

Heathland Restoration at Keston and Hayes Commons Part of Darwin's Landscape Laboratory

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Abstract

The heathland, acid grassland and lowland valley mire of Hayes and Keston Commons (Northwest Kent) have long been popular places for Londoners on a day out, and for naturalists and scientists to visit, including Charles Darwin who studied round-leaved sundew in Keston Bog and earthworms on the heathland. This paper describes the history of the commons and reasons for the decline in habitat quality and species diversity since the mid 20th century. Actions taken to halt and reverse habitat degradation and species loss include clearance of secondary woodland and scrub, soil scraping, re-seeding of heather, bracken removal, building dams across the valley mire and cutting and clearing purple moor-grass from Keston bog. Detailed field surveys have been key in guiding and monitoring the success of management decisions. Raising awareness of the importance of heathland habitat has been very successful in reconciling concerns of the local community and enlisting the support of many volunteers whose work has been vital for this long-term project. The area of heathland, lowland valley mire and fen habitat has now increased, the area covered by some uncommon plant species has expanded and other species have reappeared. Much remains to be done, however, and maintenance of the newly restored areas requires on-going work by volunteers, input from various countryside agencies and involvement of the local authority whose support is crucial but a cause of concern should their funding continue to be reduced.

Introduction

Hayes and Keston Commons are situated near Bromley on the southern edge of the Thames Basin in vice county 16, 12 miles (19.3 km) from central London and but within the M25. Part of the commons was designated a Site of Special Scientific Interest (SSSI) in 1951 because of its heathland, acid grassland and valley mire habitats which covered 3.9 ha in 1990 and currently extend beyond the SSSI to 9.5 ha. The SSSI has since been extended to include part of the River Ravensbourne, associated wet woodland and dry acid grassland, grading to wet neutral bay meadows in an area known as 'Ravensbourne Open Space'. Together with an adjoining semi-natural ancient coppiced woodland known as Padmall Wood, the SSSI is part of a Site of Metropolitan Importance and was declared a Local Nature Reserve (LNR) in 2005. The LNR covers 118 ha and is owned and managed by the London Borough of Bromley (LBB). See map, Figure 1.

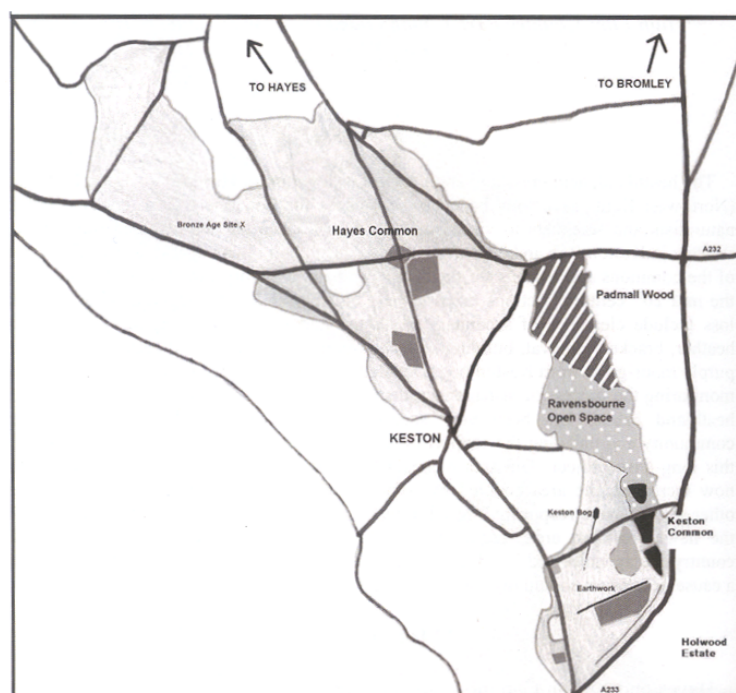


FIGURE 1. Hayes and Keston Common Local Nature Reserve.

Heathland and acid grassland communities occupy the higher ground on dry, infertile, acid soils which have 'developed above the free-draining sands and gravels of the Blackheath Pebble Beds (see Figure 2). Soil profiles dug in these areas show a humus iron podsol with an average pH of 3.6 in the top 5 cm. At the junction of this stratum with the sticky clays of the Woolwich Beds there are springs which feed the River Ravensbourne (Leach, 1916: 142). Three large ponds lie along its course in the south east of the area (see map, Figure 1). In a narrow valley on the western side of Keston Common peat has formed above a layer of impermeable clay (Lovis, 1951) giving rise to lowland valley mire habitat. This area is known as Keston Bog. The peat soil here has a pH of about 3.8. The bog is fed by springs along the valley sides and a seasonal stream which flows north and is culverted underneath a road (Fishponds Road) that bisects Keston Common from east to west. The pH of water in the bog pools of the main bog is 3-4.6, varying seasonally.

History of the commons

The commons lie 140-150 in above ordnance datum (OD) at their highest point, while just to the east, at Holwood, a hill rises to 150-160 in above OD. Iron Age people built a large hillfort here which has been dated to about 200BC (Brian Philp, pers. comm.) and has a commanding view north over the Thames valley. It lies close to a ditch and bank feature also thought to have been constructed in the Iron Age which crosses Keston Common from east to west (O'Neil, 1933). Both are designated Scheduled Ancient Monuments. Excavations on Hayes Common by archaeologist Brian Philp discovered evidence of earlier settlement: flints worked in Neolithic times (4000-2000 BC) and a Bronze Age farmstead dating back to 1400-500BC, with querns for grinding corn and loom weights for weaving sheep's wool (Philp, 1973). Farming since these early times and later by Romans and Saxons, whose settlements were very nearby, is likely to have led to leaching of nutrients through the quick draining Blackheath Beds, resulting in impoverished, nutrient poor soil.

Philp (1973) described a field system on Hayes Common dated between 1580 and 1797 and pictures and photographs of the commons from the early 19th century until the late 1930s show that they were open and grazed until then (Williams, 1984: 5, 72, 73 & 1988: 46, 47). When grazing ceased much of the heathland vegetation was gradually succeeded by birch/oak secondary woodland with some beech (*Fagus sylvatica*; latin nomenclature follows Stace, 2010). Parts of the heathland were planted with scots pine (*Pinus sylvestris*) during the 19th and early 20th centuries, both for amenity value around the ponds and elsewhere, in straight lines, presumably for timber. The lines of pine trees can be seen in aerial photographs taken in the 1940s but have since self-seeded. Gravel was extracted for local road building in Victorian and Edwardian times, resulting in the formation of a gully on Keston Common, south of Westerham Road car park and small quarries on Hayes Common. Use of some of Hayes Common during World War II as part of the ring of air defences around London interrupted the development of secondary woodland in some areas and where buildings were demolished post war and the rubble removed, lichen heath developed; see Appendix IV for a list of lichen species.

Since Victorian times Hayes and Keston Commons have attracted many visitors, especially from London; one of Unwin's 'Half-holiday Handbooks' (Unwin, 1882) recommends visiting Keston Common and 'the famous Sphagnum bog' and there are species records dating from the 19th century (e.g. Scargill, 1898). Most notably Charles Darwin who lived 2 1/2 miles (4.02 km) away at Down House, observed and studied round-leaved sundew (*Drosera rotundifolia*) at Keston Bog (Baxter, 1929) and collected it from here to use in laboratory experiments in his greenhouse (Darwin, 1887). These experiments were designed to discover what stimulated round-leaved sundew to trap and digest insects, and led to Darwin publishing 'Insectivorous Plants' in 1875' (Darwin, 1875). Darwin also studied earthworms on Hayes and Keston Commons, recording in a notebook on October 15th 1880 (Darwin, undated) how he looked for them here in soil under heathland, lichen heath, pathsides, glade and where heath had been burnt. These observations were published in his book 'The Formation of Vegetable Mould through the action of worms with observations of their habits' (Darwin, 1881).

Erosion of parts of the commons caused by visitor numbers has been a factor affecting species survival here for a considerable time. The Kentish Times (Anon., 1930) recorded that on Whitsun Bank Holiday Monday 17,000 people arrived at Hayes Station and the commons were 'submerged all day beneath a sea of people'. Old records show that about seventeen higher plant species may have been lost from the heathland and acid grassland since Victorian times (see Appendix II). In 1951 J.D. Lovis recorded the plant species of Keston Bog and their locations and compared his findings with those made by Parsons (1912). Lovis (1951) reported that only one of the species listed by Parsons had disappeared, meadow thistle (*Cirsium dissectum*), although three species recorded prior to 1912, ivy-leaved bellflower (*Wahlenbergia hederacea*), bogbean (*Menyanthes trifoliata*) and marsh clubmoss (*Lycopodiella inundata*) were no longer present. Regular surveying by amateur naturalists and specialists from the Natural History Museum shows that loss of species diversity in the lowland valley mire appears to have accelerated in the second half of the 20th century: a further eighteen species of higher plants and ferns have been lost from the bog since 1951 (see Appendices I and II).

Lovis (1951) also reported vandalism of Keston Bog, which was subsequently fenced and made less accessible. An understorey of holly (*Ilex aquifolium*) and rhododendron (*Rhododendron ponticum*) grew here under encroaching birch (*Betula spp.*), oak (*Quercus spp.*) and self-seeded scots pine, shading and reducing water availability for the bog plants and increasing nutrient input from dead leaves. Water availability in Keston Bog was further reduced when a housing estate was built in the 1980s to the west of it, reducing the catchment area. Purple moor-grass (*Molinia caerulea*) invaded as the bog dried, smothering smaller plants and further decreasing water availability. Round-leaved sundew which requires high light and water availability together with soil low in available nitrogen, became extinct here in 1986. The fen areas south of the main bog and south of Fishponds Road described by Lovis in 1951 became restricted to a small area associated with water seepage west of the main bog with loss of species including marsh bedstraw (*Galium palustre*), ragged robin (*Silene flos-cuculi*) and bog stitchwort (*Stellaria alsine*). The two latter are still present in the wet meadows of Ravensbourne Open Space into which water from the bog drains (see map, Figure 1). The bog south of Fishponds Road became overgrown by bramble (*Rubus fruticosus*).

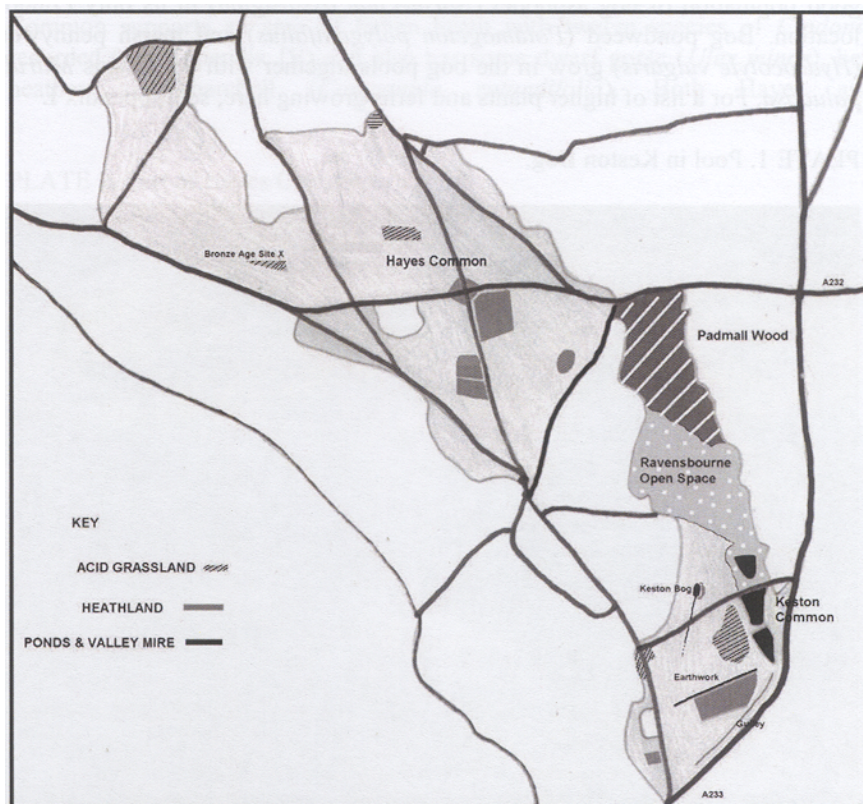


FIGURE 2. Habitats of Hayes and Keston Commons.

Current flora and fauna

Lowland valley mire (Keston Bog)

Keston Bog covers an area of about 0.4 ha. and currently supports seven species of *Sphagnum* moss, including *S. magellanicum*, rare in the south-east (see Sheahan, 2010 and Appendix III; moss and liverwort names follow Atherton et al., 2010). Six species of sedge are found here and sharp-flowered rush (*Juncus acutiflorus*) dominates some of the bog pools. Cross-leaved heath (*Erica tetralix*) grows along and below the springline. Also present are common cottongrass (*Eriophorum angustifolium*), tormentil (*Potentilla erecta*) and a good population of bog asphodel (*Narthecium ossifragum*) in its only London location. Bog pondweed (*Polamogeton polygonifolius*) and marsh pennywort (*Hydrocotyle vulgaris*) grow in the bog pools together with the fungus *Mitrella paludosa*. For a list of higher plants and ferns growing here, see Appendix I.



PLATE 1. Pool in Keston Bog.

Water shrew (*Neomysfodiens*) was found here in 2005 and the nationally scarce water beetle *Heliochares punctatus*, which is confined to low-lying peaty areas, was recorded in 2010 during an aquatic invertebrate survey (ECOSA, 2010). Many plant species present appear to have a much more restricted distribution now compared with when Lovis made his observations in 1951 and the fen areas he described between the main bog and the road, and to some extent South of the road, were not present in 2009.

Heathland

The heathland covers 6.7 ha (see Figure 2). There are fairly pure stands of Heather (*Calluna vulgaris*) in some places; in other areas it forms part of an acid grassland/heathland mosaic. On Keston Common, bilberry (*Vaccinium myrtillus*) is locally abundant, bell heather (*Erica cinerea*) occasional. Hayes Common supports an area of lichen heath with twelve species of *Cladonia* recorded (see Appendix IV) and also has some dwarf gorse (*Ulex minor*), bell heather and harebell (*Campanula rotundifolia*). Both Hayes and Keston Commons support the common lizard (*Zootoca vivipara*) and slow-worm (*Anguisfragilis*). There is also a small population of adder (*Vipera berus*), one of four within the M25. Invertebrates recorded since 2006 include many associated with heathland such as green tiger beetle (*Cicindela campestris*).



PLATE 2. Part of Hayes Common.

Acid grassland covers approximately 2.4 ha, in isolated patches (see Figure 2), and consists of the sheep's-fescue (*Festuca ovina*), common bent-grass (*Agrostis capillaris*) and sheep's sorrel (*Rumex acetoselia*) grassland habitat type (Rodwell, 1992), but the composition varies according to the pressures on it. Above the ponds the grassland suffers from overuse and erosion due to visitor pressure with damage caused by picnics, informal football, illegal camping, barbecues and trampling. This area is species-poor with common cat's-ear (*Hypochaeris radicata*) and heath rush (*Juncus squarrosus*), both of which tolerate some trampling, some small relict growths of heather and occasional lady's bedstraw (*Galium verum*). Regular mowing with removal of clippings around a war memorial allows the survival of small plants including common whitlowgrass (*Erophila verna*), parsley-piert (*Aphanes arvensis*), bird's-foot (*Ornithopus perpusillus*), common stork's-bill (*Erodium cicutarium*), buck's-horn plantain (*Plantago coronopus*) and upright chickweed (*Moenchia erecta*). There is also some meadow saxifrage (*Saxifraga granulata*) in this area. In areas where the grassland is part of a heathland mosaic, wavy hair-grass (*Deschampsia flexuosa*) tends to dominate with some common cow-wheat (*Melampyrum pratense*). Along the old gravel extraction gully, where Blackheath pebbles are near the surface, there is a patch of the UK scarce hoary cinquefoil (*Potentilla argentea*).

For lists of higher plants and ferns present today, and those no longer recorded, see Appendices I and II. For a list of moss species recorded from Keston heathland, acid grassland and lowland valley mire, see Appendix III.

As has happened in many other areas during the second half of the 20th century, the heathland, acid grassland and valley mire habitats of Hayes and Keston Commons have become reduced and fragmented by encroachment of secondary woodland. In the bog, water availability has been reduced partly by encroaching trees and scrub, but generally drier summers and some reduction of the catchment area due to development have exacerbated the problem. Increased nutrient input from dead leaves and probably from the road bisecting the common is likely to have been to the detriment of species such as round-leaved sundew and some Sphagnum species. Methods used to try and restore these habitats, promote the spread of those species which have become much reduced in extent and encourage the return of those which have been lost are described below.

Methods of restoration

The earliest recorded restoration work carried out on Hayes and Keston Commons dates back to the 1970s when Orpington Field Club (OFC), a group of amateur naturalists including experts who regularly monitored local plants, fungi and some animal groups, recognised that the special flora of Keston Bog was at risk. In 1978, working with London Borough of Bromley (LBB), they began pulling saplings from the bog annually and cutting and clearing purple moor-grass (*Molinia caerulea*) every- autumn. LBB council officers met with them regularly and used their expertise to inform management of nature conservation sites in the borough, including at Hayes and Keston Commons. Advice was sought from Kent Trust for Nature Conservation (now Kent Wildlife Trust), the Nature Conservancy Council (now Natural England), and later also from others carrying out heathland restoration projects, including staff working on Hothfield Common, Burnham Beeches and Lopham and Redgrave Fen. Gradually, larger-scale restoration works have been undertaken, and local Friends groups have been formed who, working with LBB site managers, continue the work started by the OFC. Since 2010 restoration work has been supported by Higher Level Stewardship (HLS) funding, overseen by Natural England. This is due to continue until 2020.

Lowland valley mire

Drainage improvements

Dams were put across the valley to slow drainage through Keston Bog. Six dams have been installed in the main bog and two others in the southern part of the valley. The first of these were installed in 1981, 1983 and 1990. Two further dams were added by the National Rivers Authority (now Environment Agency) in 1994 and the most northerly dam was installed in 2010. The bog pools are maintained through annual cutting and clearing of reeds and grasses in autumn.

Trees and scrub clearance

Pine trees were felled in and around the bog in 1981/1982 and 1986/1987 and 1992. Grant funding obtained through London's Heathland Heritage project enabled further tree felling in 2005/2006 and trees have been removed from the bog every winter since. Smaller scrub was removed by volunteers working with the LBB Site Manager; saplings were pulled by hand, encroaching bramble cleared and reeds controlled. Chemical treatments are not used in the bog because of the risks to this sensitive habitat.

Soil scraping

Careful soil scraping to remove accumulated leaf litter has been carried out in small areas. Great care was taken to remove only the leaf litter and not damage the layer of underlying peat. A trial scrape from the Blackheath Beds exposure at the top of the valley side down to the bog pools was carried out in March 2009, removing leaf litter from a two metre wide transect and exposing the underlying peat in order to encourage germination of any dormant bog plant seeds in the seed bank; in particular those of round-leaved sundew. Each year, following tree felling in the bog, further soil scraping has removed leaf litter which had accumulated beneath them, reducing nutrient input to the soil and exposing seepage areas and the dormant seeds of bog plants.

Control of purple moor-grass

Various methods have been used to try to reduce the growth of purple moor- grass in Keston Bog, because it threatens to smother smaller plants, particularly *Sphagnum* growing in the gulleys between tussocks, and also contributes to the drying out of the bog through transpiration and to nutrient input via leaf litter. The OFC cut purple moor-grass in a trial area in spring and autumn from 1988-1997. Since 2009, the grass has been cut immediately after flowering and before setting seed (July), and then cut again in the autumn. The first cut has been done by hand, with grass carefully collected straight into plastic bags to prevent any seeds being sown. The second cut is done mechanically using a brushcutter, with the arisings raked and removed. Tussocks of the grass nearest the bog were also winched out in the winters of 2007 and 2008, but only at the northern and southern boundaries to avoid compression of the peat soils by heavy machinery.

Pollution control

To reduce pollution from the road entering the northern part of the bog valley and discourage access to this sensitive area, a screen of vegetation has been retained along the roadside. Applying to LBB to have the road closed has also been suggested to local residents.

Heathland

The heathland areas of Keston and Hayes have been greatly encroached upon by secondary woodland species, and as a result, larger scale felling and soil scraping have been required in order to restore wider areas of heathland.

Gorse and tree removal

Trees and scrub have been removed every winter since 2005/2006. On the heathland of Hayes and Keston, European gorse is treated by cutting and treating stumps with 'Timbrel' (50%) leaving 15-25% cover for invertebrates and birds. Tree seedlings are cut and the stumps treated with the herbicide 'Round-up Bioactive' (20%). Some trees have been retained for birds, fungi and invertebrates, but spread of trees and scrub in these areas is prevented.

Soil scraping

In 2005/2006, a large area of heathland (approximately 0.8 ha) was clear felled and the soil scraped off. Some of the soil was retained on site in banks. More recently, soil has been carefully scraped from smaller areas to remove accumulated leaf litter and gorse seeds.

Heather seeding

Heather seeding has been carried out where tree and scrub cover has been removed. On Hayes Common, the 0.8 ha scrape from 2005/2006 was reseeded by local schoolchildren using heather seed obtained from Esher Common. Some bare ground has been retained, providing warm areas to encourage invertebrates, such as solitary bees, to nest and where reptiles can bask to raise their body temperatures. On Keston Common, heather cut as part of the management regime to retain a varied age structure has been used to seed areas where trees have been felled or scrub cut back.

Bracken control

Bracken is pulled, cut or bruised three times a year in all areas under restoration. Some is retained for invertebrates and cover for birds.

Acid grassland

In the acid grassland areas, management largely consists of an annual autumnal cut-and-take, with additional control of scrub margins. There is currently a frequent mowing regime around Keston War Memorial, where the short grass enables survival of small spring ephemerals.

Access and interpretation

Public support and understanding for the restoration works have been encouraged through the installation of information boards on the heathland areas of Keston and Hayes. Heritage Lottery funding paid for walks, talks, events, training days, surveying, producing the Keston and Holwood Darwin Trail and an information board about Keston Bog. LBB funded a further nature trail 'The Ravensbourne Trail' to celebrate the designation of Hayes and Keston Commons, Ravensbourne Open Space and Padmall Wood as a Local Nature Reserve (LNR).

Results

Lowland valley mire

Drainage improvements

The small catchment area supplying water to Keston Bog makes it very vulnerable to reduced rainfall, but the dams have successfully slowed the movement of water through the bog. Sphagnum has appeared in the lowest water body behind the newest dam, where scots pine grew until removed in spring 2010. This most recent darn should enable the bog to extend downhill and improve species survival if there is a prolonged spell of dry weather or a series of years with below average rainfall. Annual cutting and removal of grasses and reeds from the bog pools has increased the area of Sphagnum, bog pondweed and marsh pennywort.

Tree and scrub clearance

Tree and scrub clearance have increased the open area in and around the lowland valley mire to 0.5 ha, increasing drainage from the valley sides as well as improving light reaching the ground flora. There has been some development of *Sphagnum* at the both ends of the main bog following tree and scrub clearance of the eastern valley side which has resulted in improved water availability towards the bottom of the slope. In the area between the main bog and the road that was described by Lovis in 1951 as fen, star sedge (*Carex echinata*) and *Juncus* spp. are increasing and lesser spearwort (*Ranunculus flammula*) has reappeared following tree felling along the western valley side. Since trees were cut back and bramble scrub was cleared from the bog south of Fishponds Road in 2009, *Sphagnum palustre* and *S. flexuosum* have both increased in area, as has *Polytrichum commune* and species of *Juncus*. Purple moor-grass has appeared at the edge of the boggy areas.

Soil Scraping

Careful soil scrapes along the valley sides have exposed seepage areas with peat soil which are being colonised by *Sphagnum* and *Juncus* spp., Common yellow-sedge (*Carex demissa*), algae and liverworts. Colonization of the trial scrape from the top of the bog to the pools has been slow, but there are now areas covered by *Sphagnum*, bog asphodel and toad rush (*Juncus bufonius*). Purple moor-grass seedlings have been removed when they appear in the scrape area.

Control of purple moor-grass

Cutting and clearing purple moor-grass twice annually rather than just in the autumn has led to a great reduction in vigour of the grass in the valley bottom, but it invades where scrub clearance is carried out and preventing it from setting seed remains a priority. Areas recently scraped of leaf litter are particularly vulnerable. Holes resulting from winching out purple moor-grass tussocks in 2007/2008 are now supporting *Sphagnum* species on the sides.

Changes to the bog flora

At the top of the valley sides, where there is no peat but Blackheath Beds, the area is now reverting to heathland. Moisture levels in the bog appear to have improved during the last three summers (2010-2013) and although the pools have continued to lose their open water by July or August, the floors of the depressions still remain damp. The degree of drying out of the pools remains dependent on the amount of precipitation, however, and during periods of low rainfall (for example, spring 2012) much of the bog becomes dry. In some areas, particularly towards the southern part of the main bog, heather and bilberry are increasing, especially on top of the dry tussocks of purple moor-grass. Most of the *Sphagnum* species, bog asphodel common cottongrass and cross-leaved heath are increasing in extent within the main bog but round-leaved sundew has not returned to date and the population of *Sphagnum magellanicum* remains threatened; just five plants of the latter were reported by Sheahan in 2010. In 2013 these had increased to about 10 and two additional small clumps were found on the southern side of the trial scrape (Hendy, pers. comm.). Dr Fred Rumsey found *Pellia neesiana* in Keston Bog in 2010, a

new vice county record (see Bosanquet, 2011) and in 2011 the moss *Straminergon stramineum* was reported here for the first time Hendey (2011).

The water shrew, first recorded here in 2005, was again recorded in 2013.

Heathland

Tree and scrub clearance

A total of 3.7 ha of secondary woodland and scrub has been cleared from the heathland. Under the terms of the Higher Level Stewardship agreement a further 7.7 ha remains to be removed by 2020. Work carried out to inform and involve the local community has been successful in increasing practical volunteer support and local interest. Some complaints are still received regarding tree felling, but these are now few. European gorse control remains a problem, and repeated cutting and treating of cut stumps has been necessary. The continuing restoration work is designed to ensure that the lowland valley mire will eventually be continuous with the heathland/acid grassland mosaic above the Keston ponds and areas of heathland on Hayes Common will link together.

Soil scraping

Soil scraping on heathland areas appears to have facilitated germination and growth of heather and reduced the amount of germinating gorse seed. The area scraped free of soil on Hayes Common in 2007 and reseeded now supports abundant bell heather, heather and acid grassland.

Changes to the heathland flora and fauna

Heather appears to be regenerating well in areas cleared of small trees and scrub but not scraped, as well as in the areas where larger trees were felled and soil scraped. The amount of bilberry on Keston Common has increased markedly. Hoary cinquefoil is also expanding its range in the old gravel extraction gully where gorse has been cut back, although the patch is threatened in other areas by invasive grasses which need to be kept in check by regular cutting and clearing in autumn. The adder population is carefully monitored by Kent Reptile and Amphibian Group and appears stable.

Acid grassland

The area of acid grassland has increased to 2.4 ha following the felling of secondary woodland and scrub removal. Spring ephemerals and other small plants of acid grassland continue to survive around the war memorial. Meadow saxifrage (*Saxifraga granulata*) had a very good year in 2010 when it appeared on both sides of the roads in reasonable amounts. In other years mowing has taken place too early and a constant watch is required to prevent contractors from cutting the plants before they flower and set seed.

Discussion

A great deal of work has been carried out on Hayes and Keston Commons in recent years to try to restore the heathland and lowland valley mire habitats. Key factors facilitating this work have been access to good survey work, the support of the local community and external funding allied to long-term management.

Access to good historical records has enabled understanding of the former extent of these habitats, the species present in the past and their exact locations. In particular the paper by Lovis (1951) has proved invaluable in regard to the restoration of Keston Bog. Assistance provided more recently by experts in different plant and animals groups continues to be vital in providing scientifically sound information which is used to inform management decisions.

Interpretation and other work carried out to raise awareness of the importance of heathland habitat has been very successful in reconciling concerns of the local community, such as loss of trees, and enlisting the support of many volunteers. The emphasis on public support has led to a

changed approach, with progressive thinning rather than clear felling now carried out, as this appears to be a more acceptable option. Further public support would be required for some longer-term options to be realised, such as the closure of Fishponds Road to reduce pollution entering Keston Bog.

As the restoration work has developed, a problem has arisen of how to maintain the areas of heathland, acid grassland and valley mire as they increase in size. Currently the Friends of Keston Common and the Bromley Countryside Volunteers spend an average of 600 hours annually working on heathland areas. In addition, Conservation Volunteers have been monitoring the adder population, clearing and poisoning stumps of young trees and scrub every winter since 2005 and the Friends of Hayes Common have been working since 2001 to reduce holly in secondary woodland on Hayes Common in order to open up glades to encourage the survival of relict heather populations. This reliance on volunteer hours and labour-intensive management techniques means that maintaining the increasing area of open land will be dependent on retaining volunteer enthusiasm and interest. In the longer term, low intensity grazing by cattle is a conservation option but because of the proximity of the commons to a large urban population and the popularity of the area with visitors, animal welfare is a considerable issue. Fencing of parts of the common for grazing will also be unpopular with some visitors and will require special permission from the Planning Inspectorate. Currently, policing of camping and the use of barbecues on the commons is a problem, with late night parties causing considerable littering as well as the danger of the fires spreading to the vulnerable heathland habitats.

As newly restored heathland habitats begin to emerge, it is important to view them on a larger scale and try to connect these areas to improve wildlife populations. Working each year to clear separate fairly small areas, which are gradually becoming linked together, has allowed the lizard and slow worm to become more widespread, but the possibility of linking heathland on Hayes and Keston Commons is unlikely since they are separated by semi-natural ancient woodland and houses with gardens. Some mobile species may be able to cross these areas or be carried by birds or other animals, others species are unlikely to do so. The adder population, although currently stable, is very isolated being one of only four widely separated populations within the M25, so its long-term future is uncertain.

In Keston Bog there has been some species recovery since restoration work began, but the round-leaved sundew has failed to reappear despite the reduction in shading and improvement in water availability resulting from removal of trees and scrub both in the bog and its catchment area. Although the input of nutrients from leaf litter is much reduced and soil scraping has removed it from some parts, it is possible that nutrient levels may still be too high for round-leaved sundew to re-establish, always assuming viable seeds have survived in the seed bank. The large size of the bog asphodel here may be an indicator of high levels of nutrients (Joyce Pitt, pers. comm.). The quality of the water entering the main bog from Fishponds Road is unknown, but the increase in traffic since the 1950s is likely to have led to alterations in water chemistry and efforts to see if road closure may be possible need to be redoubled. The appearance of heather and bilberry near the bog pools at the southern end of the bog is a worrying sign of decreased water availability and dry summers with a falling water table may lead to a change in habitat designation, possibly to wet heath.

Funding is a key factor in the future success of the heathland restoration at Hayes and Keston Commons. Recently, external funding has been very important, particularly when allied to long-term management as is the case with the HLS funding from Natural England. Internal funding by LBB has been reduced and the amalgamation of the Countryside Service with the Parks Service has led to a halving in the staff numbers carrying out countryside management. It is likely that both staff and funding will be further reduced in the future. This would affect future funding opportunities such as HLS, the targets of which volunteers alone are unlikely to be able to fulfil without professional support and advice. In the past most of the Sites of Importance for Nature Conservation belonging to LBB, including Hayes and Keston Commons, were managed by an ecologist who engaged contractors to carry out nature conservation work. Insufficient financial and physical support given to the ecologist led to many of the problems now being addressed on Hayes and Keston Commons, and the current-council approach of using contractors chosen on cost alone will probably lead to more problems than it solves.

Conclusion

Hayes and Keston Commons contain the remnants of historical heathland, acid grassland and lowland valley mire habitats. They have the potential for recovery and through active management the conservation status of these remnants can be enhanced and connected to create a thriving ecosystem. The small areas of recovered heathland and improvements in the lowland valley mire indicate that a long-term management programme based on the methods detailed in this paper will bring about improvement to the habitats of Hayes and Keston Commons, but notwithstanding the early signs of success, much still remains to be achieved. Such a long-term project requires the continuing involvement of the local authority, volunteer groups and input from the various countryside agencies.

Without the introduction of a grazing regime, simply maintaining the existing restoration areas will rely on a vast amount of volunteer effort which, considering the number of groups involved, needs coordinating to ensure the best outcome. It remains to be seen if this professional supervision can continue, especially in view of the uncertainty surrounding the future of local authority funding. Without the on-going support of the local authority, the encouraging results of the existing restoration are likely to be reversed.

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Trail guides to Keston and Hayes Commons, can be downloaded from the London Borough of Bromley web site: www.bromley.gov.uk/

Appendix I

Higher plant and ferns of Hayes and Keston Commons, excluding areas of secondary woodland and neutral grassland. (All records post 2010 unless otherwise stated).

Species name	Common name	Location
<i>Agrostis capillaris</i>	Common bent	HC, KC
<i>Agrostis stolonifera</i>	Creeping bent	HC, KC, KB
<i>Aira caryophyllaea</i>	Silver hair-grass	HC
<i>Airapraecox</i>	Early hair-grass	HC
<i>Allium vineale</i>	Wild onion	KC
<i>Aphanes arvensis</i>	Parsley piert	WM
<i>Arabidopsis thaliana</i>	Thale cress	HC
<i>Arrhenatherum elatius</i>	False oat-grass	HC, KC
<i>Betula pendula</i>	Silver birch	HC, KC
<i>Betula pubescens</i>	Downy birch	HC, KC
<i>Blechnum spicant</i>	Hard-fem	KB
<i>Brachypodium sylvaticum</i>	False Brome	HC, KC
<i>Calluna vulgaris</i>	Heather	HC, KC, KB
<i>Campanula rotundifolia</i>	Harebell	HC
<i>Cardamine flexuosa</i>	Wavy bitter-cress	KB
<i>Carex binervis</i>	Green-ribbed sedge	KB
<i>Carex demissa</i>	Common yellow-sedge	KB
<i>Carex echinata</i>	Star sedge	KB
<i>Carex nigra</i>	Common sedge	KB
<i>Carex panicea</i>	Carnation sedge	KB
<i>Carex pilulifera</i>	Pill sedge	KC
<i>Cerastium glomeratum</i>	Sticky mouse-ear	KC
<i>Cerastium fontanum</i>	Common mouse-ear	HC, KC, WM
<i>Cerastium semidecandrum</i>	Little mouse-ear	KC, WM
<i>Cirsium arvense</i>	Creeping thistle	HC
<i>Convallaria majalis</i>	Lily-of-the-valley	HC, KC
<i>Cytisus scoparius</i>	Broom	HC, KC
<i>Danthonia decumbens</i>	Heath-grass	HC, KC
<i>Deschampsia flexuosa</i>	Wavy hair-grass	HC, KC
<i>Dryopteris dilatata</i>	Broad buckler-fem	KC, KB
<i>Epipactis helleborine</i>	Broad-leaved helleborine	HC, KC
<i>Erica cinerea</i>	Bell heather	HC, KC
<i>Erica tetralix</i>	Cross-leaved heath	KB
<i>Eriophorum angustifolium</i>	Common cottongrass	KB
<i>Erodium cicutarium</i> agg.	Common stork's-bill	HC, KC, WM
<i>Erophila verna</i>	Common whitlowgrass	KC
<i>Festuca fliformis</i>	Fine-leaved sheep's-fescue	HC, KC
<i>Festuca ovina</i> agg.	Sheep's-fescue	KC
<i>Frangula alnus</i>	Alder buckthorn	HC, KC
<i>Galium saxatile</i>	Heath bedstraw	HC
<i>Galium verum</i>	Lady's bedstraw	KC
<i>Geranium lucidum</i>	Shining crane's-bill	HC, KC
<i>Geranium molle</i>	Dove's-foot crane's-bill	KC
<i>Glechoma hederacea</i>	Ground-ivy	KC
<i>Glyceria</i> sp.	Sweet-grass	KB
<i>Holcus lanatus</i>	Yorkshire-fog	HC, KC, KB
<i>Hydrocotyle vulgaris</i>	Marsh pennywort	KB
<i>Hypochaeris radicata</i>	Cat's-ear	HC, KC, WM
<i>Ilex aquifolium</i>	Holly	HC, KC, KB
<i>Juncus acutiflorus</i>	Sharp-flowered rush	KB
<i>Juncus bufonius</i> agg.	Toad rush	KB
<i>Juncus bulbosus</i>	Bulbous rush	KB
<i>Juncus effusus</i>	Soft-rush	KB
<i>Juncus squarrosus</i>	Heath rush	KC
<i>Koeleria macrantha</i>	Crested hair-grass	KC
<i>Lonicera periclymenum</i>	Honeysuckle	HC, KC
<i>Lotus pedunculatus</i>	Greater bird's-foot-trefoil	KB
<i>Luzula campestris</i>	Field wood-rush	KC, WM

<i>Luzulaforsteri</i>	Southern wood-rush	HC
<i>Melampyrum pretense</i>	Common cow-wheat	HC, KC
<i>Moenchia erects</i>	Upright chickweed	WM
<i>Molinia caerulea</i>	Purple moor-grass	KC, KB
<i>Myosotis arvensis</i>	Field forget-me-not	HC
<i>Myosotis ramosissima</i>	Early forget-me-not	KC
<i>Narthecium ossifragum</i>	Bog asphodel	KB
<i>Ornithopus perpusillus</i>	Bird's-foot	WM
<i>Pedicularis sylvatica</i>	Lousewort	HC
<i>Pilosella officinarum</i>	Mouse-ear-hawkweed	WM
<i>Pinus sylvestris</i>	Scots pine	KC
<i>Plantago coronopus</i>	Buck's-hom plantain	KC, WM
<i>Polygala serpyllifolia</i>	Heath milkwort	HC
<i>Potamogeton polygonifolius</i>	Bog pondweed	KB
<i>Potentilla argentea</i>	Hoary cinquefoil	KC
<i>Potentilla erects</i>	Tonnentil	HC, KB
<i>Prunus laurocerasus</i>	Cherry laurel	HC, KC
<i>Prunus spinosa</i>	Blackthorn	HC, KC
<i>Pteridium aquilinum</i>	Bracken	HC, KC
<i>Quercus cerris</i>	Turkey oak	KC
<i>Quercus petraea</i>	Sessile oak	HC, KC
<i>Quercus robur</i>	Pendunculate oak	HC, KC
<i>Quercusx rosacea</i>	Hybrid oak	KC
<i>Ranunculus bulbosus</i>	Bulbous buttercup	HC, WM
<i>Ranunculus flammula subsp. flammula</i>	Lesser spearwort	KB
<i>Rhododendron ponticum</i>	Rhododendron	KC, KB
<i>Rubusfruticosus agg.</i>	Bramble	HC, KC
<i>Rumex acetosella</i>	Sheep's sorrel	HC, KC
<i>Salix cinerea subsp. Oleifolia</i>	Grey willow	KB
<i>Saxifraga granulate</i>	Meadow saxifrage	KC, WM
<i>Silene flos-cuculi*</i>	Ragged-robin	
<i>Sorbus aria</i>	Common whitebeam	KC
<i>Sorbus aucuparia</i>	Rowan	HC, KC
<i>Stellaria alsine*</i>	Bog stitchwort	
<i>Stellaria pallida</i>	Lesser chickweed	KC
<i>Taraxacum sect. Erythrosperma</i>	Dandelion	WM
<i>Taxus baccata</i>	Yew	KC, WM
<i>Teucrium scorodonia</i>	Wood sage	HC, KC
<i>Trifolium dubium</i>	Lesser trefoil	WM
<i>Trifolium micranthurn</i>	Slender trefoil	WM
<i>Trifolium striatum</i>	Knotted clover	WM
<i>Ulex europaeus</i>	Gorse	HC
<i>Ulex minor</i>	Dwarf gorse	HC
<i>Vaccinium myrtillus</i>	Bilberry	KC, KB
<i>Veronica arvensis</i>	Wall speedwell	WM

* Once present in Keston Bog (Lovis 1951), currently present in wet meadow downstream from Keston Bog

HC = Hayes Common; KC = Keston Common; KB = Keston Bog
WM = War Memorial on Keston Common

Appendix II

Species recorded on Hayes and Keston Commons no longer present.

Species	Site of last record: recorder, date	Source
<i>Alopecurus aequalis</i>	Common: Scargill 1895-97	Scargill (1898)
<i>Cirsium palustre</i>	Keston Bog: Lovis 1951	Lovis (1951)
<i>Claytonia perfoliata</i>	Bog: Lovis 1921	Lovis (1951)
<i>Cuscuta epithymum</i>	Hayes Common: Scargill 1892-96 on gorse	Scargill (1898)
	Keston Common: Snelling 03.09.1901 on heather	Knowiden (2000)
<i>Dactylorhiza tnaculata</i> subsp. <i>ericetorum</i>	Keston Bog: Lovis 1951	Lovis (1951)
<i>Drosera rotundifolia</i>	Keston Bog: Pitt 1986	Pitt (pers. Comm.)
<i>Eleocharis tnuiticaulis</i>	Keston Bog: Lovis 1951	Lovis (1951)
<i>Filago tninima</i>	Hayes Common: Scargill 1892-97 in old gravel pits	Scargill (1898)
<i>Filago vulgaris</i>	Hayes Common: Scargill 1892-97 in old gravel pits	Scargill (1898)
<i>Galium palustre</i>	Keston Bog: Lovis 1951	Lovis (1951)
<i>Genista anglica</i>	Keston Bog: Boniface 1952	BSBI database
<i>Genista tinctoria</i>	Henry Terry 1873	Terry (1978)
<i>Hypericum elodes</i>	Henry Terry 1873, Keston: Scargill 1892-96	Scargill (1898)
<i>Hypericum pulchrum</i>	Henry Terry 1873	Terry (1978)
<i>Lepidium heterophyllum</i>	Hayes Common: Scargill 1897	Scargill (1898)
<i>Lycopodiella inundata</i>	Keston Bog: Chandler 1930	BSBI database
<i>Mentha arvensis</i>	Keston Bog: Lovis 1951	Lovis (1951)
<i>Menyanthes trifoliata</i>	Keston Bog: pre 1911	Lovis (1951)
<i>Myrica gale</i>	Keston Bog: Boniface 1952	BSBI database
<i>Osmunda regalia</i>	Keston Common: Pitt 1990	Pitt in Hardy (1990)
<i>Parnassia palustris</i> *	Keston Common: Playfair 1882	Scargill (1898)
<i>Pinguicula vulgaris</i> *	Keston Common: Playfair 1882	Scargill (1898)
<i>Ranunculus lingua</i>	Keston Bog: Pitt 1990	Pitt in Hardy (1990)
<i>Salix repens</i>	Keston Bog: Lovis 1951	Lovis (1951)
<i>Scieranthus annuus</i>	Keston Common: Playfair 1897 Hayes Common: Griffin 1904	Scargill (1898) Brevis & Griffin (1909)
<i>Scutellaria minor</i>	Keston Bog: Pitt 1990	Pitt in Hardy (1990)
<i>Senecio sylvaticus</i>	Hayes Common: Scargill 1898	Scargill (1898)
<i>Silene flos-cuculi</i> **	Keston Bog: Lovis 1951	Lovis (1951)
<i>Solidago virgaurea</i>	Keston Common: Snelling 03.09.1901 Hayes Common: Burton 1987	Knowiden (2000)
<i>Stellaria alsine</i> **	Keston Bog: Lovis 1951	BSBI database Lovis (1951)
<i>Succisa pratensis</i>	Keston Bog: Lovis 1951	Lovis (1951)
<i>Trichophorum germanicum</i>	Keston Bog: Lovis 1951	Lovis (1951)
<i>Trifolium incarnatum</i>	Hayes: Scargill 1897 waste ground and gravel pits	Scargill (1898)
<i>Tussilago farfara</i>	Keston Bog: Lovis 1951	Lovis (1951)
<i>Ulex minor</i>	Keston Bog: Lovis 1951. Now Hayes Common only	Lovis (1951)
<i>Veronica scutellata</i>	Keston Bog: Noted extinct by Lovis in 1951	Lovis (1951)
<i>Viola palustris</i>	Keston Common: Playfair 1893	Scargill (1898)
<i>Wahlenbergia hederacea</i>	Keston Bog: Pre 1911	Lovis (1951)

* Introduced, according to the Woolwich Surveys (Brevis & Griffin, 1909)

** Still present in wet meadow downstream from Keston Bog

Appendix III

Mosses of Keston Common and Keston Bog.

Species	Habitat
<i>Atrichum undulatum</i>	Keston Bog
<i>Aulacomnium palustre</i>	On ground
<i>Brachythecium rutabuium</i>	On beech tree
<i>Bryum capillare</i>	Heathland (alien sp.)
<i>Campylopus introflexus</i>	Heathland
<i>Campylopus pyriformis</i>	Heathland
<i>Ceratodon purpureus</i>	Along gulley in shaded acid grassland
<i>Dicranella heteromalia</i>	On beech tree
<i>Dieranoweisia cirrata</i>	On beech tree
<i>Frullania dilatata</i>	Fire site on heathland
<i>Funaria hygrometrica</i>	On beech tree
<i>Hypnum cupressiforme</i>	Along gulley in shaded acid grassland
<i>Hypnum jutlandicum</i>	On beech tree
<i>Hypnum resupinatum</i>	On ground
<i>Kindbergia praelonga</i>	Along gulley in shaded acid grassland
<i>Lepidozia reptans</i>	
<i>Lophocolea bidentata</i>	On ground
<i>Lophocolea heterophylla</i>	On beech tree
<i>Metzgeria furcata</i>	
<i>Orthodontium lineare</i>	On beech tree
<i>Orthotrichum affine</i>	Keston Bog
<i>Pellia neesiana</i>	Heathland
<i>Pleurozium schreberi</i>	On fallen tree root plate
<i>Pogonatum aloides</i>	
<i>Polytrichastrum formosum</i>	Keston Bog
<i>Polytrichum commune</i> var. <i>commune</i>	Acid grassland, heathland
<i>Polytrichum juniperinum</i>	Acid grassland
<i>Pseudoscleropodium purum</i>	Along gulley in shaded acid grassland
<i>Pseudotaxiphyllum elegans</i>	On beech tree
<i>Rhynchostegium confertum</i>	Acid grassland
<i>Rhytidiadelphus squarrosus</i>	Keston Bog
<i>Sphagnum angustifolium</i>	Keston Bog
<i>Sphagnum capillifolium</i> ssp. <i>rubellum</i>	Keston Bog
<i>Sphagnum cuspidatum</i>	Keston Bog
<i>Sphagnum fallax</i>	Keston Bog
<i>Sphagnum inundatum</i>	Keston Bog
<i>Sphagnum magellanicum</i>	Keston Bog
<i>Sphagnum palustre</i>	Keston Bog
<i>Straminergon stramineum</i> *	Keston Bog: in <i>Sphagnum</i>
<i>Syntrichia laevipila</i>	On beech tree

Determined by Dr Fred Rumsey (Natural History Museum)

* Determined by Jan Hendey 2011

Appendix IV

Lichen of Hayes Lichen Heath (TQ412650) in 2010.

Baeomyces rufus

Cetraria aculeata

Cladonia cervicornis subsp. *cervicornis*

Cladonia cervicornis subsp. *verticillata*

Cladonia chlorophaea sensu lato

Cladonia coniocraea

Cladonia diverse

Cladonia fimbriata

Cladonia floerkeana

Cladonia furcata

Cladonia glauca

Cladonia macilenta

Cladonia portentosa

Cladonia pyxidata

Cladonia ramulosa

Hypogymnia physodes

Trapeliopsis granuloma

Determined by I. Blatchley; nomenclature follows Smith (2009).