MG 5	<i>Cynosurus cristatus</i> – <i>Centaurea nigra</i> grassland	4	7.11	5.27	6.10	4.15
MG 7e	<i>Lolium perenne</i> – <i>Plantago lanceolata</i> grassland leys	18	7.06	5.30	6.18	5.52
OV 2	<i>Briza minor</i> – <i>Silene gallica</i> community	1	7.10	5.17	6.47	5.76
OV 19	<i>Poa annua</i> - <i>Matricaria perforata</i> community	2	7.16	4.94	6.56	6.02
OV 22	<i>Poa annua</i> – <i>Taraxacum officinale</i> community	3	7.21	5.03	6.59	6.11
OV 23	<i>Lolium perenne</i> – <i>Dactylis glomerata</i> community	1	7.15	4.87	6.45	5.55
SD 8	<i>Festuca rubra</i> – <i>Gallium verum</i> fixed dune grassland	1	7.23	<i>4.81</i>	6.04	<i>3.87</i>

Mammal and bird species

The summer of 2008 was not conducive to recording animals other than the more common mammals and birds due to the weather. These were recorded on an *ad hoc* basis as seen when recording vegetation or walking across campus. More formal records for birds visiting a feeding station outside Crew Building were contributed by Dr Graham Russell. A total of 8 mammal species, including the campus cats, and 21 bird species were recorded (Table 5). None of these is rare on a national scale but short-eared owls, roe deer, kestrels, pheasants and green woodpeckers are not frequent urban visitors.

Table 5: Mammal and bird species

Alphabetical list of scientific names of mammals and birds recorded on campus (with common names for ease of interpretation). Bird records contributed by Dr Graham Russell, CECS, School of GeoSciences, University of Edinburgh

species name	common name
<i>Accipiter nisus</i>	sparrow hawk
<i>Anas platyrhynchos</i>	mallard
<i>Apodemus sylvaticus</i>	long-tailed field mouse (wood mouse)
<i>Asio flammeus</i>	short-eared owl
<i>Capreolus capreolus</i>	roe deer
<i>Carduelis carduelis</i>	goldfinch
<i>Columba palumbus</i>	wood pigeon
<i>Corvus corone</i>	carrion crow
<i>Corvus frugilegus</i>	rook
<i>Corvus monedula</i>	jackdaw
<i>Erithacus rubecula</i>	robin
<i>Felis catus</i>	domestic cat
<i>Fringilla coelebs</i>	chaffinch
<i>Oryctolagus cuniculus</i>	rabbit
<i>Parus caeruleus</i>	blue tit
<i>Parus major</i>	great tit
<i>Passer domesticus</i>	house sparrow
<i>Periparus ater</i>	coal tit
<i>Phasianus colchicus</i>	common pheasant
<i>Pica pica</i>	magpie
<i>Picus viridis</i>	green woodpecker
<i>Pipistrellus pipistrellus</i>	common pipistrelle
<i>Prunella modularis</i>	dunnock (hedge-sparrow; hedge accentor)
<i>Pyrrhula pyrrhula</i>	bullfinch
<i>Sciurus carolinensis</i>	grey squirrel
<i>Sorex araneus</i>	common shrew
<i>Troglodytes troglodytes</i>	wren
<i>Turdus merula</i>	blackbird
<i>Turdus philomelos</i>	song thrush
<i>Vulpes vulpes</i>	fox

Fungi

Although the summer of 2008 was not ideal for birds and mammals the wet weather produced an excellent crop of fruiting bodies from fungi of various types. Again these were not formally surveyed during the biodiversity audit but a total of 14 species were identified from their fruiting bodies, the familiar toadstools and mushrooms, in a one hour survey (Table 6). Most of these occurred in the woodland areas of campus or in the bark mulch used to suppress weeds in the formal beds (Figure 2).

Table 6: Fungi species

Alphabetical list of scientific names of fungi recorded on campus (with common names when available).

species name	common name
<i>Agaricus campestris</i>	scaly wood mushroom
<i>Clytocybe gibba</i>	no common name
<i>Collybia confluens</i>	clustered tough shank
<i>Collybia peronata</i>	no common name
<i>Laccaria laccata</i>	the deceiver
<i>Lactarius deliciosus</i>	saffron milk-cap
<i>Leccinum scabrum</i>	birch bolete
<i>Lycoperdon perlatum</i>	common puffball
<i>Paxillus involutus</i>	brown roll-rim
<i>Piptoporus betulinus</i>	birch polypore
<i>Pluteus plautus</i>	no common name
<i>Russola rosea</i>	no common name
<i>Russula xerampelina</i>	no common name
<i>Tricholoma terreum</i>	grey tricholoma



Figure 2: Brown roll-rims

*Group of brown roll-rims (*Paxillus involutus*) growing in formal bed 204. Five pence piece indicates scale.*

Invertebrates

Invertebrates have been particularly difficult to record this summer as most trapping methods require extended periods of dry weather. However Dr Colin Legg has been recording hoverfly species, by observation only, and has recorded 24 different species on King's Buildings Campus (Table 7). This list includes *Sphegina sibirica* (Figure 3), a species on the Scottish Biodiversity list, and *Parasyrphus annulatus*, a species that has not previously been recorded in the east of Scotland (Dipterists' Forum, 2005).

Table 7: Hoverfly species

Alphabetical list of scientific names of hoverflies recorded on campus (no common names available), their abundance on campus, occurrence in Scotland and habitat/foodsource preferences where known. Records contributed by Dr Colin Legg (CECS, School of GeoSciences, University of Edinburgh)

Species name	abundance	occurrence in Scotland	habitat/foodsource
<i>Baccha elongata</i>	2	widespread	low vegetation and shade; larvae predators of aphids
<i>Cheilosia bergenstammi</i>	1	common	larvae live on <i>Senecio jacobaea</i>
<i>Episyrphus balteatus</i>	abundant	abundant	larvae predators of aphids
<i>Eristalis arbustorum</i>	1	widespread	larvae develop in rotting vegetation
<i>Eristalis interruptus</i> **	1	widespread	
<i>Eristalis pertinex</i>	common	abundant	larvae develop in rotting vegetation
<i>Eupeodes corollae</i>	several	widespread	adults associated with Fabaceae (pea family)
<i>Eupeodes luniger</i>	several	widespread (Lowland)	larvae predators of aphids
<i>Helophilus pendulus</i>	frequent	abundant	larvae develop in wet manure
<i>Melangyna lasiophthalma</i>	3	widespread	woodland species; larvae predators of aphids
<i>Melanostoma scalare</i>	abundant	abundant	low vegetation, especially grasses; larvae predators of aphids
<i>Meliscaeva auricollis</i>	2	infrequent	ground layer and shrub species; larvae predators of aphids
<i>Meliscaeva acinctella</i>	several	common	
<i>Neoascia podagrica</i>	2	common	
<i>Parasyrphus annulatus</i>	1	rare (not recorded for S Scotland except Glasgow and Arran)	
<i>Platycheirus albimanus</i>	abundant	abundant	hedgerows; larvae predators of aphids
<i>Platycheirus manicatus</i>	1	common	
<i>Sphegina sibirica</i>	2	uncommon. Scottish Biodiversity List but rapidly expanding distribution	
<i>Sphaerophoria scripta</i> **	1	uncommon	larvae predators of aphids
<i>Sphaerophoria sp</i> ***	1		
<i>Syritta pipiens</i>	3	common	larvae develop in compost
<i>Syrphus ribesii</i>	abundant	abundant	larvae predators of aphids
<i>Syrphus torvus</i>	*	common	large stands of mature trees
<i>Syrphus vitripennis</i>	*	common	larvae predators of aphids
<i>Volucella pellucens</i>	common	common	bramble flowers; larvae scavenge the nests of social wasps

* Indistinguishable from *S. ribesii* in field so relative abundance not known

** No voucher specimen - uncertain identification

*** Female that cannot be identified, but not *S Scripta* (only key for genus is for males)



Figure 3: *Sphegina sibirica*

Female Sphegina sibirica feeding on Hydrangea petiolaris courtesy of Dr Colin Legg. Image of male Sphegina sibirica adapted from original at Dipterists' Forum (2005)

Other invertebrates that have been noted around the campus include: devil's coach-horses (*Staphylinus olens*) who are regular visitors around Crew building, common garden snails (*Helix aspersa*) living in their hundreds in the drainage spaces of a wall, the three common bumble bee species (*Bombus terrestris*; *B. lucorum*, *B. lapidarius*), and honey bee (*Apis mellifera*). These are a small selection of the more prominent and easily recognisable species from a wide range of invertebrates that reflect the variety of habitats in the grounds of King's Buildings.

Management

Management of the King's Buildings campus is overseen by the University's Estates and Buildings Office. The Landscape Section is responsible for all soft landscape throughout the campus, including; shrub borders; arboricultural works; winter snow clearing and gritting; maintenance of lawns and the occasional hard landscape feature. They are also involved with in-house design for new building works and the planned refurbishment of existing landscaped areas (Estates and Buildings, 2007).

Academic use

The request to academics and PhD students in the Schools of GeoSciences and Biological Science, University of Edinburgh and Scottish Agricultural College (SAC) for information regarding how the green space on the King's Buildings campus is used for teaching and research purposes resulted in several responses.

Teaching

The rough grass areas, especially the strip between West Mains road and the Ashworth building, are used for teaching basic plant identification (Field Biology, 2nd year undergraduate) and more specialised tree and grass identification to classes of undergraduate and post-graduate students as part of several courses.

The wooded hill area to the north of the James Clerk Maxwell building is used to discuss root physiology in a final year (senior honours) class.

The rows of sycamore (*Acer pseudoplatanus*) bordering campus on Mayfield Road and West Mains Road are used to demonstrate the significant difference between trees for a range of characters (diameter at breast height; canopy cover; leaf size; tar spot frequency; etc.) and to calculate whether

there are significant relationships between tree size and other variables (Scientific Enquiry, 3rd year undergraduate)

The same course (Scientific Enquiry) uses a range of trees, grass and shrubs on campus to calculate carbon storage.

Lothian Equal Access Programme for Schools (LEAPS) uses several of the mown lawns to teach a range of sampling methods to students and to compare the percentage cover of grass species, mosses, other plants and bare ground between parcels of land.

In 2008, as a result of the Biodiversity audit, a biodiversity tour of the King's Buildings campus was planned and successfully tested as part of the Doors Open programme and again during Green Week.

A tree trail has been planned out and is used successfully to teach native tree identification skills (both in summer and winter) as part of undergraduate and post graduate courses run both by School of GeoSciences and the Scottish Agricultural College. It is intended that this will be developed into a self-learning resource for public and academic use; with appropriate signage and supporting information available on a dedicated website.

The campus green space is also utilised for plant identification training in continuing professional development courses run by IEEM (the professional body of ecologists and environmental managers).

Research

Native tree species on campus are being used to ascertain the effects of increased irradiation on the plant cell walls of leaves as part of a PhD research project supervised by Dr Andy McLeod.

In another PhD project, supervised by Dr Gail Jackson, *Acer pseudoplatanus* (sycamore) saplings have been planted as part of a formal experiment to measure the effects of drought on the young plants and record the results of aphid infestation (Figure 4).

Artificial ponds have been constructed in plastic pipes in an experiment to determine the effects of water depth and nutrient levels on the growth rate of common reed (*Phragmites australis*) as part of a PhD project on constructed wet-lands supervised by Dr Kate Heal (Figure 5).



Figure 4: PhD project supervised by Dr G Jackson

Rows of Acer pseudoplatanus (sycamore) saplings in an experimental plot to test the effects of drought and aphids. Located in parcel 17



Figure 5: PhD project supervised by Dr K Heal

Artificial “ponds” with *Phragmites australis* (common reed) plants in an experiment to determine the effects of water depth and nutrient levels on growth rate. Located in parcel 59

MSc projects conducted on campus include research into the changing phenology of tree species with climate change; specifically bud burst.

An apiary managed by the University beekeeper (Faye Gibbons) has been set up in the south west of the campus. There are five hives of *Apis mellifera* (honey bee) and a small workshop (Figure 6). In addition to producing honey and mead the hives are of value to scientific research into bee behaviour including colony collapse, the apiary is used by the Royal (Dick) Veterinary College as a teaching medium for bee husbandry and knowledge of bee diseases and parasites, and the beekeeping team interact with the general public on open days and outreach projects.



Figure 6: The King's Buildings apiary

Five working hives protected from the public in a remote corner of campus.

Grassland around the hives is being planted with spring flowering species that provide the bees with food early in the season and a small orchard of rare British apple trees have been planted in containers around the pond in the Grant Institute: Tydeman's Late Orange (russet), a dessert apple, and Harry Masters Jersey and Michelin, both cider apples. These are all in the same pollination group and will rely on visits from the bees for successful fruit production. They also contribute to the overall biodiversity of the campus.

Amenity use

The campus houses the Science and Engineering College of the University and is the workplace for over 5000 students and 1500 staff making it comparable in size to the University of St Andrews. Although there was no formal survey to determine amenity use of the campus green space as part of the biodiversity audit observations were made throughout 2008 and early 2009.

The larger mown grass parcels, particularly the parcels to the south of King's Buildings Centre (parcel 15) and north of the Grant Institute (parcel 1), are well used by staff and students (and their children) during good weather for picnic lunches, informal games of football, cricket and Frisbee, and T'ai Chi. These and several other sites were temporary homes to a spectacular array of snowmen and other snow sculptures constructed during the cold snap in early February 2009. Post graduation parties, end of term barbecues, class photographs and other events are regularly held on the many and varied outdoor areas.

Secluded areas with seating, often surrounded by formally planted parcels, are also well used in good weather throughout the year. A favourite site is to the east of King's Buildings Centre surrounded by parcels 125 and 126.

A small area in the south east corner of campus is maintained by a group of students as an allotment, providing fresh vegetables throughout the year and adding to the range of habitats for invertebrates and their larvae.

Discussion

When considering the biodiversity and management of the King's Buildings campus it is important to realise that the grounds link directly with the Local Nature Reserve on Blackford Hill and the Hermitage of Braid (Figure 7) and that until the construction of the Joseph Black Building in 1920 the King's Buildings site was part of a farm. This is not an urban environment.



Figure 7: Local Nature Reserve on Blackford Hill and the Hermitage of Braid

Gorse scrub and grassland on Blackford Hill and mature woodland in the valley of the Braid Burn, Hermitage of Braid.

It is also important to recognise that KB is a vibrant and growing University campus with a requirement to maintain an acceptable outward appearance to visitors and the general public (especially our neighbours in the surrounding area) while satisfying the requirements of the large staff and student population.

Diversity of species and habitat

The present diversity of habitat on campus is the result of a mosaic of green space in a range of shapes and sizes; each with its own characteristics. A cursory Phase 1 Survey, based on the assumption that KB was an urban site, would categorise all of the grass parcels as amenity grassland sown with a rye grass mix. The more rigorous audit carried out for this report has identified a range of grassland and other vegetation types that recognise the potential of the site as a key contributor to biodiversity within Edinburgh and an important buffer zone between the rural habitats to the south and west of the campus and the city environment to the north and east.

Grass parcels

None of the 126 native plant species recorded on the grass areas of the King's Buildings Campus are rare on a national scale, but several are rare in regularly mown suburban lawns e.g. lady's bedstraw, cut-leaved cranes-bill, dove's-foot cranes-bill, wall lettuce, field madder and wild basil. These less common plant species are consistently found on the smallest parcels of grassland so there is a danger that proposals to develop a few large green spaces in the management plans for the campus could be extremely deleterious to the biodiversity of KB as a whole. It is important that these grass areas are not treated as if they were amenity grassland, such as is found in city parks, and therefore dispensable. That is not to say that every square metre of green space must be retained but that future development should take into account some of the more important small parcels.

These are:

- Parcels 7 and 8 - the lime/sycamore grove at the east side of campus (south of gate 4) which have unique vegetation and soil characteristics. This area has the highest concentration and diversity of spring flowers (figure 8) and parcel 7 is also the sole site for Arum lilies (figure 9) and Jacob's ladder
- Parcels 58 and 60 – the smallest rough grass parcels (Figures 10 and 11). These were identified as having low numbers of species, however 58 is the only parcel where wild basil (*Clinopodium vulgare*) was recorded and is one of 3 sites for lady's bedstraw (*Galium verum*) and knapweed (*Centaurea nigra*) while 60 contains the rarely recorded false brome (*Bromis sterilis*). Both of these parcels are linked to larger mown areas and could potentially be extended
- The semi-natural woodland and rough grassland at the western perimeter of the campus including parcels 62, 37, 61 and 41. These form an important natural buffer zone around the campus and contain large numbers of native woodland species including wild garlic (an ancient woodland indicator species).
- In the western area, where large-scale development is planned over the next 10-20 years parcel 63, a small, apparently insignificant but very important green space should be retained. This area is partially surrounded by a wall and is only 138m² but has the most diverse collection of grass species on campus, many of which are rarely recorded elsewhere.
- Parcels 35 and 36 have extensive bulb planting and could be retained as a green northern perimeter in front of the multi-storey car park.
- Mature trees in the western area, particularly native species, should be retained where possible.

Some of the larger grass parcels are equally important for different reasons. None of them seem to be immediately threatened by planned development to the campus but may be at risk from inappropriate placing of building materials and heavy machinery when works takes place nearby. Potentially vulnerable areas are:

- Parcels 13, 14 and 15 – the large grassy areas in the centre of campus on and around “the mound”. These are adjacent to the proposed development of KB Centre in 2009/10. The spaces are well used amenity areas and perform an important outdoor space for formal and informal social functions. Deer and rabbits graze on these sites in early morning because of their proximity to relatively large areas of woodland and ground cover
- Parcel 17 – to the west of the above. This parcel is potentially more at risk than the others and at least part of it has already been earmarked as a potential works site for the new development. Its potential to expand the central green “heart” of the campus should not be underestimated. The experimental site currently on this site could be removed at the end of the PhD for which it was designed and the parcel restored to species rich grassland in keeping with the other areas
- Parcels 51-54, 76 and 1 – the north and east perimeters of the campus. With the exception of parcel 1 these are rough grass areas. They are the favoured sites for teaching plant identification because of the variety of common species in sufficient abundance for specimens to be collected without risk to any of the species. The parcels are also impromptu picnic sites in good weather and have a magnificent array of daffodils in spring (Figure 12) followed by wild hyacinths then native tall herbs and grasses throughout the summer. These long narrow strips are also important to bee diversity. Solitary and colonial bee species (including honey bees) all prefer to forage on linear features for pollen and nectar.

Formal beds

The formal beds are equally important to the biodiversity of KB. The diversity of plant species and carefully arranged planting schemes provide large and small areas of dense ground cover which provide shelter and habitat for mammals, birds, reptiles, amphibians and invertebrates throughout the year; habitats that could not easily be provided using Scotland’s relatively few native, low-lying, bushy species. These exotics and cultivars provide continuous colour throughout the year, without resorting to the more usual (and labour intensive) flower beds favoured by parks and gardens, and are presented in an array of shapes and growth forms that break up the harsh contours of buildings without detracting from their unique architectural styles (Figure 13). They also add to the seclusion and privacy around outdoor seating in peaceful areas (Figure 14).

Trees, woodland and informal beds

Many of the mature trees and wooded areas on campus are relicts from the farm that stood on this site and are mainly native or naturalised species that were planted as field boundaries and shelter belts or as single trees and smaller groupings as shade for animals. These are used extensively for teaching identification and form the basis of a tree trail around the campus.

As the campus grew, the practice of planting mixed groups and single trees continued with exotic species being used more frequently. Many of these are decorative and faster growing than the native species. Several are closely related to native species, often horticultural varieties that are very similar in appearance to the native trees, and provide the same ecosystem

services of food and habitat for native birds and animals (Figure 16). A large section of the mound area has been planted with a mixed group of birches, larches and pines (Figure 15). All of these contribute to the biodiversity of KB.

The well-established hedge that encloses the campus to north and east is mainly privet but also contains beech, hawthorn, elder and occasional individuals of other species suggesting that it is the original farm boundary. Like the tree species these are all native or naturalised species and the hedge provides an important corridor that allows animals (particularly small mammals, reptiles and amphibians) to safely move around campus. The much larger but more recent *Leylandii* hedge along the northern boundary of the campus is less important ecologically and adds only one species to the diversity of the campus. It successfully cushions the impact of golf balls from the adjoining golf course although this could be achieved just as effectively with a slower growing hedge of mixed, woodland-edge, woody species.

Recently there has been a trend for planting short avenues of non-native species alongside new buildings (mainly hornbeam cultivars) and these look out of place compared with the obviously managed but more comfortable appearance of the rest of the campus. In addition these species do not provide any of the ecological or functional qualities of the older plantings. The growing numbers of non-native trees on campus do not pose an immediate threat to the surrounding Local Nature Reserve, however with climate change many of these species could become prolific and their seeds will easily be dispersed by wind or birds into the surrounding countryside and become established outside the confines of the campus or hybridise with closely related native species.

Animals, birds and unusual habitats

The animals and birds on campus have not been formally audited and recorded, with the exception of hoverflies. Some wild animals cause damage to trees and other plants. Rabbits and grey squirrels, both non-native mammals, occur in very large numbers and can be extremely destructive. Their numbers have increased rapidly over the last few years since the resident campus foxes were disturbed during building work and now only visit KB occasionally in their nightly travels. Other animals, like roe deer, green woodpeckers, pheasants and kestrels, highlight the importance of the site to visiting native species for safe habitat and sources of food.

Some of the specialist habitats utilised by both plants and animals are more unusual than others. Common garden snails shelter in their hundreds in the drainage spaces of a brick wall supporting an earth embankment on the west side of campus (Figure 17) and on a study course of mosses and lichens some nationally rare moss species were recorded growing in the lime mortar between the ornamental setts around the Eduard Paolozzi statues outside the Swann Building (Figure 18).

The significance of the small scale biodiversity of habitats on campus is further established by the diversity of hoverfly species recorded, each dependant on a different environment for the development of their larvae and plant species for food.



Figure 8: Spring beauty

Snake's head fritillaries and anemone de Caan under the lime trees photographed during early April in parcel 7. These follow snowdrops and celandines, and the wild hyacinths and Jacob's ladder are still to flower.



Figure 9: Arum lily berries

Clusters of red and orange photographed in late autumn in parcel 7



Figure 10: Small scale diversity in parcel 60 (above)

*Oxe-eye daisies (*Leucanthemum vulgare*) in mixed grasses including *Bromus sterilis**

Figure 11: Rarely recorded species in parcel 58 (left)

*Lady's bedstraw (*Galium verum*) and knapweed (*Centaurea nigra*)*



Figure 12: Daffodils

These dense banks of daffodils and narcissus on the large perimeter grass parcels are a welcome sign that spring has finally arrived



Figure 13: Crew Building

The variety of species and growth forms in this formal bed give year round colour that complement the Crew Building entrance



Figure 14: Secluded seating

Slow growing evergreens around a single bench provide peaceful revision space near the James Clerk Maxwell Building



Figure 15: Silver birch grove

(left) Naturalised planting on the "mound" opposite the Alexander Graham Bell Building



Figure 16: Non-natives provide food

(above) Autumn berries on an ornamental Sorbus species



Figure 17: Habitat for *Helix aspersa*

Brick supporting wall with drainage spaces; each one a safe haven for common garden snails (inset)



Figure 18: Habitat for rare mosses

Rare mosses growing in the lime cement between the stone setts under the Paolozzi statues in front of the Swann Building

Management

Green space: Maintenance and planning

The current layout of green space in the King's Buildings campus has not been designed in a structured way but has evolved alongside the development of the College of Science and Engineering over the last almost 90 years. As a result the whole campus is richly diverse. The range of size and shape of formal and informal beds, and the diversity of plant species growing in them match the diversity of architectural styles of buildings on the campus.

There is almost 1 kilometre of hedging around the perimeter of the campus split between 501 metres of privet/mixed woodland hedge to the north and east of campus and 436 metres of Leylandii hedge to the south of campus. Hedge trimming is a major operation and the total area of hedge to be cut annually is 4359m² (1307m² privet + 3052 m² Leylandii).

Despite its diversity the remaining campus green space is relatively low maintenance. Rough grass parcels require annual mowing; most formal beds are mulched annually to suppress weeds and plants are pruned or cut back on an annual or bi-annual basis; occasionally beds are cleared and replanted when existing plants die or become too large (e.g. blocking sightlines on pathways or roads).

As a direct result of this biodiversity audit all of the trees on campus have been tagged, their location mapped and their status of health recorded by the Landscape Section of Estates and Buildings (John Turpin and his workforce). This information will facilitate future monitoring of specific trees and planning for replacement of old, diseased and damaged individuals.

Building, construction and planning

The King's Buildings Campus is a vibrant and growing site that requires continuous building and renovation to provide space for the continued quality of teaching and research required by its residents. Immediate plans include the development of KB Centre and surrounds. An extensive longer term plan (10-20 years) involves "the creation of 18 state-of-the-art research and teaching facilities. The plan would also see the creation of a "green heart" area to form a social focus for students and staff with landscaping, a library and study facilities" (Estates and Buildings press release November 2008).

While these improvements are much needed and to be commended recent history suggests that implementation of large scale (and even small scale) improvements can have a massive negative impact on people, plants, animals and overall biodiversity.

The following two cases are examples of building and construction work that were recorded during 2008.

Case1: The construction of a secure, brick-built, gas canister store to the south of the chemistry building (Figure 19).

- The completed gas store measures approximately 6.0 m x 2.7 m with a 0.6 m access path on 2 sides. Total area = 21.78 m²
- The construction site (not including the area of the building) measures approximately 6.0 m x 5.4 m (to the south of the building) + 7.2 m x 4.5 m

(to the west of the building) + 12.0 m x 2.0 m (access route). Total area = 90.6 m²

- All access, building materials and plant were positioned on green space (parcels 65 – rough grass, 32 – mown grass and 98 - shrub). The building has been constructed in what was the shrub bed



Figure 19: Unnecessary damage to green space

Case 1: gas canister store. The extent of the damage caused to the surrounding green space from building work and inconsiderate placement of heavy machinery. The photographs were taken after the contractors had restored and reseeded the site.

Case 2: The construction of the new Waddington building (Phase1) to the east of the Rutherford building (Figure 20).

- The completed building measures 665m²
- The construction site (not including the area of the building) measures 2,300m²
- All access, building materials and plant were positioned on green space (parcels 11 – botany lawn, 232, 234 – shrub and commemorative trees, part of 231 – shrub). Affected to a lesser extent were a pond and two parcels of rough grass
- The building has been constructed on bed 234. Restoration of the site has been achieved with 1,178 m² of hard landscaping which covers most of parcel 11, part of 231 and all of 232 which had previously been green space



Figure 20: Extensive loss of green space

Case 2: The New Waddington Building. Instead of restoring the Botany lawn and surrounds after construction the area is restored with hard landscaping

In both cases the building contractors should have had a biodiversity obligation written into their contracts agreeing to return surrounds to their

original state. To fulfil BREEAM (Building Research Establishment Environmental Assessment Method) requirements an ecology champion should be on site to ensure that damage is kept to a minimum. Figure 19 shows the extent of the damaged area around the gas store after the site had been restored by contractors with re-seeded soil.

Figure 20 shows the area around the completed Waddington building. Prior to the construction work the 2,800 m² Botany lawn (almost 12% of the grassed areas on campus) was by far the largest mown grassland area on campus and a favourite venue for picnics, barbecues and parties; it was also the site of several commemorative trees, all recent memorials. This is now reduced to a narrow strip of less than 1,000m² containing a few, large trees.

These scenarios must be avoided in future construction work, including the redevelopment of King's Buildings Centre in 2009/10 and the long term planning and design of campus (draft plan currently available for public consultation).

The University is serious about its commitment to biodiversity and with this in mind Estates and Buildings have declared their intention to achieve a BREEAM rating of EXCELLENT in the future construction of buildings on University grounds. This is a method of assessing the positive and negative effects of a new building and the construction process using a set of criteria based on: management of the construction site, the health and well being of the future occupants, energy efficiency in both construction methods and in the finished building, transport and distance to amenities, efficiency of water use, green building materials used, impact on land use, biodiversity and ecology of site and pollution.

Academic and amenity use

Academic

The green space on campus is already used for a wide range of teaching and research activities. Despite this, a common comment from respondees was that they felt the campus was underused as an academic resource because of lack of a few native species or vegetation types. A range of suggestions was made for small improvements to the campus that would increase teaching resources and enrich biodiversity by creating natural habitats.

1. create wild-flower meadows by assisted planting or seeding with native plant species in unmown grass areas
2. develop a wider range of native under-storey species in wooded areas by assisted planting or seeding
3. create dry heathland vegetation under conifer/birch woodland on the "mound" by planting ericaceous species and native ferns
4. plant small groupings of native trees and shrubs in new planting on campus and avoid monocultural avenues of non-native and horticultural varieties
5. locate future formal experimental sites in a bespoke area within the Bush Estate

Higher education and research institutes in general have a responsibility to increase the biodiversity content in their training and education to raise awareness and understanding, and to put biodiversity at the heart of our culture. The University of Edinburgh in its College of Science and Engineering campus at the King's Buildings can develop the grounds in such a way that they strengthen the biodiversity content of courses in ecology, zoology, plant science, environmental science, animal biology, forestry, agriculture and fisheries; natural resource and environmental management; architecture, economics, business management, environmental engineering and many more.

Amenity

The green space on the campus has high amenity value for everyone located at the King's Buildings. Parcels of land, large and small, are utilised throughout the year and are extremely important to the well-being of the staff and students of the science faculty who do not have the same access to city parkland and amenities as their colleagues in the Central (George Square) Area of the University and the areas around the student residencies at Pollock Halls.

At KB parcels 125, 126 and 127 (700m² in total) serve the same purpose as streetside cafés (Figure 21) and even the smallest grassy parcels can substitute for the Meadows or George Square Gardens and are occupied as picnic areas whenever the sun shines (Figure 22).



Figure 21: Café culture at KB

Students enjoying lunch in a seated area in the suntrap: east side of KB Centre



Figure 22: Impromptu picnic site

Enjoying some early sunshine (April 2009), with lunch, on the grass in parcel 59

Conclusions

The main aims of the biodiversity audit of the King's Buildings Campus were to survey existing vegetation and assess the significance of the features found. The King's Buildings campus is diverse in both species and habitats.

The survey

The survey resulted in records for 126 native and naturalised plant species, 426 exotic species and horticultural varieties and 124 tree species.

A map showing the broad distribution of vegetation types (woodland, grassland etc) was produced using Phase 1 Survey. The species data recorded in the grassland parcels were analysed and compared with the National Vegetation Classification of natural vegetation types to assess the natural value of the vegetation on campus. This resulted in 10 different vegetation types being identified and mapped and demonstrated that there is significant natural diversity on the campus.

The vegetation data were supplemented with informal records of mammals, birds, fungi and invertebrates with particular emphasis on hoverflies. None of the individual species are rare in a national context, although some are locally rare, and many are very rare in urban environments.

Long-term objectives

The audit can now be used facilitate the development of a biodiversity action plan for the King's Buildings campus with clear, long-term objectives and a timetabled programme for implementation. Recommendations to retain and enhance biodiversity, based on the information presented in this document, follow this section.

The role of the University

The University has undertaken to implement the Scottish Government strategy for the conservation and enhancement of biodiversity and have made a general commitment to:

- increase awareness, understanding and enjoyment of biodiversity, and engage many more people in conservation and enhancement
- develop an effective management framework that ensures biodiversity is taken into account in all decision making
- restore and enhance biodiversity through better planning, design and practice

This document is the first stage in raising awareness of the current, healthy state of biodiversity on the King's Buildings campus. It is intended that the document will be readily available and will increase the understanding of the complexities of biodiversity to a wider audience.

The Estates and Buildings commitment to achieving EXCELLENT ratings in BRREAM assessments and certification should ensure that biodiversity is taken into account in decision making and that an effective management framework is developed.

Aspiration to achieve BREEAM certification will have a positive influence in planning and design of new buildings and also in their construction. This should ensure that biodiversity is automatically restored and enhanced.

Recommendations

On the basis of this audit and the information presented in this document the following suggestions and recommendations are made to enhance and retain biodiversity of vegetation on the King's Buildings campus over a 10-20 year period. Animal diversity will increase as more diverse habitats provide suitable nesting sites and foraging sites. It should be unnecessary to erect additional artificial nesting and roosting boxes.

1. preserve the range of variation in size, shape and content of green space parcels (semi-natural, grassland and formal beds)
2. increase abundance of summer-flowering meadow species in the larger rough grass boundary parcels (51, 52, 53, 54 and 67). Suggested species: *Lotus corniculatus*, *Papavar rhoeas*, *Knautia arvensis*, *Medicago lupulina*, *Galium verum*, *Centaurea nigra*, *Ranunculus acris*, *Malva moschata*, *Leucanthemum vulgare*, *Lychnis flos cuculi*, *Silene dioica*, *Silene alba*, *Sanguisorba minor*, *Achillea millefolium* and *Rhinanthus minor* (bird's-foot trefoil, field poppy, field scabious, black medick, lady's bedstraw, knapweed, meadow buttercup, musk mallow, ox-eye daisy, ragged robin, red campion, white campion, salad burnet, yarrow and yellow rattle)
3. introduce additional meadow species to smaller rough grass parcels. Suggested species: *Anthemis arvensis*, *Centaurea cyanus*, *Chrysanthemum segetum*, *Matricaria recutita*, *Myosotis arvensis* and *Papavar dubium* (corn chamomile, cornflower, corn marigold, scented mayweed, forget-me-not and long-headed poppy)
4. introduce woodland and hedgerow species in areas where appropriate. Suggested species: *Stachys officinalis*, *Geum urbanum*, *Myrrhus odorata*, *Teucrium scorodium*, *Digitalis purpurea*, *Lamium alba*, *Aliaria petiolata* and *Vicia sativa* (betony, wood avens, sweet cicely, wood sage, foxglove, white dead-nettle, mustard garlic and common vetch)
5. introduce lowland dry heath species to the "mound" under the birch and conifer stand. Suggested species: *Calluna vulgaris*, *Erica tetralix*, *Erica cinerea*, *Vaccinium vitis-idea*, *Vaccinium myrtillus* and *Dryopteris* spp (native heathers, blaeberry, cowberry, male fern and buckler ferns)
6. create small aspen/alder/willow grove beside pond or similar damp area
7. gradually replace Leylandii hedge by planting native hedge behind the existing hedge. Suggested species: *Crataegus monogyna*, *Prunus spinosa*, *Acer campestre*, *Rosa canina* and *Sambuca nigra* (hawthorn, blackthorn, field maple, dog rose and elder)
8. replace dead and diseased tree species with native species and plant in small mixed groups

When managing the site the University should continue to promote and enhance biodiversity by achieving BREEAM certification prior to any building development. There should be minimum disruption and loss of green space and provision of on site supervision for all construction work. The non-urban status of King's Buildings campus should be emphasised.

Any future formal experimental sites required for research should be located in a bespoke area within the Bush Estate.

References

- Dipterists' Forum (2005) *Hoverfly Recording Scheme*. Available from: <http://www.hoverfly.org.uk/portal.php> [accessed 2nd December 2008]
- EAUC (undated) *Biodiversity on Campus: An EAUC practical guide*. Available from: http://www.eauc.org.uk/file_uploads/bio/biog_pt1.pdf [accessed 24th November 2008]
- Estates and Buildings (2007) *Estates and Buildings Landscape Section*. Available from: <http://www.estates.ed.ac.uk/works/landscape/grounds.htm> [accessed 10th April 2009]
- IEEM (2007) *Code of Professional Conduct: guidance to members*. Professional Issues Series 5. Available from: http://www.ieem.net/docs/05-Code_of_Professional_Conduct.pdf [accessed 24th November 2008]
- Legg, C.J. (unpublished) *ComKey: Community Identification version 2.0 [2008]; NVC Classification data file 1.0*. Copyright Colin Legg, University of Edinburgh
- Nature Conservancy Council (1990) *Handbook for Phase 1 Habitat Survey: a technique for environmental audit*. Nature Conservancy Council, Peterborough
- RMJM (2007) *King's Buildings Planning Framework*. Estates and Buildings, University of Edinburgh (internal document)
- Rodwell, J.S. (1991-2000) *British Plant Communities*, volumes 1-5. Cambridge University Press, Cambridge
- Scottish Executive (2004) *Scotland's Biodiversity; it's in your hands*. Scottish Executive, Edinburgh
- Scottish Government (2007) *Scotland's Biodiversity; it's in your hands. A progress report 2005-07*. Scottish Government, Edinburgh

Appendices

Appendix 1: Native and naturalised plant species

Alphabetical list of scientific names of native and naturalised plant species recorded on campus (with common names for ease of interpretation).

species name	common name
<i>Acaena novae-zelandiae</i>	piri-piri burr
<i>Acer pseudoplatanus</i> (sap)	sycamore
<i>Acer</i> sp (seed)	maple species
<i>Achillea millefolium</i>	yarrow
<i>Aegopodium podagraria</i>	ground elder
<i>Agrostis capillaris</i>	common bent
<i>Alium ursinum</i>	bear garlic, ramsons
<i>Alopecurus pratensis</i>	meadow fox-tail
<i>Anthoxanthum odoratum</i>	sweet vernal grass
<i>Anthriscus sylvestris</i>	cow parsley
<i>Arrhenatherum elatius</i>	false oat-grass
<i>Arum maculatum</i>	arum lily
<i>Atrichum undulatum</i>	st katherine's moss
<i>Bellis perennis</i>	daisy
<i>Betula pendula</i> (seed)	silver birch
<i>Brachypodium sylvaticum</i>	slender false brome
<i>Bromus mollis</i>	soft brome
<i>Bromus sterilis</i>	barren brome
<i>Campanula glomerata</i>	clustered bellflower
<i>Campanula latifolia</i>	giant bellflower
<i>Capsella bursapastores</i>	shepherd's purse
<i>Cardamine hirsuta</i>	hairy bitter-cress
<i>Centaurea nigra</i>	common knapweed
<i>Cerastium fontanum</i>	common mouse-ear
<i>Chamerion angustifolium</i>	rosebay willowherb
<i>Cirsium arvense</i>	creeping thistle
<i>Cirsium vulgare</i>	spear thistle
<i>Clinopodium vulgare</i>	wild basil
<i>Corylus avellana</i>	hazel
<i>Crocus vernus</i>	spring crocus
<i>Cynosurus cristatus</i>	crested dog's-tail
<i>Cytisus scoparius</i>	broom
<i>Dactylis glomerata</i>	cock's-foot
<i>Digitalis purpurea</i>	foxglove
<i>Elymus repens</i>	couch
<i>Epilobium ciliatum</i>	American willowherb
<i>Epilobium hirsutum</i>	great willowherb
<i>Epilobium montanum</i>	broad willowherb
<i>Epilobium roseum</i>	pale willowherb
<i>Equisetum sylvaticum</i>	wood horsetail

species name	common name
<i>Festuca nigrescens</i>	chewing's fescue
<i>Filipendula ulmaria</i>	meadowsweet
<i>Fragaria vesca</i>	wild strawberry
<i>Fraxinus excelsior</i> (seed)	ash
<i>Fritillaria meleagris</i>	fritillary
<i>Fumaria densiflora</i>	dense-flowered fumitory
<i>Galanthus nivalis</i>	snowdrop
<i>Galeopsis tetrahit</i>	common hemp-nettle
<i>Galium aparine</i>	sticky willie
<i>Galium verum</i>	lady's bedstraw
<i>Geranium dissectum</i>	cut-leaved crane's-bill
<i>Geranium molle</i>	dove's-foot crane's-bill
<i>Geranium pratense</i>	meadow crane's-bill
<i>Geum urbanum</i>	wood avens
<i>Hedera helix</i>	ivy
<i>Heracleum sphondylium</i>	hogweed
<i>Hieracium</i> agg.	hawkweed
<i>Holcus lanatus</i>	Yorkshire fog
<i>Hyacinthoides hispanica</i>	Spanish bluebell
<i>Hypnum cupressiforme</i>	a moss
<i>Hypochaeris radicata</i>	cat's ear
<i>Impatiens glandulifera</i>	Himalayan balsam
<i>Knautia arvensis</i>	field scabious
<i>Lamium album</i>	white dead-nettle
<i>Lamium purpureum</i>	red dead-nettle
<i>Lapsana communis</i>	nipplewort
<i>Lathyrus pratensis</i>	meadow vetchling
<i>Leucanthemum vulgare</i>	ox-eye daisy
<i>Lolium perenne</i>	rye grass
<i>Lunularia cruciata</i>	a thallose liverwort
<i>Luzula multiflora</i>	many-headed woodrush
<i>Lychnis flos-cuculi</i>	ragged robin
<i>Lythrum salicaria</i>	purple loosestrife
<i>Malva moschata</i>	musk-mallow
<i>Matricaria discoidea</i>	pineapple weed
<i>Mycelis muralis</i>	wall lettuce
<i>Myosotis arvensis</i>	field forget-me-not
<i>Narcissus</i> sp.	daffodil and narcissus
<i>Papavar dubium</i>	long-hesded poppy
<i>Persicaria bistorta</i>	common bistort
<i>Persicaria maculosa</i>	redshank
<i>Phleum pratense</i>	large-leaved timothy
<i>Plagiomnium undulatum</i>	a moss
<i>Plantago lanceolata</i>	ribwort plantain
<i>Plantago major</i>	greater plantain

species name	common name
<i>Poa annua</i>	annual meadow-grass
<i>Poa trivialis</i>	rough meadow-grass
<i>Polygonatum multiflorum</i>	Solomon's seal
<i>Polygonum aviculare</i>	knot grass
<i>Primula veris</i>	cowslip
<i>Prunella vulgaris</i>	self-heal
<i>Prunus spinosa</i>	blackthorn
<i>Quercus</i> sp (seedling)	oak species
<i>Ranunculus acris</i>	meadow buttercup
<i>Ranunculus repens</i>	creeping buttercup
<i>Rhytiadelphus squarrosus</i>	a moss
<i>Rosa canina</i>	dog rose
<i>Rubus fruticosus</i>	bramble
<i>Rumex acetosa</i>	common sorrel
<i>Rumex acetosella</i>	sheep's sorrel
<i>Rumex crispus</i>	curled dock
<i>Rumex obtusifolius</i>	broad-leaved dock
<i>Sagina procumbens</i>	procumbent pearlwort
<i>Sambucus nigra</i> (sap)	elder
<i>Scilla verna</i>	spring squill
<i>Senecio jacobaea</i>	ragwort
<i>Senecio vulgaris</i>	groundsel
<i>Sherardia arvensis</i>	field madder
<i>Silene alba</i>	white campion
<i>Silene dioica</i>	red campion
<i>Sonchus asper</i>	sow-thistle
<i>Sorbus aucuparia</i>	rowan
<i>Stellaria graminea</i>	lesser stitchwort
<i>Stellaria media</i>	chickweed
<i>Taraxacum officinale</i>	dandelion
<i>Tragopogon pratensis</i>	jack-go-to-bed-at-noon
<i>Trifolium campestre</i>	hop trefoil
<i>Trifolium pratense</i>	red clover
<i>Trifolium repens</i>	white clover
<i>Tripleurospermum inodorum</i>	scentless mayweed
<i>Trisetum flavescens</i>	golden oat-grass
<i>Urtica dioica</i>	stinging nettle
<i>Veronica chamaedrys</i>	germander speedwell
<i>Veronica serpyllifolia</i>	thyme-leaved speedwell
<i>Viburnum opulus</i>	guelder rose
<i>Vicia sativa</i>	common vetch

Appendix 2: Exotic species and horticultural varieties

Scientific names are used throughout to avoid confusion between closely related species and cultivars.

Species name and cultivar	Species name and cultivar
<i>Abelia schumannii</i>	<i>Carex comans</i> 'Bronze'
<i>Abelia x grandiflora</i>	<i>Carex morrowii</i>
<i>Abies koreana</i>	<i>Carex morrowii</i> 'Variegata'
<i>Acaena</i>	<i>Carex oshimensis</i> 'Evergold'
<i>Acaena green</i>	<i>Carex testacea</i>
<i>Acanthus spinosus</i>	<i>Caryopteris incana</i>
<i>Acer</i> 'George Forrest'	<i>Caryopteris tangutica</i>
<i>Acer palmatum</i>	<i>Cassinia fulvida</i>
<i>Acer palmatum</i> 'Dissectum'	<i>Ceanothus</i> 'Blue Mound'
<i>Acer palmatum</i> 'Orange Dream'	<i>Ceanothus impressus</i> cv
<i>Agapanthus</i> 'Royal Blue'	<i>Ceanothus thyrsiflorus</i> 'Repens'
<i>Alchemilla mollis</i>	<i>Celmisia coriacea</i>
<i>Amelanchier laevis</i>	<i>Cerastium tomentosum</i>
<i>Amelanchier lamarckii</i>	<i>Chamaecyparis lawsoniana</i> 'Tamariscifolia'
<i>Anemathele lessoniana</i>	<i>Chamaecyparis lawsoniana</i> cv
<i>Aralia elata</i>	<i>Chamaecyparis nootkatensis</i>
<i>Arbutus unedo</i>	<i>Chamaecyparis obtusa</i> 'Karamachiba'
<i>Arctostaphylos uva ursi</i>	<i>Chamaecyparis thyoides</i> 'Ericoides'
<i>Aruncus dioicus</i> 'Sylvester'	<i>Chasmanthium latifolium</i>
<i>Astrantia major</i>	<i>Chusquea culeou</i>
<i>Azara serrata</i>	<i>Cistus aquilaria</i> 'Maculatus'
<i>Bamboo sp</i>	<i>Clematis armandii</i>
<i>Berberis buxifolia</i>	<i>Clematis montana</i> cv
<i>Berberis buxifolia</i> 'Nana'	<i>Convolvulus cneorum</i>
<i>Berberis darwinii</i>	<i>Cornus alba</i>
<i>Berberis evergreen</i>	<i>Cornus alba</i> 'Elegantissima'
<i>Berberis sp</i>	<i>Cornus controversa</i>
<i>Berberis sp</i>	<i>Cornus koreana</i>
<i>Berberis thunbergii</i>	<i>Cornus kousa</i>
<i>Berberis thunbergii</i> 'Green Ornament'	<i>Cornus mas</i>
<i>Berberis thunbergii</i> 'Atropurpurea'	<i>Cornus stolonifera</i> 'Flaviramea'
<i>Berberis thunbergii</i> 'Rose Glow'	<i>Cornus stolonifera</i> 'Kelseyi'
<i>Berberis verruculosa</i>	<i>Cortaderia selloana</i>
<i>Berberis wilsoniae</i>	<i>Corylopsis spicata</i>
<i>Berberis x ottawensis</i> 'Superba'	<i>Corylus avellana</i> 'Contorta'
<i>Berberis x stenophylla</i>	<i>Corylus maxima</i> 'Purpurea'
<i>Bergenia</i> 'Bressingham White'	<i>Cotinus coggygria</i>
<i>Bergenia</i> 'Rotblum'	<i>Cotinus coggygria</i> 'Foliis Purpureis'
<i>Bergenia</i> 'Winterglut'	<i>Cotoneaster</i>
<i>Bergenia cordifolia</i>	<i>Cotoneaster lacteus</i>
<i>Blechnum penna marina</i>	<i>Cotoneaster</i> 'Cornubia'
<i>Buddleia</i> 'Royal Red'	<i>Cotoneaster</i> 'Oakwood'
<i>Buxus sempervirens</i>	<i>Cotoneaster</i> 'Skogholm'
<i>Calluna vulgaris</i> 'Hirsuta'	<i>Cotoneaster bullatus</i>
<i>Calluna vulgaris</i> 'Alba'	<i>Cotoneaster conspicuus</i>
<i>Calluna vulgaris</i> cv purple	<i>Cotoneaster dammeri</i>
<i>Calluna vulgaris</i> 'H.E. Beale'	<i>Cotoneaster horizontalis</i>
<i>Calluna vulgaris</i> var hirsuta	<i>Cotoneaster hybrid</i>
<i>Carex</i> 'Silver Spectre'	<i>Cotoneaster lacteus</i>

Species name and cultivar	Species name and cultivar
<i>Carex comans</i>	<i>Cotoneaster microphyllus</i>
<i>Cotoneaster radicans</i>	<i>Fargesia</i> 'Simba'
<i>Cotoneaster salicifolius</i>	<i>Fargesia nitida</i> 'Nymphenburg'
<i>Cotoneaster salicifolius</i> 'Gnome'	<i>Fatsia japonica</i>
<i>Cotoneaster salicifolius</i> 'Repens'	<i>Festuca glauca</i>
<i>Cotoneaster simonsii</i>	<i>Forsythia</i> 'Gold Tide'
<i>Cotoneaster</i> x 'Cornubia'	<i>Forsythia</i> cv
<i>Crinodendron hookerianum</i>	<i>Forsythia x intermedia</i> cv
<i>Crinum powellii</i>	<i>Fuchsia</i> cv
<i>Crococsmia</i> 'George Davison'	<i>Fuchsia magellanica</i>
<i>Crococsmia</i> 'Lucifer'	<i>Garrya elliptica</i>
<i>Crococsmia</i> 'Orangeade'	<i>Garrya elliptica</i> female form
<i>Cryptomeria japonica</i> 'Bandai'	<i>Garrya elliptica</i> male form
<i>Cryptomeria japonica</i> 'Elegans'	<i>Gaultheria shallon</i>
<i>Cupressocyparis leylandii</i> 'Castlewella Gold'	<i>Genista hispida</i>
<i>Cynara cardunculus</i>	<i>Geranium</i> 'Claridge Druce'
<i>Cynara dracunculoides</i>	<i>Geranium</i> 'Johnsons Blue'
<i>Daphne tangutica</i>	<i>Geranium</i> 'Olba'
<i>Decaisnea fargesii</i>	<i>Geranium</i> 'Orla'
<i>Deschampsia caespitose</i> cv	<i>Geranium</i> cv
<i>Desfontainea spinosa</i>	<i>Geranium</i> cv 'Wargrave Pink'
<i>Diascia</i> cv	<i>Geranium</i> cv small purple flo.
<i>Dierama pendula</i>	<i>Geranium macrorrhizum</i> 'Alba'
<i>Dierama pendulum</i>	<i>Ginkgo biloba</i>
<i>Dryopteris wallichianum</i>	<i>Griselinia littoralis</i>
<i>Elaeagnus</i> (rootstock)	<i>Griselinia littoralis</i> 'Variegata'
<i>Epimedium perralderianum</i>	<i>Gunnera manicata</i>
<i>Erica</i>	<i>Hamamelis mollis</i> cv
<i>Erica vagans</i> D.F. Maxwell'	<i>Hebe</i> 'Autumn Glory'
<i>Erica carnea</i> cv	<i>Hebe</i> 'Golden Nugget'
<i>Erica carnea</i> white	<i>Hebe</i> 'Greensleeves'
<i>Erica erigena</i> 'Alba'	<i>Hebe</i> 'MacEwanii'
<i>Erica vagans</i>	<i>Hebe</i> 'Mrs. Winder'
<i>Erica vagans</i> pink	<i>Hebe</i> 'Pewter Dome'
<i>Erica vagans</i> rose	<i>Hebe</i> 'Red Edge'
<i>Erica vagans</i> white	<i>Hebe</i> 'White Gem'
<i>Eryngium agavaefolium</i>	<i>Hebe</i> 'Wiri Charm'
<i>Eryngium pandanifolium</i>	<i>Hebe armstrongii</i>
<i>Escallonia</i> 'Apple Blossom'	<i>Hebe buxifolia</i>
<i>Escallonia</i> cv	<i>Hebe buxifolia</i> 'Odora'
<i>Escallonia</i> cv dark pink	<i>Hebe canterburiensis</i>
<i>Escallonia macrantha</i>	<i>Hebe cupressoides</i>
<i>Eumorphus sericea</i>	<i>Hebe</i> cv
<i>Euonymus alatus</i>	<i>Hebe pimelioides</i> 'Quicksilver'
<i>Euonymus fortunei</i> 'Coloratus'	<i>Hebe pinguifolia</i> 'Pagei'
<i>Euonymus fortunei</i> 'Emerald n Gold'	<i>Hebe pinguifolia</i> 'Sutherlandii'
<i>Euonymus fortunei</i> 'Vegetus'	<i>Hebe rakaiensis</i>
<i>Euonymus</i> variegated silver	<i>Hebe recurva</i>
<i>Euphorbia amygdaloides</i> 'Rubra'	<i>Hebe salicifolius</i>
<i>Euphorbia griffithii</i>	<i>Hebe vernicosa</i>
<i>Euphorbia robbiae</i>	<i>Hedera algeriensis</i> 'Ravensholst'
<i>Euryops acraeus</i>	<i>Hedera canariensis</i> 'Gloire de Marengo'
<i>Exochorda macrantha</i>	<i>Hedera canariensis</i> 'Ravensholst'

Species name and cultivar	Species name and cultivar
<i>Fargesia</i> 'Bimbo'	<i>Hedera colchica</i>
<i>Hedera helix</i>	<i>Mauritanicus</i>
<i>Hedera helix</i> 'Buttercup'	<i>Miscanthus</i> 'Silberlicht'
<i>Hedera helix</i> 'Gold Heart'	<i>Molinia caerulea</i> 'Variegata'
<i>Heuchera</i> cv	<i>Muscari armeniacum</i>
<i>Hoheria sexstylosa</i> 'Stardust'	<i>Nepeta x faassenii</i>
<i>Hosta sieboldii</i> 'Elegans'	<i>Nerine bowdenii</i>
<i>Hydrangea macrophylla</i> 'Hortensia'	<i>Olearia haastii</i>
<i>Hymenanthera angustifolia</i>	<i>Olearia macrodonta</i>
<i>Hypericum</i>	<i>Olearia nummularifolia</i>
<i>Hypericum</i> 'Hidcote'	<i>Olearia paniculata</i>
<i>Hypericum androsaemum</i>	<i>Olearia solandri</i>
<i>Hypericum calycinum</i>	<i>Olearia x haastii</i>
<i>Ilex aquifolium</i> 'Ferox Argentea'	<i>Ophiopogon planipes</i>
<i>Ilex aquifolium</i> silver variegated, female	<i>Osmanthus heterophyllus</i>
<i>Indocalamus variegatus</i>	<i>Osmanthus x burkwoodii</i>
<i>Jasminum nudiflorum</i>	<i>Ozothamnus rosmarinifolia</i>
<i>Juniperus chinensis</i> 'Kuriwao Gold'	<i>Ozothamnus rosmarinifolia</i> 'Silver Jubilee'
<i>Juniperus communis</i> 'Repanda'	<i>Pachysandra terminalis</i>
<i>Juniperus communis</i> cv	<i>Paeonia lutea</i> 'Ludlowii'
<i>Juniperus conferta</i>	<i>Panicum</i> 'Heavy Metal'
<i>Juniperus</i> cv	<i>Parrotia persica</i>
<i>Juniperus recurva</i> 'Coxii'	<i>Parthenocissus quinquefolia</i>
<i>Juniperus sabina</i> 'Tamariscifolia'	<i>Parthenocissus tricuspidata</i>
<i>Juniperus x media</i>	<i>Penstemon</i> 'Garnet'
<i>Juniperus x media</i> cv	<i>Pernettya mucronata</i>
<i>Juniperus x media</i> 'Grey Owl'	<i>Pernettya mucronata</i> cv
<i>Juniperus x media</i> 'Hetzii'	<i>Philadelphus</i> 'Manteau d'Hermine'
<i>Kalmia latifolia</i>	<i>Philadelphus coronarius</i> 'Aureus'
<i>Kniphofia</i> 'Timothy'	<i>Phlomis fruticosa</i>
<i>Kniphofia uvaria</i>	<i>Phormium</i> 'Jester'
<i>Kolkwitzia amabilis</i>	<i>Phormium</i> 'Rainbow Queen'
<i>Lamium galeobdolon</i> 'Variegata'	<i>Phormium</i> 'Yellow Wave'
<i>Laurus nobilis</i>	<i>Phormium tenax</i>
<i>Lavandula officinalis</i>	<i>Phormium tenax</i> 'Purpureum'
<i>Leucothoe fontanesiana</i>	<i>Photinia davidiana</i>
<i>Leycesteria formosana</i>	<i>Photinia x fraseri</i> 'Red Robin'
<i>Libertia grandiflora</i>	<i>Phygelius capensis</i>
<i>Ligularia</i>	<i>Phygelius capensis</i> cv
<i>Liquidambar styraciflua</i>	<i>Phyllitis scolopodendron</i>
<i>Liriope muscari</i>	<i>Phyllostachys</i>
<i>Lonicera involucrata</i>	<i>Phyllostachys aurea</i>
<i>Lonicera pileata</i>	<i>Phyllostachys</i> cv
<i>Lonicera standishii</i>	<i>Phyllostachys nigra</i>
<i>Luzula sylvatica</i>	<i>Phyllostachys vivax</i> 'Aureocaulis'
<i>Luzula sylvatica</i> 'Aurea'	<i>Physocarpus opulifolius</i>
<i>Luzula variegata</i>	<i>Pieris</i>
<i>Magnolia</i> 'Star Wars'	<i>Pieris</i> 'Forest Flame'
<i>Magnolia</i> 'Susan'	<i>Pieris japonica</i> 'Little Heath Green'
<i>Magnolia stellata</i>	<i>Pinus mugo</i>
<i>Mahonia aquifolium</i>	<i>Pinus mugo</i> 'Carstans Wintergold'
<i>Mahonia aquifolium</i> 'Smaragd'	<i>Pinus mugo</i> 'Mughus'
<i>Mahonia japonica</i> 'Bealii'	<i>Pittosporum tenuifolium</i>
<i>Mahonia japonica</i> 'Charity'	<i>Poa cita</i>

Species name and cultivar	Species name and cultivar
<i>Podocarpus andinus</i>	<i>Sasa veitchii</i>
<i>Polygonum affine</i>	<i>Schizostylus coccinea</i>
<i>Polygonum affine</i> 'Darjeeling Red'	<i>Sedum</i> 'Bertram Anderson'
<i>Polypodium vulgare</i>	<i>Sedum spectabile</i>
<i>Polystichum</i> 'Dahlem'	<i>Senecio elaeagnifolius</i>
<i>Polystichum setiferum</i> 'Proliferum'	<i>Senecio laxifolius</i>
<i>Potentilla arbuscula</i> 'Beesii'	<i>Senecio munroi</i>
<i>Potentilla</i> cv	<i>Skimmia japonica</i>
<i>Potentilla nana</i> 'Argentea'	<i>Skimmia japonica</i> 'Marlot'
<i>Polygonum affine</i>	<i>Skimmia japonica</i> 'Rubella'
<i>Prunus</i>	<i>Skimmia laureola</i>
<i>Prunus</i> 'Okame'	<i>Skimmia reevesiana</i>
<i>Prunus cerasifera</i>	<i>Sophora tetraptera</i>
<i>Prunus laurocerasus</i> 'Camaellifolium'	<i>Sorbaria aitchisonii</i>
<i>Prunus laurocerasus</i> 'Cherry Brandy'	<i>Spiraea</i> cv
<i>Prunus laurocerasus</i> 'Otto Luyken'	<i>Spiraea douglasii</i> 'Menziesii'
<i>Prunus laurocerasus</i> 'Zabeliana'	<i>Spiraea japonica</i> 'Goldflame'
<i>Prunus lusitanica</i>	<i>Stachyurus praecox</i>
<i>Prunus lusitanica</i> 'Variegata'	<i>Stephanandra incisa</i> 'Crispa'
<i>Prunus</i> sp	<i>Stipa</i> 'Frosted Curls'
<i>Prunus tenella</i>	<i>Stipa gigantea</i>
<i>Pulmonaria</i> 'Blue Ensign'	<i>Stipa tenuissima</i>
<i>Pyracantha</i>	<i>Symphoricarpos albus</i>
<i>Pyracantha</i> 'Soleil D'or'	<i>Symphoricarpos x chenaultii</i> 'Hancock'
<i>Pyracantha</i> 'Red Column'	<i>Syringa x josiflexa</i> 'Bellicent'
<i>Pyracantha</i> 'Teton'	<i>Syringa meyeri</i> 'Palibin'
<i>Rhododendron</i> 'Blue Danube'	<i>Syringa x prestoniae</i> cv
<i>Rhododendron</i> 'Cunningham White'	<i>Taxus baccata</i>
<i>Rhododendron</i> 'Kermesina'	<i>Taxus baccata</i> 'Dovastonii Aurea'
<i>Rhododendron</i> 'Vuycks Scarlet'	<i>Taxus baccata</i> 'Repandens'
<i>Rhododendron</i> cv	<i>Teucrium chamaedrys</i>
<i>Rhododendron luteum</i>	<i>Thuja</i> cv
<i>Rhus typhina</i>	<i>Thuja occidentalis</i> cv
<i>Ribes alpinum</i>	<i>Tsuga canadensis</i> 'Jeddeloh'
<i>Rosa</i> 'Nozomi'	<i>Ulex gallii</i>
<i>Rosa</i> 'Pink Bells'	<i>Uncinia rubra</i>
<i>Rosa</i> cv	<i>Verbena bonariensis</i>
<i>Rosa pimpinellifolia</i>	<i>Viburnum davidii</i>
<i>Rosa rubrifolia</i>	<i>Viburnum farrerii</i>
<i>Rosa rugosa</i>	<i>Viburnum plicatum</i>
<i>Rosa</i> sp	<i>Viburnum rhytidophyllum</i>
<i>Rosa virginiana</i>	<i>Viburnum</i> sp
<i>Rosmarinus officinalis</i>	<i>Viburnum tinus</i>
<i>Rubus</i> 'Beneden'	<i>Viburnum x 'Pragense'</i>
<i>Rubus calycinoides</i> 'Betty Ashburner'	<i>Viburnum x bodnantense</i> 'Dawn'
<i>Rubus cockburnianus</i>	<i>Viburnum x burkwoodii</i>
<i>Rubus koreanus</i>	<i>Vinca major</i>
<i>Rubus odoratus</i>	<i>Vinca major</i> 'Variegata'
<i>Rubus tricolor</i>	<i>Vinca minor</i>
<i>Salix lanata</i>	<i>Vinca minor</i> 'Argenteo-variegata'
<i>Salvia</i>	<i>Vinca minor</i> cv
<i>Sarcococca confusa</i>	<i>Waldsteinia ternata</i>
<i>Sarcococca hookerianum</i> 'Digyna'	<i>Yucca filamentosa</i>

Appendix 3: Tree species

Scientific names are used throughout to avoid confusion between closely related species and cultivars.

Common names of British native and naturalised species have been included in brackets and horticultural varieties in single quotes.

cv denotes unknown cultivar name: sp denotes unknown species name.

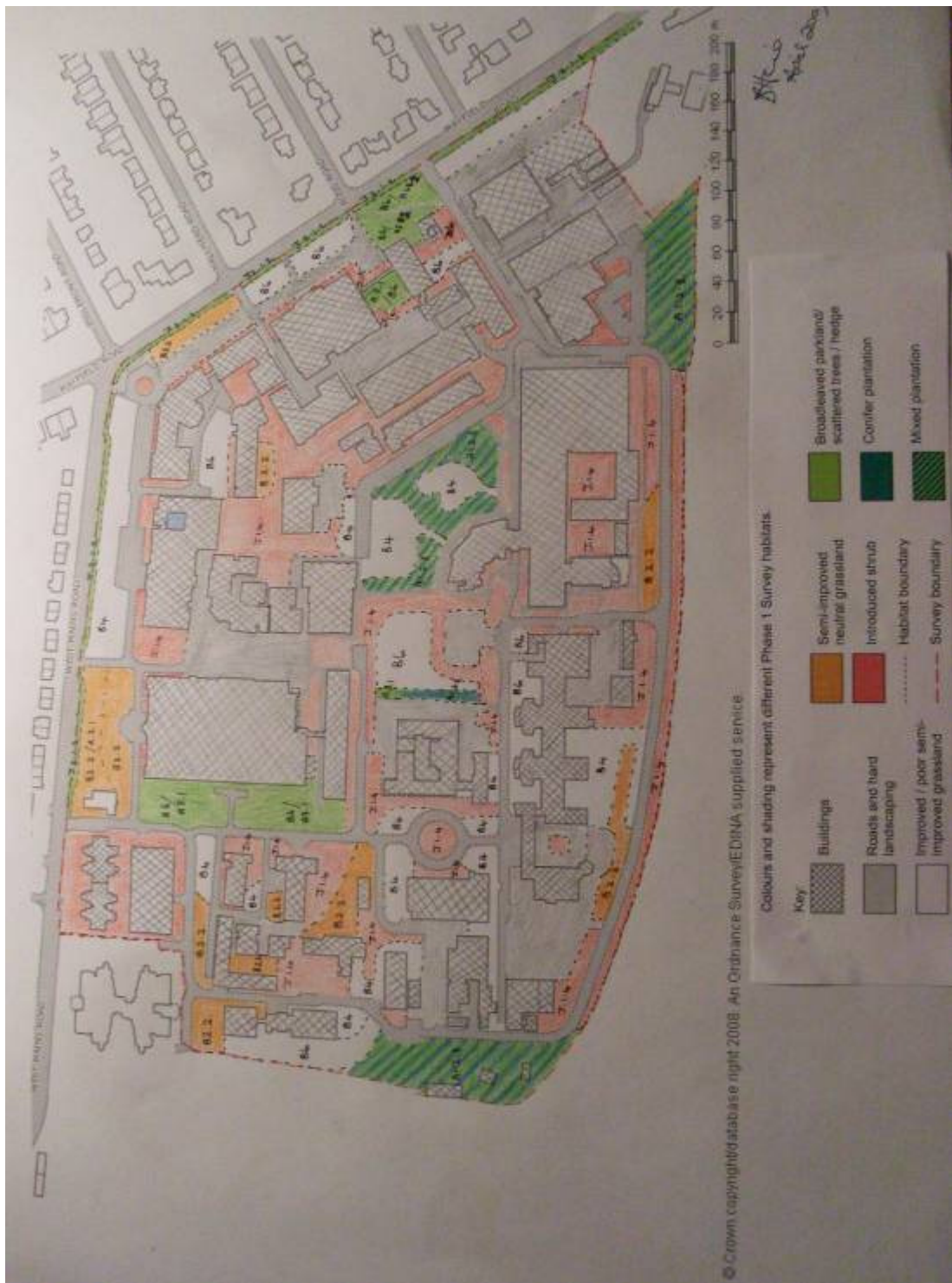
Species name and cultivar	Number of individuals	%
<i>Abies grandis</i> (grand fir)	2	0.2%
<i>Abies koreana</i>	2	0.2%
<i>Abies</i> sp	4	0.3%
<i>Acacia melanoxylon</i>	1	0.1%
<i>Acer campestre</i> (field maple)	13	1.1%
<i>Acer cappadocicum</i>	4	0.3%
<i>Acer cappadocicum</i> 'Rubrum'	1	0.1%
<i>Acer davidii</i> 'George Forrest'	2	0.2%
<i>Acer griseum</i>	2	0.2%
<i>Acer macrophyllum</i>	5	0.4%
<i>Acer palmatum</i>	9	0.7%
<i>Acer platanoides</i> (Norway maple)	23	1.9%
<i>Acer platanoides</i> 'Crimson King'	5	0.4%
<i>Acer pseudoplatanus</i> (sycamore)	166	13.7%
<i>Acer pseudoplatanus</i> 'Purpureum'	5	0.4%
<i>Acer rufinerve</i>	2	0.2%
<i>Acer saccharinum</i> (sugar maple)	4	0.3%
<i>Aesculus hippocastanum</i> (horse chestnut)	1	0.1%
<i>Alnus cordata</i> (Italian alder)	5	0.4%
<i>Alnus firma</i>	5	0.4%
<i>Alnus glutinosa</i> (common alder)	1	0.1%
<i>Alnus incana</i> (grey alder)	3	0.2%
<i>Alnus incana</i> 'Imperialis'	4	0.3%
<i>Amelanchier lamarckii</i>	1	0.1%
<i>Araucaria araucana</i> (monkey puzzle)	2	0.2%
<i>Betula albo-sinensis</i>	5	0.4%
<i>Betula albo-sinensis</i> 'Fascination'	3	0.2%
<i>Betula ermanii</i> 'Holland'	3	0.2%
<i>Betula pendula</i> (silver birch)	102	8.4%
<i>Betula pendula</i> 'Dalecarlica'	2	0.2%
<i>Betula pendula</i> 'Tristis'	3	0.2%
<i>Betula</i> sp	4	0.3%
<i>Betula utilis</i>	13	1.1%
<i>Calocedrus decurrens</i>	4	0.3%
<i>Carpinus betulus</i> (hornbeam)	2	0.2%
<i>Carpinus betulus</i> 'Fastigata'	37	3.1%
<i>Carpinus betulus</i> 'Frans Fontaine'	3	0.2%
<i>Castanea sativa</i> (sweet chestnut)	1	0.1%
<i>Cedrus atlantica</i>	1	0.1%
<i>Cedrus brevifolia</i>	2	0.2%
<i>Cedrus deodara</i>	5	0.4%
<i>Cercidiphyllum japonicum</i>	12	1.0%
<i>Chamaecyparis lawsoniana</i>	3	0.2%
<i>Chamaecyparis lawsoniana</i> 'Columnaris Glauca'	3	0.2%
<i>Chamaecyparis lawsoniana</i> 'Pottenii'	1	0.1%
<i>Chamaecyparis lawsoniana</i> 'Stewartii'	1	0.1%

Species name and cultivar	Number of individuals	%
<i>Chamaecyparis lawsoniana</i> cv	9	0.7%
<i>Chamaecyparis nootkatensis</i>	1	0.1%
<i>Chamaecyparis nootkatensis</i> 'Pendula'	1	0.1%
<i>Cornus controversa</i>	1	0.1%
<i>Cornus kousa</i>	1	0.1%
<i>Corylus colurna</i>	2	0.2%
<i>Crataegus monogyna</i> (hawthorn)	2	0.2%
<i>Cupressus sempervirens</i>	2	0.2%
<i>Eucalyptus</i> sp	2	0.2%
<i>Fagus sylvatica</i> (beech)	34	2.8%
<i>Fagus sylvatica</i> 'Asplenifolia'	1	0.1%
<i>Fagus sylvatica</i> 'Pendula'	1	0.1%
<i>Fagus sylvatica</i> 'Purpurea'	1	0.1%
<i>Fraxinus excelsior</i> (ash)	22	1.8%
<i>Fraxinus excelsior</i> 'Jaspedia'	2	0.2%
<i>Fraxinus ornus</i>	1	0.1%
<i>Fraxinus oxycarpa</i> 'Raywood'	14	1.2%
<i>Ginkgo biloba</i>	2	0.2%
<i>Juglans nigra</i> (walnut)	1	0.1%
<i>Laburnum anagyroides</i>	1	0.1%
<i>Larix decidua</i> (European larch)	30	2.5%
<i>Larix</i> sp	3	0.2%
<i>Liquidamber styraciflua</i>	1	0.1%
<i>Magnolia soulangeana</i>	2	0.2%
<i>Malus tschonoskii</i>	2	0.2%
<i>Metasequoia glyptostroboides</i>	2	0.2%
<i>Nothofagus antarctica</i>	2	0.2%
<i>Nothofagus procera</i>	6	0.5%
<i>Parrotia persica</i>	2	0.2%
<i>Picea breweriana</i>	2	0.2%
<i>Picea</i> sp	5	0.4%
<i>Pinus contorta</i> (lodgepole pine)	64	5.3%
<i>Pinus mugo</i>	6	0.5%
<i>Pinus nigra</i> (Corsican pine)	105	8.7%
<i>Pinus pinea</i> (stone pine)	4	0.3%
<i>Pinus</i> sp	2	0.2%
<i>Pinus sylvestris</i> (Scots pine)	157	13.0%
<i>Platanus x hispanica</i>	1	0.1%
<i>Populus tremula</i> (aspen)	1	0.1%
<i>Prunus avium</i> (gean or wild cherry)	22	1.8%
<i>Prunus cerasifera</i>	4	0.3%
<i>Prunus</i> cv	9	0.7%
<i>Prunus</i> cv (sato zakura)	6	0.5%
<i>Prunus domestica</i>	1	0.1%
<i>Prunus sargentii</i>	1	0.1%
<i>Prunus serrula</i>	9	0.7%
<i>Quercus alnifolia</i>	1	0.1%
<i>Quercus frainetto</i>	1	0.1%
<i>Quercus ilex</i>	5	0.4%
<i>Quercus robur</i> (English oak)	16	1.3%
<i>Quercus robur</i> 'Fastigiata Koster'	5	0.4%
<i>Quercus rubra</i>	3	0.2%

Species name and cultivar	Number of individuals	%
<i>Salix babylonica</i> 'Tortuosa'	4	0.3%
<i>Salix caprea</i> (goat willow)	1	0.1%
<i>Salix</i> sp	1	0.1%
<i>Sophora tetraptera</i>	1	0.1%
<i>Sorbus aria</i> (whitebeam)	6	0.5%
<i>Sorbus aucuparia</i> (rowan or mountain ash)	7	0.6%
<i>Sorbus commixta</i>	12	1.0%
<i>Sorbus hupehensis</i>	8	0.7%
<i>Sorbus intermedia</i> (Swedish whitebeam)	6	0.5%
<i>Sorbus</i> sp	3	0.2%
<i>Sorbus thibetica</i> 'John Mitchell'	3	0.2%
<i>Taxus baccata</i> (yew)	3	0.2%
<i>Taxus baccata</i> 'Dovastonii Aurea'	1	0.1%
<i>Thuja plicata</i>	9	0.7%
<i>Thujopsis dolabrata</i>	1	0.1%
<i>Thujopsis dolabrata</i> 'Variegata'	3	0.2%
<i>Tilia platyphyllos</i> (large-leaved lime)	13	1.1%
<i>Tilia x europaea</i> (common lime or linden)	7	0.6%
<i>Ulmus</i> 'Dampieri Aurea'	2	0.2%
<i>Ulmus angustifolia</i> 'Sarniensis'	7	0.6%
<i>Ulmus glabra</i> (wych elm)	5	0.4%
<i>Ulmus procera</i> (English elm)	20	1.7%
<i>Ulmus</i> sp	1	0.1%
<i>X Cupressocyparis leylandii</i> 'Castlewellan Gold'	6	0.5%
<i>X Cupressocyparis leylandii</i>	12	1.0%
<i>Zelkova serrata</i>	4	0.3%
total number of species	124	
total number of individuals	1209	

Appendix 4: Phase 1 Survey Map

The original of this map is on A3 and is held by Barbra Harvie



Appendix 5: National Vegetation Classification Map

The original of this map is 150 x 90 cm (approx) and is held by Barbra Harvie

