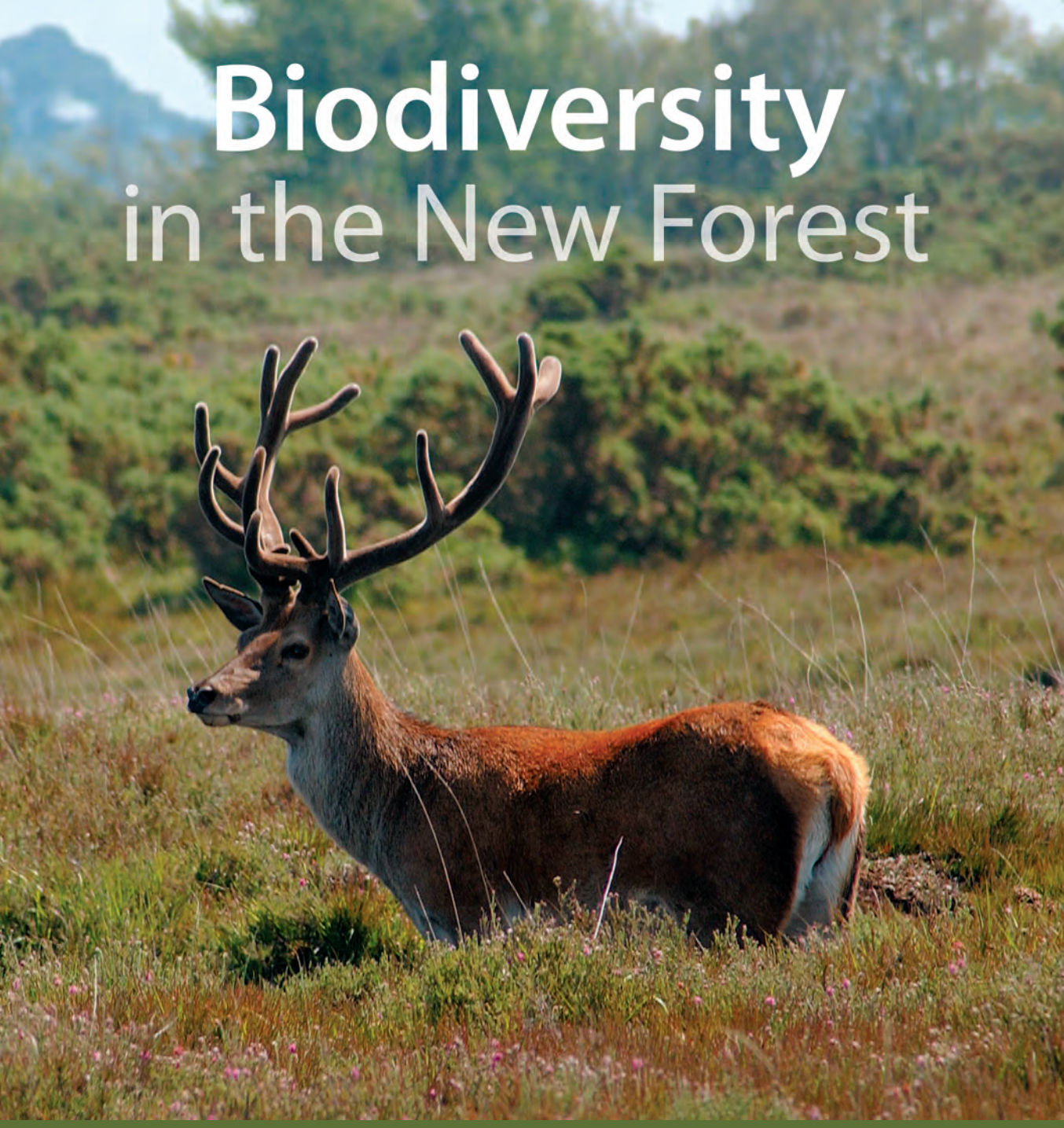
Biodiversity in the New Forest



Edited by Adrian C. Newton

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Dedicated to the memory of
Muriel Eliza Newton (1929–2009),
who loved the New Forest,
especially the donkeys.

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Back cover: Wood Crates (Adrian Newton)

The maps in this book are for illustrative purposes only, and do not represent the legal definition of National Park boundaries or any other feature

Contents

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8 Vascular plants

Martin Rand and Clive Chatters

Introduction

The New Forest is nationally and internationally recognised for its rich wildlife, which is largely dependent on a land management regime that has all but disappeared from lowland Northern Europe. Vascular plants (flowering plants, conifers, ferns and their relatives) play an important part in this diversity, both as constituents and by underpinning much of the other life of the area.

In this chapter we consider what geographical and environmental factors make the Forest flora significant, before going on to examine the history and current state of our knowledge. Finally, at a time when the future management of the Forest is under particular scrutiny, we present a couple of anecdotes that we believe provide important lessons for how we view the Forest and what should be done with it.

Which New Forest?

First we must explain what we mean by the New Forest. To many visitors it is the unenclosed land and to a lesser extent the silvicultural Inclosures of the Crown lands. These are the areas over which they are generally free to roam. However, this ignores the coast and the large area of enclosed land within the Forest curtilage, both of which are essential to the Forest as a working landscape and contain a significant part of its diversity.

At the other extreme we have the modern New Forest administrative district, which has the advantage of including a part of the Avon Valley grasslands and all of the coast and enclosed lands. But it is a poor definer of the biogeographical entity that we would recognise as the 'true Forest', whether we take an inclusive or a narrow view. Large parts of the lower Avon are lost to neighbouring authorities, but it extends deep into the Wessex chalklands of Cranborne Chase.

When a firm defining boundary has been needed for reference, it has traditionally been the Perambulation of the Forest, defining the extent of land over which Forest Law operated. This boundary shifted in only minor ways between 1279 and 1964, at which time extensive areas of common land on its western and north-eastern boundaries were brought in. Yet it excluded significant stretches of the coastline and biologically important blocks of enclosed land.

Nowadays the most pertinent Forest, since it will be treated as a unit for planning and many land management purposes, is the National Park. Although it may lack some areas that the wildlife conservationist

Figure 33
The New Forest National Park boundary (dark line), with the area of the Perambulation shaded in grey. (Redrawn from maps provided by the New Forest Park Authority, © Crown Copyright / all rights reserved.)

regrets, it includes the whole of the Solent coast and the enclosed lands behind, takes in a sweep of enclosed Ancient Countryside along the northern border, and makes small incursions into the Avon Valley flood plain (Figure 33). This is the New Forest that we refer to in the rest of this chapter. It encompasses about 57,000 ha. Of this, 64%, some 36,800 ha, are known to be high quality semi-natural habitats, of which over 32,100 ha are recognised as having national or international importance for wildlife.

What makes the New Forest flora significant?

The New Forest has been regarded with interest and affection by British field botanists for the past 150 years, and many visit it each year from across the country. The overall biological interest of the area has been recognised both nationally (through designation of over half its extent as a Site of Special Scientific Interest or SSSI) and internationally (as a Special Area of Conservation, or SAC, under the EU Habitats Directive).

It is instructive to look at the ways in which the Forest contributes to vascular plant diversity nationally and internationally. Consider, for instance, the number of taxa found on the British Red Data List (Cheffings and Farrell 2005). This gives a total of 73 taxa, excluding those that have been transient. If one adds species that are not on the Red List, but are rare or scarce in Britain, then this increases to 115. ('Rare or scarce' is defined as occurring in fewer than 100 of the 10 km × 10 km Ordnance Survey grid squares; the total number of such squares mapped for the United Kingdom excluding Northern Ireland is roughly 2,850). For a full list of these taxa, see Appendix 1.

At the national level this is not a bad total, given the relatively impoverished state of our native flora following the most recent ice age. Yet there are a couple of interesting features of this Red List set. First is the number of species for which the Forest is noted which do not appear on the list. One factor here is that the Forest provides a lowland southern outpost for species that have strong populations and occupy large areas elsewhere in the country. We shall return to this shortly. However it should also be recognised that there are cases where the New Forest is a significant (and in at least one case, the only) factor in keeping plants off the Red List. The International Union for the Conservation of Nature (IUCN) defines Red List criteria primarily in terms of population size, Extent of Occurrence (how broad a geographical area the species occurs in) and Area of Occupancy (how much territory it maintains within that extent). The Forest acts as a bulwark against decline in each or all of these measures in one instance or another.

Also of note is the number of Red List taxa that would not be considered quintessentially Forest plants. These include many coastal species and some species of arable land. It may be argued that inclusion of these is an arbitrary effect of employing the National Park boundaries. However there is no doubt that the Solent coast and its hinterland provide important national refugia for sedimentary coastline plants and for farmland denizens of neutral to acidic soils; the reasons for this are intimately bound up with the Forest's history and present management. The grazing of shorelines is one of its most visible manifestations. These habitats are amongst the most vulnerable in the area, from changes in land management practices in one case and from recreational pressures in the other.

The Red List encompasses many levels of threat, and many valued New Forest plants fall into the category 'Least Concern'. A more extreme and interesting question to ask is: if the New Forest were to vanish overnight, what taxa would suffer a worsening of conservation status at the national level and beyond? We have approached this question rather subjectively, and the analysis could be strengthened by rigorously reapplying the IUCN criteria to this mercifully hypothetical situation. Our estimates are that 30 taxa would be affected; interestingly, only 13 of these are current Red List species. See Appendix 2 for a listing.

Of these 30, 10 or 11 taxa are of international significance (that is, they would rate Red Listing or legal protection beyond our shores, and the destruction of the New Forest would have a noticeable effect on their populations). They include a single British endemic species (the eyebright *Euphrasia anglica*) and two apparently endemic hybrids (the New Forest water-crowfoot *Ranunculus* × *novae-forestae* and the horsetail *Equisetum* × *bowmanii*), largely confined to the Forest.

At an international level, this is not a paltry list but it does not rate among the most notable areas for plant diversity within Europe. To take a couple of French examples, it compares well with the protected areas of Franche-Comté in Eastern France, with an extent roughly six times that of the Forest, and holding roughly twice the number of statutorily protected and Red Listed plants (data from Ferrez and Prost 2001). On the other hand the département of Pyrenées-Orientales, a French plant diversity hotspot with a flora of 3,653 native and naturalised taxa, has over 700 taxa protected above the local departmental level (Tela Botanica 2008). The authors estimate that the Albères massif and adjoining coast, with an area roughly two-thirds that of the New Forest, supports about a quarter of these taxa, and of these some 15–20%, or around 30, would have a similar significance beyond the French borders. This analysis could be improved by more detailed examination of the French Red Data Books, of which only the first volume is published so far (see Olivier *et al.* 1995), but the area sustains 23 of the most vulnerable taxa. This is a meaningful comparison with our doomsday criterion, since the French Red List is weighted towards endemics, near-endemics and other taxa for which France holds a significant part of the global population, whereas the British list is much more closely focused on local national status.

We should not be too surprised at these figures, as there are few geographically isolating factors that have operated on the New Forest in the post-glacial

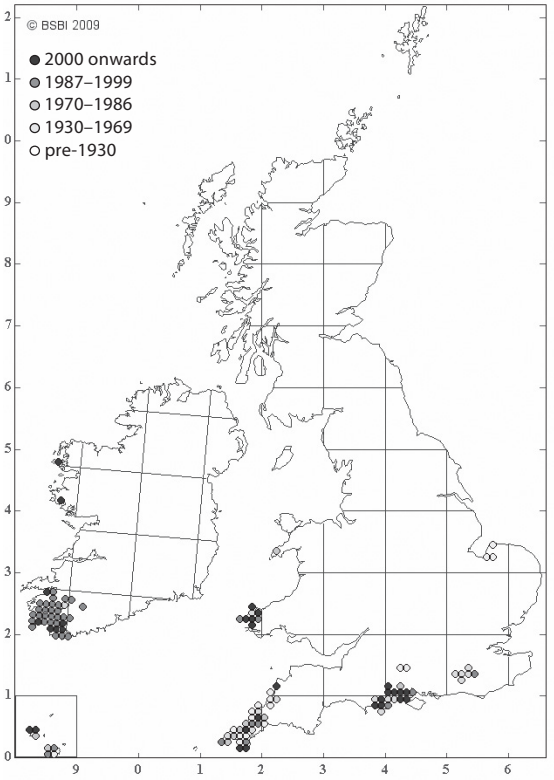

Figure 34
Distribution of yellow centaury *Cicendia filiformis*.

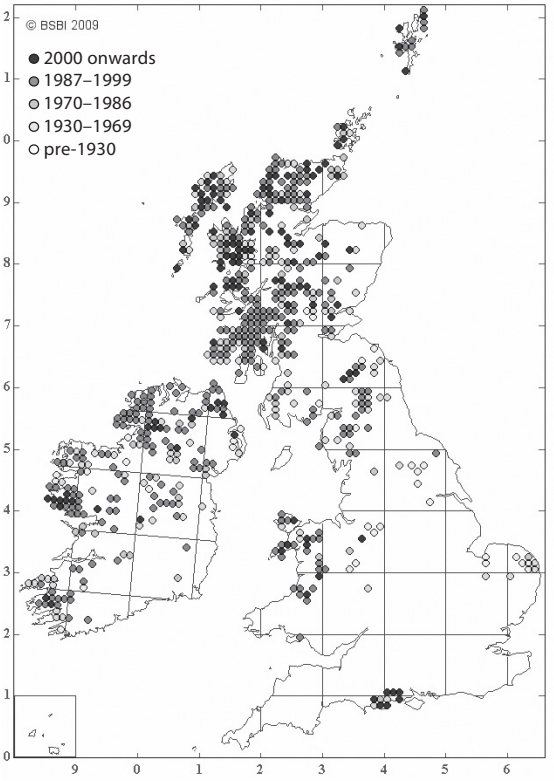

Figure 35
Distribution of bog sedge *Carex limosa* in the UK.

geological past, so the drivers for endemism and specialised floras have not been present. If we are to define the importance of the New Forest flora on the national or international stage, we must go beyond a simple head-counting exercise.

It has often been noted that the New Forest harbours many species towards the edge of their geographical range. Appendix 3 gives a list of those with 'Western' and 'Northern' affinities. Most famous are the 'Atlantic' or 'Oceanic' species, the former being intolerant of low winter temperatures and the latter of prolonged drought (see, for instance, Dahl (1998) and, for 'Atlantic' ferns, Page (2006)). A classic example of a Mediterranean–Atlantic plant is yellow centaury *Cicendia filiformis*. Its past and present British distribution is shown in Figure 34, where darker spots represent records in recent decades and progressively lighter spots show earlier distribution. Oceanic species are more prominent among the lower plants, but hay-scented buckler-fern *Dryopteris aemula* is one example only recorded on the Forest in quite recent times.

The Forest is less often noted as an outpost for Montane and Boreal species. Because of the distribution of highlands in the British Isles we tend to think of these all as 'Northern' species, but the distinctions may be more subtle in an international context. For example, bog sedge *Carex limosa* is a classic Boreal–Montane species that has always had a very restricted distribution in lowland Britain (Figure 35),

Figure 36
Distribution of bog sedge *Carex limosa* in France.

where temperature is also likely to play a part in determining its distribution. That this is related to environmental conditions rather than merely geographical latitude is illustrated by its 'mirror' distribution in France, where the cool, peat-forming environment that it requires is found predominantly in the mountains of the centre and east, with a few lowland outliers (Figure 36).

One must be careful when considering such species not to rely solely on present-day distributions. Bog orchid *Hammarbya paludosa*, if one considers only its present-day distribution, might be accounted a Boreal–Montane species with rather strict Boreal affinities

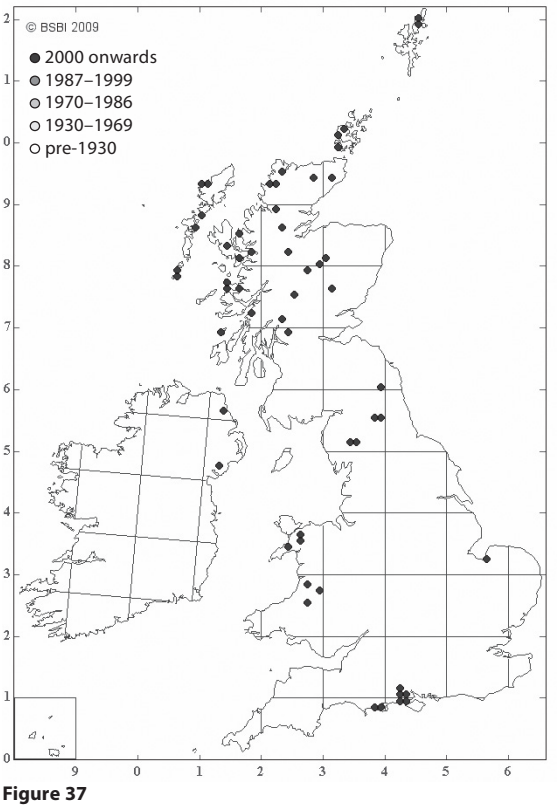

Figure 37
Current distribution of bog orchid *Hammarbya paludosa* in the UK.

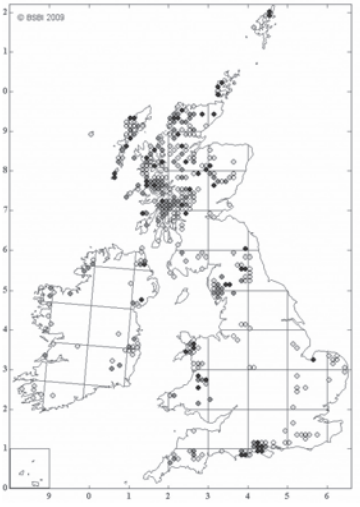

Figure 38
Historical distribution of bog orchid *Hammarbya paludosa* in the UK.

- 2000 onwards
- 1987–1999
- 1970–1986
- 1930–1969
- pre-1930

(Figure 37). However, the historical map shows that lowland Britain in the recent past provided plenty of niches for the bog orchid; the same can be demonstrated for other Boreal plants with broader tolerances. The losses are overwhelmingly due to habitat destruction and degradation, certainly not to recent climate change, although the improving climate of the past few centuries may have been a minor factor (Figure 38).

This leads us to consider a new viewpoint on the New Forest: a refuge for plants that are in decline in lowland Britain. A visual assessment from *Atlas 2000* (Preston *et al*. 2002) suggests that the Forest supports over 100 taxa that are now declining (see Appendix 4). The rates of decline are very wide-ranging, but the species represented are overwhelmingly characteristic of 'low-input' land management regimes. More will be said on this in the next section, but some examples follow.

At one end of the scale of decline is pennyroyal *Mentha pulegium*, which was once widespread through lowland Britain, but has almost disappeared as a native plant from the wider countryside, along with its preferred habitat of tightly grazed commons and village greens (Figure 39). At the other end of the scale, marsh pennywort *Hydrocotyle vulgaris* is undergoing a gradual attrition in midland and eastern Britain at the edges of its main range, as shown by the lighter dots for lost sites in those areas (Figure 40). An outstanding example is field gentian *Gentianella campestris*. This has been thought of as a predominantly northern and generally upland plant in Britain, and its present distribution only serves to emphasise that more strongly (Figure 41). However the historic map shows just how widespread it once was in the lowlands; even in strongholds such as Cumbria, which probably held the best populations south of the Scottish Border, it has lost half of its area of occupation (Halliday 1997) (Figure 42).

Figure 39
Distribution of pennyroyal *Mentha pulegium* in the UK.

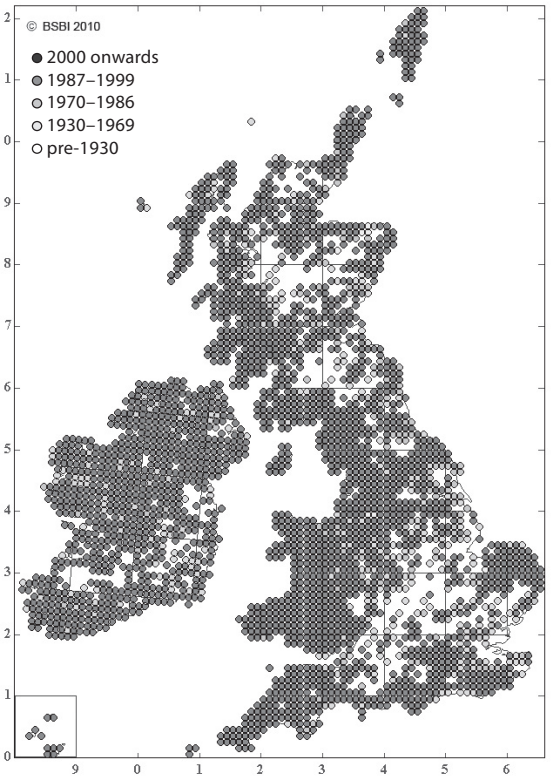

Figure 40
Distribution of marsh pennywort *Hydrocotyle vulgaris* in the UK.

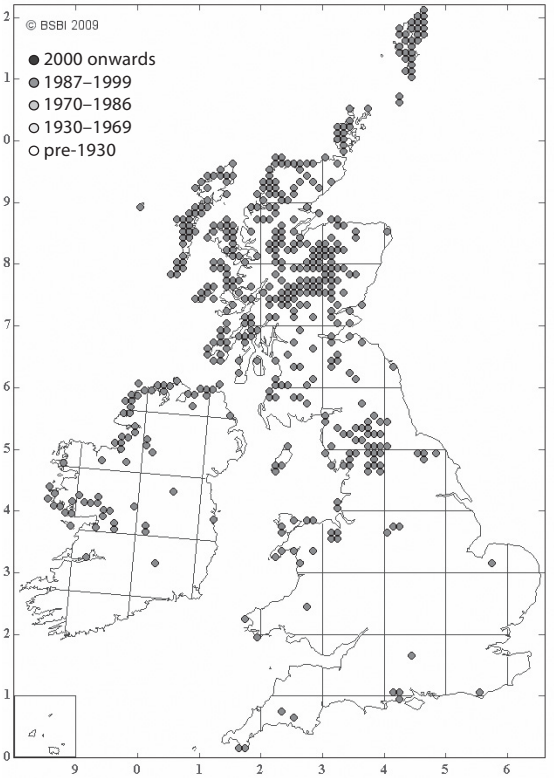

Figure 41
Distribution of field gentian *Gentianella campestris* in the UK.

Surveys carried out across the country by Plantlife International, and in Hampshire by the BSBI, New Forest Study Group and Hampshire Flora Group suggest that the New Forest is now a stronghold for this species in southern Britain, with populations typically one or two orders of magnitude greater than those found elsewhere. Yet this conspicuous and attractive species went largely unremarked here until very recently, and was not noted by the earlier workers on the flora at all.

Environmental characteristics

Appendix 1 gives British Red List species found in the Forest. Appendix 2 details the nationally and regionally significant species (those whose loss from the Forest would have an impact on the status of the plant nationally or internationally), and Appendix 4 gives those undergoing lowland decline; we refer here to these latter two lists collectively as the 'New Forest Notables'.

Each of these lists has been annotated with the Broad Habitat denotations of the habitats where it is known to occur, drawn from Hill *et al.* (2004) and supplemented by the authors' personal knowledge. Ellenberg indicator values for two of the most critical environmental demands (light and nitrogen) have also been added from the same source, where the scoring system is explained. A further analysis based on the growth height values and life forms given there would be interesting, and might be expected to reinforce the importance of grazing pressures in the Forest, but has not been carried out for the present chapter.

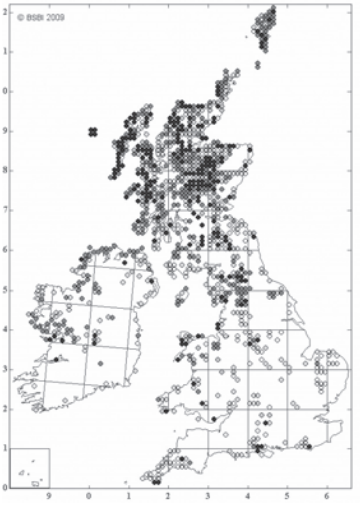

Figure 42
Historical distribution of field gentian *Gentianella campestris* in the UK.

2000 onwards
1987–1999
1970–1986
1930–1969
pre-1930

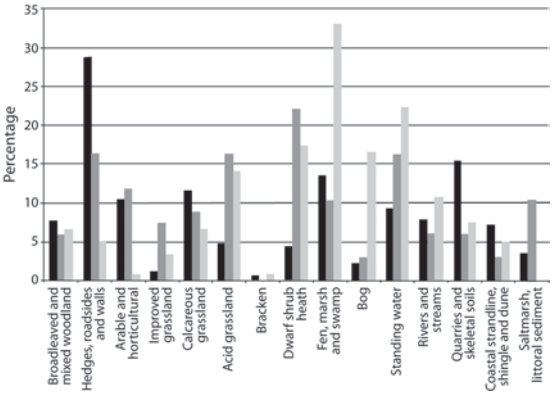

Figure 43
The habitat preferences of the Red List plants and Notables associated with the New Forest.

Figure 43 summarises the habitat preferences of the Red List plants and Notables against those of all British taxa. (As species can appear in more than one habitat, the total representation of one of these sets can exceed 100% in total). It is not surprising that acid grassland, heath and bog plants figure so prominently. However all mire and freshwater habitats are heavily represented. The low-intensity land use benefits the entire catchment and drainage; systems, rather than individual habitats within them, deserve to be the subject of conservation. There is nothing remarkable about the representation of woodland species, but coastal and arable plants are notably well-featured, especially on the Red List. Although the representation of calcareous grassland species is lower than the national lists, some people may still be surprised to see how high it is. Calcareous mire species also make up a significant proportion of those appearing under 'Fen, marsh and swamp'. The Tertiary geology of the Forest includes marly limestones, and such terrain has been much prone to agricultural improvements elsewhere in southern England in the past. But the presence of calcicoles also has to do with human activity, as we discuss in a later section.

Figure 44 shows the characterisation of our three groups of species in terms of nitrogen demand. While the national group shows a fairly even spread of taxa across the spectrum, recent works such as Braithwaite *et al.* (2006) give us an inkling of the degree to which species with high nitrogen requirements are in the ascendancy in present-day Britain. Local assessments of cover and biomass would, we are convinced, provide a picture that is even more stark. The New Forest Notables, however, show a very strong bias to low nitrogen demand. The subsidiary bump in the middle of the graph can mostly be attributed to coastal species and those of the middle and lower river systems.

Figure 45 shows a profile for light demand. All groups show a bias towards light-loving plants; as the more open and illuminated habitats tend to be more species-rich in temperate regions, this is to be expected. What is striking is the very small proportion of our Notables set that is tolerant of the higher levels of shading, and the very high proportion demanding high illumination.

These illustrations suggest why the New Forest, which must have been a somewhat special place for our flora for centuries, has become dramatically more so over the last two hundred years. Not only have the habitats supporting its most distinctive members been largely eradicated over the lowlands by building, enclosure, drainage, ploughing and fertilisation; such fragmented areas as remain have often degraded through lack of grazing, enrichment from contingent land and waterways, and the many other exigencies to which small areas of conservation value are continually exposed. In the 1810s, at the time when the Old Series Ordnance Survey maps for Hampshire were being published, a botanically minded curate could have walked the seven miles of Tertiary strata from Otterbourne to Southampton almost entirely on unenclosed land, largely grazed in common, with only the mildest of detours. The only remnant of this that survives, albeit in a much modified state and an urban setting, is Southampton Common itself.

In summary, the New Forest holds an important group of higher plants of Atlantic and Mediterranean–Atlantic distribution. These are distribution patterns for which Britain plays a significant role in biodiversity

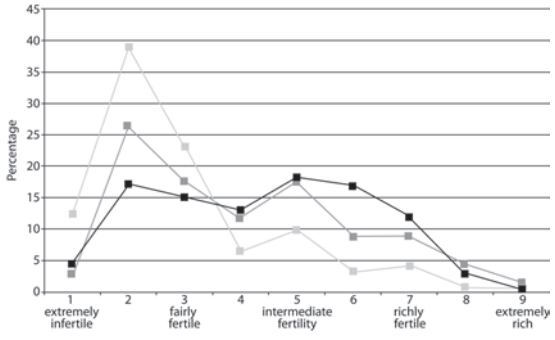

Figure 44
Nitrogen requirement of Red List plants and Notables associated with the New Forest.

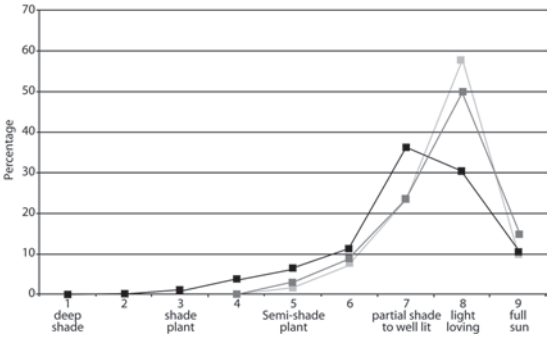

Figure 45
Light requirement of Red List plants and Notables associated with the New Forest.

conservation. It also serves as an outpost for Boreal and Boreal–Montane species, in which role it stands as a "relic of a relic" with respect to the former more widespread occurrence of these plants in the lowlands. It is a repository of the declining plants of stressed environments: low in nutrient input, heavily grazed, sporadically burnt, highly illuminated, and low in biomass, but rich in species diversity. It is not just a focus of the always rare, but is a last resort of the formerly common. In this role it assumes importance within the whole of northern Europe, where similar low-input or slow-input pastoral regimes have vanished just as in Britain; and where many species such as small fleabane *Pulicaria vulgaris*, even where they had a wider distribution and once occurred more abundantly on the Continent, are now close to terminal decline.

Our knowledge of the flora

It is not easy to undertake archival research on the Forest's flora and vegetation; much of the knowledge came late. John Goodyer, who held a steward's post at Holbury, supplied a few records in the 17th century, and there were more in Camden's *Britannia* in 1695. Eighteenth-century records came from the herbarium of Dean Garnier and the *Hampshire Repository* of 1799, and the scenic qualities of the Forest were clearly being appreciated by 1791 when Gilpin published his *Remarks on Forest Scenery*; but records remained sparse up to 1830. The 8th and last edition of Hooker and Arnott's *British Flora* in 1860 included just five localities that can be identified to the New Forest, and these include two of the most recent discoveries. By contrast, south-east Hampshire has nearly twice that number, and a single site in neighbouring Sussex (Amberley Wild Brooks) has almost as many. One can speculate that until the last great wave of enclosures, many now valued Forest species went unremarked in the published literature because they would have been of wide occurrence.

Much of the Forest can hardly have been easy of access in earlier centuries, and where early records can be localised at all, they tend to align with a couple of main thoroughfares. There will have been few livings able to sustain our wandering curate with an eye for nature; William Gilpin's Boldre was an obvious exception. The civil parish of Denny Lodge remains one of the least populated in all of England, upland regions included. The coming of the railway in 1847 made the Forest much more accessible from afar, its choice of route simultaneously damaging, and laying open to view, some of the finest lowland valley-mire systems on the Forest and in Europe. Papers on the plant life of the Forest began to appear in numbers in the national journals from the 1850s. Wise's *The New Forest: its History and Scenery*, first published in 1863, had a significant natural history content for the general reader. It is striking how many of the records from the latter half of the 19th century cluster around the railway stations and their closest neighbouring villages.

The 19th century efforts to record the Forest flora in detail, starting with Bromfield, supported by meticulous observers such as the Groves brothers, Trimen and Dyer, and occasionally pronounced on by the great and good of the national botanical scene, culminated in the first edition of Frederick Townsend's *Flora of Hampshire* in 1884. Here for the first time the occurrence, and a view on the abundance, of many New Forest species was documented in an accessible document. Townsend also took an interest in many critical taxa. His account of the Hampshire *Euphrasia* (eyebright) species, which appeared in the 1904 edition of the *Flora*, still makes useful reading.

Marshall was a major contributor at the end of the 19th century, although his contribution is somewhat obscured by being largely sunk within this second edition of the *Flora*. Work by various people, including members of the Hampshire Field Club, continued through the early part of the 20th century, and Rayner's *Supplement* to the *Flora* appeared in 1930. There are archives remaining to be mined from this period; but in general, while knowledge of the Forest was deepening, there was no concerted move towards a comprehensive, systematic, detailed record of the Forest's flora and vegetation.

The initiative for this had to wait until the 1950s, when the idea of a new *Flora of Hampshire* was first mooted. The initial endeavours of Alick Westrup were taken up by others, most notably by Paul Bowman who became one of the three authors of the new *Flora of Hampshire* that eventually appeared in 1996. It is hard to overstate his contribution to our current knowledge of the distribution of New Forest plants; for the more notable taxa, behind every dot on a tetrad map or terse account in the *Flora* there lie precise location details, dates spanning over 40 years, and a brief description of the habitat and population size, meticulously written up in longhand on foolscap sheets. It would be unfair not to pay tribute also to the cohort of botanists, amateur and professional, who supported him in this task either by joining the *Flora* recording and other, national, mapping projects sponsored by the BSBI, or by conducting surveys for individual species. Many of these workers are still, blessedly, alive and active.

Work on the Forest flora since that time has concentrated on computerising the records, with a view to making them more accessible and more amenable to analysis, and on recording individual populations in detail. The advent of hand-held GPS has made it easier to pinpoint populations, allowing better monitoring over time.

Table 18 gives the earliest recorded dates of several Forest notables. Given our preceding remarks it will not be surprising that some had to wait until the mid-19th century to be discovered; but the rate at which further species, by no means all critical or inconspicuous, continued to be found in the next century is striking. A few of these, such as coral-necklace *Illecebrum verticillatum*, are now thought to be recent introductions (Pearman 2008), but this is extremely improbable for most.

Table 18
The earliest recorded dates of selected New Forest notable plant species.

Species	Earliest recorded date
Narrow-leaved lungwort *Pulmonaria longifolia*	1620
Brown beak-sedge *Rhynchospora fusca*	1713
Marsh gentian *Gentiana pneumonanthe*	1836
Marsh clubmoss *Lycopodiella inundata*	1840s
Hampshire-purslane *Ludwigia palustris*	1843
Wild gladiolus *Gladiolus illyricus*	1856
Angular Solomon's-seal *Polygonatum odoratum*	1892
Slender marsh-bedstraw *Galium constrictum*	1924
Small adder's-tongue *Ophioglossum azoricum*	1984
Hay-scented buckler-fern *Dryopteris aemula*	1987

Even more striking is the small number of sites from which many plants were known. For the Forest's most emblematic plant, wild gladiolus *Gladiolus illyricus*, seven sites had been recorded by 1900. From the more readily available documents, we have been unable to find evidence that this had increased to more than nine sites by 1950. It is hard to escape the conclusion that most botanists were content to follow well-trodden paths. Yet the efforts of a very small number of people were able to increase this total to 60 sites by 2000; the overwhelming majority of these were added in the 1950s and 1960s. Bastard balm *Melittis melissophyllum* is an equally showy plant of woodland; in 1950 its total of two known sites in 1900 had been doubled to four, yet by 2000 this had been almost doubled again despite the fact that the plant was almost certainly going into decline by then.

This little history should serve to remind us that if we want to make inferences about 'ideal' conservation practice for New Forest plants based on historical evidence, we have amazingly little to go on. We have a good understanding of the larger and longer-lived organisms – trees – and of the general vegetation communities; these are well-summarised in Tubbs (1968) and Tubbs (2001). We also understand trends in the more distant past through peat bog sampling. But for the majority of individual species, there is no detailed evidence base for the effects of human activity in the last few centuries. Nor has there been much experimental work, unless one counts the 'negative experiments' of the Forestry Commission in the 1960s and 1970s in draining bogs and destroying ancient woodland.

This is not to say that conservation activists should be paralysed by indecision. It is quite well understood how many plant communities will respond to positive intervention when their habitats have become degraded, and this has been largely borne out by a number of bold initiatives taken in the last few years. But it should serve as a warning against attempts to 'micro-manage' for the benefit of this or that individual species, when those attempts are based largely on supposition.

To summarise our current knowledge: barring a few gaps and excepting some critical groups, we have a very good idea now of where our notable Forest species are to be found, and how they fit into a national picture. We have a reasonable picture of population sizes for some species, with some idea of how they have changed or fluctuated over the past few decades. Something is known of the autecology of a few species in the Forest setting, yet there are many unanswered questions surrounding even such a flagship conservation target as wild gladiolus.

Introductions and exotic plants

Without doubt the most important introductions to the Forest, and the most drastic in their effect, have been of planted trees. Although early plantations were generally of oak *Quercus* spp., conifers have played an increasingly important part until in recent times they predominate. Planting of Scots pine *Pinus sylvestris* appears to have started, at least on any significant scale, as late as the 1820s; the Deer Removal Act of 1851 facilitated the more widespread planting of conifers. This subjected tracts of heathland to enclosure, and to aggressive natural invasion, which has remained a conservation challenge ever since. Scots pine is widespread as a native outside Britain and the provenance of early plantings is obscure, but from the 1920s the Forestry Commission was provenance testing and running selective breeding programmes on a number of species, Scots pine included.

Other coniferous species gained in importance, pre-eminently black pine *Pinus nigra* of which the Corsican pine *P. nigra* ssp. *laricio*, with a better growth form for straight clean timber, is favoured. Weymouth pine *Pinus strobus* was flirted with in the 19th century (along with other pines) but found to suffer from blister rust; its collapsing remains are still visible in a few places. Douglas fir *Pseudotsuga menziesii*, larches *Larix decidua*, *L. kaempferi* and their hybrid *L.* × *marschlinsii*, Norway spruce *Picea abies* and western hemlock *Tsuga heterophylla* all have commercially important stands. This last can show aggressive regeneration inside plantations, but not outside.

Further enclosure, and coniferisation of existing Inclosures, continued until the mid-20th century, and was finally formally halted in 1971. Since then, although replanting with conifers continues in some areas, there has been thinning from mixed stands, and more recently a programme to restore the Verderer's Inclosures to the heath from which they were so recently carved. This has had some spectacular successes in re-establishing heath and mire, for instance at Longdown and Fawley Inclosure.

The forestry practices attendant on new plantations and planting up of ancient woodland have undoubtedly done enormous damage. Most obviously they have swallowed up tracts of the vegetation that gives the New Forest its distinctiveness. Biologically

this is probably less significant, though, than the management practices and laissez-faire attitude to grazing within the Inclosures during the second half of the 20th century, which led to catastrophic declines in many species groups; invertebrates were particularly affected (see Chapter 7) but flowering plants also suffered. Ferns may be one of the few vascular plant groups that have benefited from plantation, and even there the picture is not straightforward.

On the other hand, some of the older plantings have now become valued landscape features, and no doubt a public outcry would arise if they were to be done away with completely. They have also brought in new communities of some organisms, notably fungi; see, for instance, Ferris *et al.* (2000) and Chapter 10.

Invasive ericaceous (heath) species have been less of a problem in the New Forest than in some other parts of Britain, but rhododendron *Rhododendron ponticum* is widespread and has been the target of clearance programmes. Unfortunately the enclosed lands within the Forest provide an ever-present reservoir for recolonisation. Anyone doubting the power of this species to obliterate native communities should view the enclosed private woodlands within the National Park around Redlynch, along the northern border with Wiltshire. The shrubby species *Gaultheria shallon* has so far been more of a problem on the Avon Valley heathlands beyond the Forest boundaries. There are several other species that have been introduced onto the Forest, including American cranberry *Vaccinium macrocarpon*, blueberry *Vaccinium corymbosum* and Dorset heath *Erica ciliaris* (which might be native as well as introduced). These all have very small populations and are objects of curiosity to botanists rather than concern.

The Forest's ponds and waterways contain some of its most distinctive and prized plant species and communities, yet these have to contend with a veritable botanical garden of deliberately or inadvertently introduced aquatics. The species of most conservation concern at present is New Zealand pigmyweed *Crassula helmsii*. This aquarist's oxygenating plant appears to have arrived in the Forest in the mid-1970s, since when it has spread to all parts. Figure 46 shows its known distribution across all of South Hampshire before 1987, and at the present day. Although its rate of spread is impressive, what is even more remarkable is that not a single site has been lost since the early records – a highly unusual situation for newly invasive species.

Primarily a plant of ponds and pond margins, its habitat tolerances are in fact quite broad; it can be dredged in a vegetative state from deeper water at Hatchet Pond, yet infests lightly poached damp grassland at North Gorley. At worst, it forms a smothering blanket that inhibits the growth of other plants, including many that are Forest notables. The threat it presents has been questioned; Lockton (BSBI 2007) says 'No evidence has yet emerged for it outcompeting rare native plants'. But whatever the eventual outcome may be on the broader landscape, evidence for its local effects in the Forest is not hard to

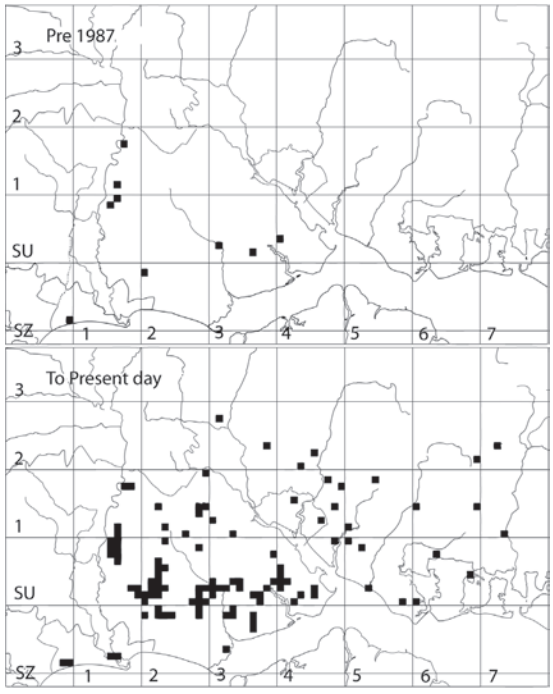

Figure 46
Distribution of New Zealand pigmyweed *Crassula helmsii* in the New Forest and South Hampshire.

find. For instance, the pond at Hilltop, near Beaulieu, became infested in 1983. Hampshire-purslane *Ludwigia palustris* ('fairly plentiful' in 1983) was last recorded there in 1986; slender marsh-bedstraw *Galium constrictum* (a 'dense patch' in 1983) in 1987. These are both nationally rare plants. Up until the present New Zealand pigmyweed continues to form a dense sward across the whole pond and its environs, and neither of the other species has re-established itself.

Since no effective method of control has been found where the solution is not more damaging than the problem, this is a phenomenon that will have to play itself out. The author's own informal observations suggest that of the more notable Forest species, shoreweed *Littorella uniflora* and lesser marshwort *Apium inundatum* seem best able to co-exist with it, while pillwort *Pilularia globulifera* and slender marsh-bedstraw seem least able to compete. This is a topic that deserves more rigorous study.

Similar concerns have been expressed nationally in the past over the waterweed species *Elodea canadensis* and *E. nuttallii*. The first of these has never been widespread in the Forest, seeming to prefer sites linked to larger and more eutrophic waterways in Hampshire. *E. nuttallii* does have quite a broad Forest distribution, but shows no rapid spread and appears on the whole to have reached a state of equilibrium.

The water-primrose species *Ludwigia grandiflora* and *L. peplis*, which are immensely invasive on the Continent and have spread rapidly northwards in our

neighbours in recent decades, have mercifully not made dramatic incursions into Britain to date. So far *L. grandiflora* has been recorded in a pond on enclosed land in the Forest, and at a couple of sites 3 km beyond the National Park boundary. They are very beautiful plants but will rapidly engulf a pond, and if they became commercially popular the risk of their being cast out into the wild would be high. The Environment Agency is taking steps to eradicate all populations in the wild and prevent the plants becoming available for sale, with the backing of DEFRA and the Royal Horticultural Society. Although these species are commonest on relatively eutrophic sites, their patent ability to colonise heathland watercourses in the Landes in south-west France should give us pause for thought.

Most of the other ornamental exotic species on the Forest, of which there are many, occupy relatively little ground and out-compete native plants either not at all, or on a very local scale. The conservationist objection to them is therefore largely aesthetic or ethical rather than scientific in basis. Given that the Forest is not a wilderness, do we nevertheless value it more for its wild qualities or as an extension of a suburban garden? Ponds and ditches to the south and west of Brockenhurst and Burley give the impression that a fanatic iris-fancier has been at work, as several carry stands of non-native *Iris*, involving at least three species. These grate on the sensibilities of most expert botanists, but the public at large would not even register them as exceptional; and as far as the author knows, no attempt has been made to eradicate them. Other plants of similar standing include the potentially invasive pickerel-weed *Pontederia cordata;* fringed water-lily *Nymphoides peltata* (native elsewhere in Britain); and coloured garden forms of water-lily that are usually named *Nymphaea marliacea*.

There are interesting 'grey areas' in the spectrum of introductions, some of which excite ambivalence, if not a touch of gentle hypocrisy, in the botanists who observe them; the authors make no claim to be free of such. Of several plantings of exotic carnivorous plants onto Forest mires, only one has been successful (from the point of view of the plant); the pitcher-plant *Sarracenia purpurea*, which is well established over quite a large tract of one bog. It would be hard to claim that it out-competes the native vegetation, but it has been accused of eating rare dragonflies. The author and Dr Richard Gornall spent a sunny afternoon in a profoundly unscientific exercise of tearing pitchers open to find what they contained. Most remains were digested to a point where they were unrecognisable, at least to non-entomologists. Those that could be identified consisted mostly of beetles and flies, the wasp beetle *Clytus arietis* being the most spectacular. No Odonata remains were found. Most botanists would probably deplore this introduction publicly, but most have also been down to admire it.

Many will also have visited the Setley colony of white forget-me-not *Plagiobothrys scouleri*, a North American species, and felt very little need to condemn it. This is perhaps because it is a delicate species that seems to fit in well with the native vegetation it inhabits, and so does not commit errors of conduct or taste. Pre-eminent in this group must be coral-necklace. While considered native in south-west Britain, it is thought of as a fairly recent arrival in the Forest (see Pearman 2008). It is now widespread and apparently still spreading, and has won an appreciative following as a Forest notable and 'honorary native'.

And so we come to 'cryptic introductions': that is, those species that have a native range nearby, that occur in situations where their status as long-standing natives is called into doubt, but whose arrival remains a matter of supposition. The former military camp between Pigbush and Beaulieu Road station introduced a lot of lime into the roadside soils and gave us at least one undoubted exotic plant, the mouse-ear hawkweed *Pilosella × floribunda*; but what are we to make of the calcicolous plants such as autumn gentian *Gentianella amarella* that also occur there? The three native sweet-briars (*Rosa rubiginosa*, *R. micrantha* and *R. agrestis*) are thought of primarily as chalk downland plants. They all occur on the Forest and may well be anciently native; yet it is remarkable how many of their sites relate to past disturbance and introduced lime in one form or another. They warn us not to be too doctrinaire in our thinking about 'aliens', and lead us on to a wider issue of Forest land use.

Cautionary tales

Figure 47 gives our assessment of the areas of the Forest that show particularly high vascular plant diversity. These are not, by and large, the least disturbed and most 'natural' areas. Figure 48 shows a further evaluation of these sites according to the degree of human disturbance and modification they have undergone. The 'yellowfield' sites are those where a significant part of the site has been influenced by direct human intervention, for example large-scale peat digging, the liming and reseeding of grassland, and sporadic conversion to arable. 'Brownfield' sites include large-scale gravel workings, marl-pit systems, aerodromes, encampments and bombing ranges. Large brownfield sites are easy to recognise. With more research, no doubt other 'green' sites could be turned 'yellow'. But in addition, many small loci of valued diversity are 'brown' (for example, car park margins and modified road embankments).

The diversity we refer to here is not an incursion of adventitious or 'weedy' species. These certainly crop up, and there are also curiosities such as the endemic downland early gentian *Gentianella anglica*, introduced to a wartime bombing range and still flourishing on its archipelago of dumped chalk. But it includes many flagship Forest species and first-rate habitat indicators. Examples are the endemic eyebright *Euphrasia anglica*, often at its most abundant on previously fertilised grass-heath and on grassland re-established over old military sites, and the Atlantic fern, small adder's-tongue *Ophioglossum azoricum*, found in grass-heath of fairly high base status, but pre-eminently around old marlpits and on World War 2 aerodromes. Many of the lime-

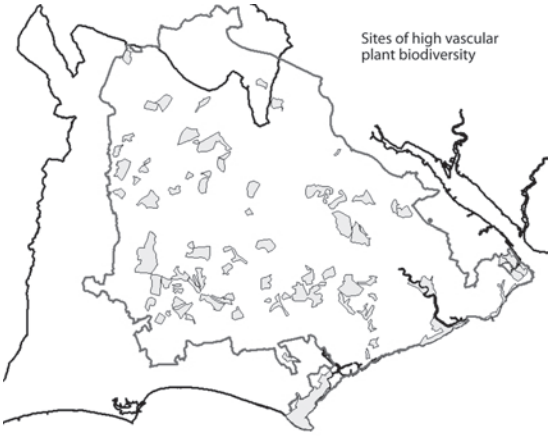

Figure 47
Areas of the New Forest with particularly high vascular plant diversity.

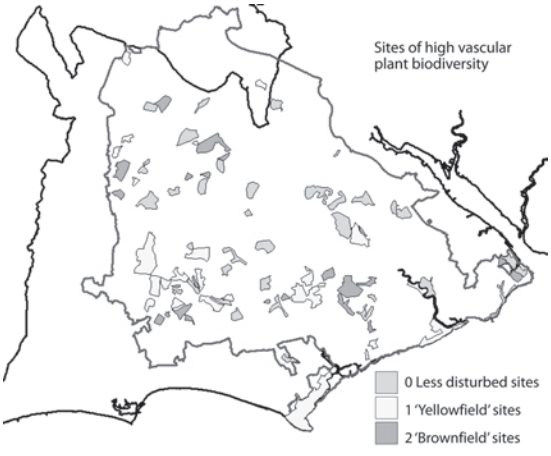

Figure 48
Areas of the New Forest with particularly high vascular plant diversity, according to the degree of human disturbance and modification they have undergone.

loving species and plants of open ground, which might otherwise have a restricted population in the Forest, occur abundantly in such places.

High species richness exists on these sites because of the past disturbance, not in spite of it. There is a difference from incursions such as modern forestry or mire drainage, which have been largely destructive of diversity. This is not to argue for a continued programme of airfield building over the Forest! However, this reminds us that the Forest is not a pristine wilderness, but has a long history of exploitation, which has served to enrich the environment at times as much as to degrade it. Its effects have not been malign because these activities have taken place on a local scale in a big, flourishing, biologically diverse setting. Time has acted not only to restore the initial damage but to exploit new niche opportunities created. This should be borne in mind when projects to 'restore' the landscape to some assumed pristine state are being considered.

Our final story concerns a single species. Figure 49 shows the New Forest distribution of small fleabane *Pulicaria vulgaris*, which represents almost all of its present-day occurrence in Britain. This annual species is betraying its scientific name by declining rapidly over most of its range in Europe. Our plants thus represent a major conservation opportunity and responsibility. The map shows all historical records and population sizes are not distinguished, but for most of the time an individual site will maintain scores or hundreds of plants (Figure 49).

Populations of small fleabane have been recorded at intervals of a few years over the last 20 years or so, and this effort has captured a succession of population explosions in the period, which are mapped on Figure 50. As one might expect for an annual plant, maintenance of populations and renewal of the seed

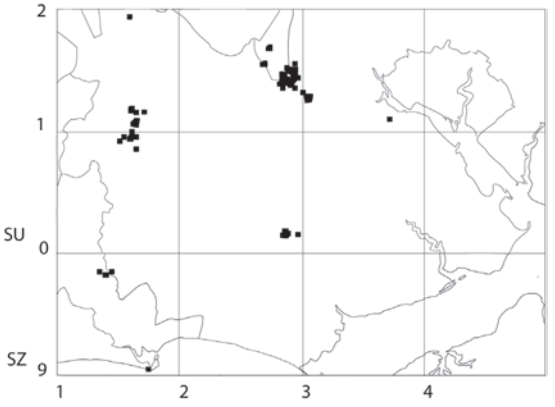

Figure 49
Distribution of small fleabane *Pulicaria vulgaris* in the New Forest.

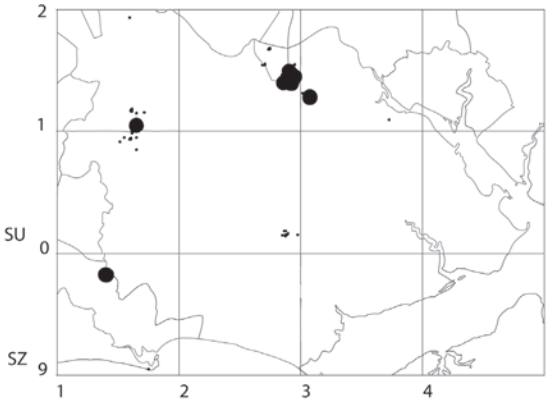

Figure 50
Major population surges of small fleabane *Pulicaria vulgaris* in the New Forest, 1990–2006.

bank depend on disturbance, and this has come in some unlooked-for ways.

For a number of years the biggest and best population occurred on a Forest trackway along which the neighbouring farmer, who also ran a haulage business, despatched his lorries to reach the nearby main road network. Since he has been prevented from following this reprehensible practice, the fleabane population has gone into a slow but steady decline.

However, this is as nothing compared to the commoner who put winter feed out on one of the National Trust commons, attracting a huge congregation of animals and creating a spectacular muddy morass. No doubt he had his knuckles rapped by the powers that be. But the effect was to bring up an estimated half a million plants of small fleabane the following year – probably more than anyone has seen anywhere else in recent decades. In contrast, a once famous site in the southern Forest was outside a commoner's cottage where old photographs show a happy assembly of geese and livestock churning up the muddy ground. Now the cottage is owned by non-commoning incomers, the scruffy patches have gone, and so has the fleabane, to be replaced by a smooth and untroubling greensward.

Conclusion

Although we like to celebrate our native wildlife – and so we should – most people now alive will have no conception of the huge impoverishment of the lowland landscape that has occurred over the past two centuries and still continues in recent decades, despite the attention now paid to conservation. The New Forest, even though it too has had its vicissitudes, stands not only as an extraordinary place in its own right, but also as a reminder of what used to be and might perhaps be again in the wider world. Conservation initiatives notwithstanding, it has achieved this status not by being a nature reserve but by its role as a living, working landscape with a diversity of use and more than a few conflicts of interest. It is sufficiently big and robust to sustain the occasional abuse, though when these reach a scale that only a government department can perpetrate the consequences can be dire enough. The best way to perpetuate its plant life, and much other biodiversity besides, is sympathetic and practical support for those people, practices and systems that have sustained it for so long.

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Appendix 1
New Forest Red List taxa (excluding extinct and impermanent).

Species	British status	Broad habitats 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	N	L
Anacamptis morio Green-winged orchid	NT						X	X														3	8
Anagallis minima Chaffweed	NT								X													3	8
Anthemis cotula Stinking chamomile	VU				X																	6	7
Baldellia ranunculoides Lesser water-plantain	NT													X	X							2	8
Blysmus compressus Flat-sedge	VU											X										3	8
Bromus secalinus Rye brome	VU				X																	4	6
Bupleurum tenuissimum Slender hare's-ear	VU			X			X															4	9
Carex divisa Divided sedge	VU						X															6	8
Chamaemelum nobile Chamomile	VU								X													5	8
Chenopodium bonus-henricus Good-King-Henry	VU			X																		8	8
Chenopodium murale Nettle-leaved goosefoot	VU				X																	7	8
Chrysanthemum segetum Corn marigold	VU				X																	5	7
Cicendia filiformis Yellow centaury	VU										X											2	9
Cuscuta epithymum Dodder	VU										X											2	7
Cynoglossum officinale Hound's-tongue	NT							X												X		6	8
Cyperus fuscus Brown galingale	VU													X								4	9
Cyperus longus Galingale	NT											X		X								5	8
Drosera anglica Great sundew	NT											X	X									1	8
Equisetum x bowmanii Bowman's horsetail	VU	X		X																		5	5
Eriophorum gracile Slender cottongrass	NT											X										2	8
Euphorbia exigua Dwarf spurge	NT				X																	5	6
Euphrasia anglica	EN										X						X					3	7
Euphrasia arctica subsp. *borealis*	DD						X					X										4	7
Euphrasia confusa	DD							X	X								X					2	8
Euphrasia micrantha	DD								X		X											2	7
Euphrasia tetraquetra	DD						X				X											3	8
Fallopia dumetorum Copse bindweed	VU	X		X																		7	6
Filago vulgaris Common cudweed	NT			X																		4	7
Galeopsis angustifolia Red hemp-nettle	CR				X												X					4	8
Genista anglica Petty whin	NT										X											2	8
Gentianella campestris Field gentian	VU							X														3	8
Gnaphalium sylvaticum Heath cudweed	EN			X							X											3	7
Hypochaeris glabra Smooth cat's-ear	VU								X													2	8
Illecebrum verticillatum Coral-necklace	VU			X										X								2	8
Leersia oryzoides Cut-grass	EN													X								7	8
Lotus angustissimus Slender bird's-foot-trefoil	NT								X													3	8
Lycopodiella inundata Marsh clubmoss	EN										X		X									1	9
Melittis melissophyllum Bastard balm	VU	X		X																		5	5
Mentha pulegium Pennyroyal	EN						X							X								7	8
Misopates orontium Weasel's snout	VU				X																	6	7
Myosurus minimus Mousetail	VU				X																	5	8
Oenanthe fistulosa Tubular water-dropwort	VU											X										6	7
Orobanche rapum-genistae Greater broomrape	NT										X											2	7
Persicaria minor Small water-pepper	VU													X	X							8	7

Species	British status	Broad Habitats 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	N	L
Persicaria mitis Tasteless water-pepper	VU													X	X							9	7
Pilularia globulifera Pillwort	NT													X								2	8
Platanthera bifolia Lesser butterfly-orchid	VU	X									X											2	6
Puccinellia fasciculata Borrer's saltmarsh-grass	VU			X																	X	7	8
Pulicaria vulgaris Small fleabane	CR								X													7	9
Radiola linoides Allseed	NT										X											2	8
Ranunculus tripartitus Three-lobed crowfoot	EN													X								3	9
Rosa agrestis Small-leaved sweet-briar	NT							X														3	8
Ruppia cirrhosa Spiral tassel-weed	NT																				X	5	7
Salicornia nitens Shiny glasswort	DD																				X	6	9
Salicornia obscura Glaucous glasswort	DD																				X	6	9
Salsola kali ssp. *kali* Prickly saltwort	VU																			X		8	9
Scleranthus annuus Annual knawel	EN								X		X						X					4	7
Silene gallica Small-flowered catchfly	EN			X	X																	5	7
Silene nutans Nottingham catchfly	NT																X					4	8
Spartina maritima Small cord-grass	EN																				X	5	9
Spergula arvensis Corn spurrey	VU				X																	5	7
Spiranthes spiralis Autumn lady's-tresses	NT							X														3	8
Stachys arvensis Field woundwort	NT			X	X																	5	8
Stellaria palustris Marsh stitchwort	VU											X										4	7
Teesdalia nudicaulis Shepherd's cress	NT								X													2	8
Torilis arvensis Spreading hedge-parsley	EN				X																	4	8
Utricularia intermedia Intermediate bladderwort	DD													X								2	8
Viola canina Heath dog-violet	NT								X		X											2	8
Viola lactea Pale dog-violet	VU										X											2	7
Wahlenbergia hederacea Ivy-leaved bellflower	NT											X			X							3	6
Zostera marina Common eelgrass	NT																				X	6	6
Zostera noltei Dwarf eelgrass	VU																				X	5	8
73 taxa																							

Key to British Red List status
CR = Critically Endanged; E = Endangered; V = Vulnerable; NT = Near Threatened; DD = Data Deficient

Key to Broad Habitat Classifications relevant to Hampshire
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8 Acid grassland
9 Bracken
10 Dwarf shrub heath
11 Fen, marsh and swamp
12 Bog
13 Standing water
14 Rivers and streams
16 Quarries and skeletal soils
17 Built-up areas and gardens
18 Supralittoral rock
19 Coastal strandline, shingle, dune
21 Saltmarsh, littoral sediment

Key to Ellenberg Nitrogen Values (N)
1 Extremely infertile
2 ↓
3 Fairly infertile
4 ↓
5 Intermediate fertility
6 ↓
7 Richly fertile
8 ↓
9 Extremely rich

Key to Ellenberg Light Values (L)
1 Deep shade
2 ↓
3 Shade plant
4 ↓
5 Semi-shade plant
6 ↓
7 Partial shade to well lit
8 Light-loving
9 Full sun

Appendix 2
Other nationally rare and scarce New Forest taxa.

Species	British status
Alopecurus bulbosus Bulbous foxtail	Scarce
Althea officinalis Marsh mallow	Scarce
Atriplex longipes Long-stalked orache	Scarce
Briza minor Lesser Quaking-grass	Scarce
Carex montana Soft-leaved sedge	Scarce
Carex punctata Dotted sedge	Scarce
Deschampsia setacea Bog hair-grass	Scarce
Elatine hexandra Six-stamened waterwort	Scarce
Eleocharis parvula Dwarf spike-rush	Rare
Euphorbia portlandica Portland spurge	Scarce
Galium constrictum Slender marsh-bedstraw	Scarce
Gastridium ventricosum Nit-grass	Scarce
Gentiana pneumonathe Marsh gentian	Scarce
Geranium purpureum ssp. *forsteri* Little-Robin	Scarce
Gladiolus illyricus Wild gladiolus	Rare
Inula crithmoides Golden samphire	Scarce
Lathyrus japonicus Sea pea	Scarce
Leucojum aestivum ssp. *aestivum* Summer snowflake	Scarce
Limonium humile Lax-flowered sea-lavender	Scarce
Limosella aquatica Mudwort	Scarce
Lotus subbiflorus Hairy bird's-foot-trefoil	Scarce
Ludwigia palustris Hampshire-purslane	Rare
Luronium natans Floating water-plantain	Scarce
Marrubium vulgare White horehound	Scarce
Medicago polymorpha Toothed medick	Scarce
Montia fontana ssp. *amporitana* Blinks	Scarce
Ophioglossum azoricum Small adder's-tongue	Scarce
Parapholis incurva Curved hard-grass	Scarce
Poa bulbosa Bulbous meadow-grass	Scarce
Polygonatum odoratum Angular solomon's-seal	Scarce
Polypogon monspeliensis Annual beard-grass	Scarce
Puccinellia rupestris Stiff saltmarsh-grass	Scarce
Pulmonaria longifolia Narrow-leaved lungwort	Scarce
Ranunculus × *novae-forestae* New Forest water-crowfoot	Rare
Rhynchospora fusca Brown beak-sedge	Scarce
Salicornia pusilla One-flowered glasswort	Scarce
Sarcocornia perennis Perennial glasswort	Scarce
Sonchus palustris Marsh sow-thistle	Scarce
Thelypteris palustris Marsh fern	Scarce
Trifolium glomeratum Clustered clover	Scarce
Trifolium suffocatum Suffocated clover	Scarce
Vulpia ciliata ssp. *ambigua* Bearded fescue	Scarce
Vulpia fasciculata Dune fescue	Scarce
43 taxa	

Appendix 3
New Forest 'regionally significant' taxa.

Species	British status	Europe	Broad Habitats 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	N	L
Callitriche brutia Pedunculate water-starwort															X								5	8
Carex montana Soft-leaved sedge								X		X													1	7
Chamaemelum nobile Chamomile	VU																							
Cicendia filiformis Yellow centaury	VU											X											2	9
Crassula tillaea Mossy stonecrop					X																		2	8
Cyperus fuscus Brown galingale	VU														X								4	9
Deschampsia setacea Bog hair-grass		X																						
Eleocharis parvula Dwarf spike-rush																					X		5	6
Equisetum × *bowmanii* Bowman's horsetail	VU	X	X		X																		5	6
Eriophorum gracile Slender cottongrass	NT	X											X										2	8
Euphrasia anglica	EN	X																						
Galium constrictum Slender marsh-bedstraw															X								2	8

Species	British status	Europe	Broad Habitats 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	N	L
Gentiana pneumonanthe Marsh gentian		X																						
Geranium purpureum ssp. *forsteri* Little-Robin																					X		3	9
Gladiolus illyricus Wild gladiolus		(X)								X	X												3	5
Illecebrum verticillatum Coral-necklace	VU				X										X								2	8
Lobelia urens Heath lobelia	VU									X		X											2	8
Ludwigia palustris Hampshire-purslane															X								4	8
Lycopodiella inundata Marsh clubmoss	EN																							
Mentha pulegium Pennyroyal	EN																							
Ophioglossum azoricum Small adder's-tongue		X								X													2	8
Pilularia globulifera Pillwort	NT	X																						
Polypogon monspeliensis Annual beard-grass								X															6	8
Pulicaria vulgaris Small fleabane	CR	X																						
Pulmonaria longifolia Narrow-leaved lungwort			X		X																		5	6
Ranunculus × *novae-forestae* New Forest water-crowfoot		X											X		X								6	7
Rhynchospora fusca Brown beak-sedge														X									1	9
Trifolium glomeratum Clustered clover										X													2	9
Ulex minor Dwarf gorse																								
Viola lactea Pale dog-violet	VU	X																						
30 taxa overall	13 taxa	10–11 taxa																						

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2 ↓
3 Fairly infertile
4 ↓
5 Intermediate fertility
6 ↓
7 Richly fertile
8 ↓
9 Extremely rich

Key to Ellenberg Light Values (L)
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2 ↓
3 Shade plant
4 ↓
5 Semi-shade plant
6 ↓
7 Partial shade to well lit
8 Light-loving
9 Full sun

Appendix 4
New Forest northern (N)/western (W) 'outpost' taxa.

Species	British provenance	
Agrostis curtisii Bristle bent	W	
Botrychium lunaria Moonwort		N
Carex curta White sedge		N
Carex lasiocarpa Slender sedge		N
Carex limosa Bog sedge		N
Carex punctata Dotted sedge	W	
Carum verticillatum Whorled caraway	W	
Cicendia filiformis Yellow centaury	W	
Deschampsia setacea Bog hair-grass	W	N
Drosera anglica Long-leaved sundew		N
Drosera intermedia Oblong-leaved sundew	W	
Dryopteris aemula Hay-scented buckler-fern	W	
Eleocharis quinqueflora Few-flowered spike-rush		N
Erica ciliaris Dorset heath	W	
Eriophorum latifolium Broad-leaved cottongrass		N
Eriophorum vaginatum Hare's-tail cottongrass		N
Euphrasia confusa	W	N
Euphrasia micrantha	W	N
Euphrasia tetraquetra	W	
Gentianella campestris Field gentian		N
Gymnadenia borealis Heath fragrant-orchid	W	N
Hammarbya paludosa Bog orchid		N
Hypericum elodes Marsh St John's-wort	W	
Isolepis cernua Slender club-rush	W	
Juncus foliosus Leafy rush	W	
Lobelia urens Heath lobelia	W	
Lotus angustissimus Slender bird's-foot-trefoil	W	
Lotus subbiflorus Hairy bird's-foot-trefoil	W	
Melittis melissophyllum Bastard balm	W	
Montia fontana ssp. *amporitana* Blinks	W	
Myrica gale Bog myrtle		N
Myriophyllum alterniflorum Alternate water-milfoil	W	
Ophioglossum azoricum Small adder's-tongue	W	
Osmunda regalis Royal fern	W	
Parentucellia viscosa Yellow bartsia	W	
Phegopteris connectilis Beech fern		N
Pinguicula lusitanica Pale butterwort	W	
Pinguicula vulgaris Common butterwort		N
Polypodium cambricum Southern polypody	W	
Ranunculus omiophyllus Round-leaved crowfoot	W	
Rhynchospora alba White beak-sedge	W	
Rhynchospora fusca Brown beak-sedge	W	
Sagina subulata Heath pearlwort	W	
Schoenus nigricans Black bog-rush	W	N
Sparganium angustifolium Floating bur-reed	N	
Sparganium natans Least bur-reed	N	
Trichophorum cespitosum Deergrass	N	
Umbilicus rupestris Navelwort	W	
Utricularia intermedia Intermediate bladderwort		N
Utricularia minor Lesser bladderwort		N
Viola lactea Pale dog-violet	W	
Wahlenbergia hederacea Ivy-leaved bellflower	W	
52 taxa	34	23

Appendix 5
Taxa significantly declining elsewhere in the lowland zone.

Species	Broad Habitats 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	N	L
Aira caryophyllea Silver hair-grass										X						X					2	8
Anacamptis morio Green-winged orchid						X	X														3	8
Anagallis minima Chaffweed								X													3	8
Anagallis tenella Bog pimpernel											X										3	8
Apium inundatum Lesser marshwort											X		X								4	7
Baldellia ranunculoides Lesser water-plantain													X	X							2	8
Bidens cernua Nodding bur-marigold													X	X							7	8
Bidens tripartita Trifid bur-marigold											X		X								7	8
Botrychium lunaria Moonwort							X									X					2	8
Calamagrostis canescens Purple small-reed											X										5	7
Carex curta White sedge											X										2	8
Carex echinata Star sedge											X	X	X								2	8
Carex hostiana Tawny sedge											X										2	8
Carex lasiocarpa Slender sedge											X										3	8
Carex pulicaris Flea sedge											X					X					2	8
Carex rostrata Bottle sedge											X										2	8

Species	Broad Habitats 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	N	L
Carex vesicaria Bladder sedge											X										4	8
Carex viridula ssp. *viridula* Small-fruited yellow-sedge											X								X		3	8
Catabrosa aquatica Whorl-grass													X	X							7	6
Chamaemelum nobile Chamomile								X													5	8
Cirsium dissectum Meadow thistle											X										2	8
Convallaria majalis Lily-of-the-valley		X						X													5	5
Cuscuta epithymum Dodder										X											2	7
Dactylorhiza incarnata Early marsh-orchid											X										2	8
Dactylorhiza maculata Heath spotted-orchid												X									2	7
Deschampsia setacea Bog hair-grass												X	X								1	8
Drosera anglica Great sundew											X	X									1	8
Drosera intermedia Oblong-leaved sundew												X		X							1	8
Drosera rotundifolia Round-leaved sundew												X									1	8
Elatine hexandra Six-stamened waterwort													X								4	7
Eleocharis acicularis Needle spike-rush													X	X							5	7
Eleocharis multicaulis Many-stalked spike-rush											X	X	X								1	8
Eleocharis quinqueflora Few-flowered spike-rush											X										2	9
Eleogiton fluitans Floating club-rush											X										2	8
Epilobium palustre Marsh willowherb											X			X							3	7
Epipactis palustris Marsh helleborine											X										3	8
Eriophorum angustifolium Common cottongrass												X									1	8
Eriophorum latifolium Broad-leaved cottongrass											X										2	9
Eriophorum vaginatum Hare's-tail cottongrass												X									1	8
Euphrasia anglica										X						X					3	7
Euphrasia micrantha								X		X											2	7
Filago minima Small cudweed																X					2	8
Filago vulgaris Common cudweed			X																		4	7
Gastridium ventricosum Nit-grass				X			X														2	9
Genista anglica Petty whin										X											2	8
Gentiana pneumonanthe Marsh gentian								X		X											1	8
Gentianella campestris Field gentian							X														3	8
Glyceria declinata Small sweet-grass													X	X							6	7
Hammarbya paludosa Bog orchid											X										1	9
Hydrocotyle vulgaris Marsh pennywort											X										3	8
Hypericum elodes Marsh St John's-wort											X										2	8
Hypochaeris glabra Smooth cat's-ear								X													2	8
Juncus squarrosus Heath rush								X				X									2	7
Limosella aquatica Mudwort													X								5	8
Littorella uniflora Shoreweed											X		X								3	8
Lycopodiella inundata Marsh clubmoss										X		X									1	9
Mentha pulegium Pennyroyal						X							X								7	8
Moenchia erecta Upright chickweed								X													3	9
Montia fontana ssp. *amporitana* Blinks											X										3	7
Myrica gale Bog myrtle												X									2	8
Myriophyllum alterniflorum Alternate water-milfoil													X	X							3	7
Nardus stricta Mat-grass								X													2	7
Narthecium ossifragum Bog asphodel												X									1	8
Oenanthe fistulosa Tubular water-dropwort											X										6	7
Oreopteris limbosperma Lemon-scented fern	X															X					3	6
Orobanche rapum-genistae Greater broomrape										X											2	7
Pedicularis palustris Marsh lousewort											X										2	8

Species	Broad Habitats 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	21	N	L
Pedicularis sylvatica Lousewort										X		X		X							2	8
Persicaria minor Small water-pepper													X	X							8	7
Persicaria mitis Tasteless water-pepper													X	X							9	7
Pilularia globulifera Pillwort													X								2	8
Pinguicula vulgaris Common butterwort											X	X									2	8
Platanthera bifolia Lesser butterfly-orchid	X									X											2	6
Polygala serpyllifolia Heath milkwort								X		X		X									2	8
Potamogeton alpinus Red pondweed													X								5	7
Potentilla palustris Marsh cinquefoil											X										3	8
Pulicaria vulgaris Small fleabane								X													7	9
Radiola linoides Allseed										X											2	8
Ranunculus parviflorus Small-flowered buttercup						X															5	7
Rhynchospora alba White beak-sedge												X									1	8
Rosa agrestis Small-leaved sweet-briar							X														3	8
Rosa pimpinellifolia Burnet rose										X						X			X		3	8
Rosa sherardii Sherard's downy-rose	X		X													X					4	6
Sagina nodosa Knotted pearlwort											X								X		3	8
Sagina subulata Heath pearlwort								X		X											4	8
Salix aurita Eared willow	X															X					3	7
Salix repens Creeping willow										X									X		3	8
Schoenus nigricans Black bog-rush											X										2	8
Serratula tinctoria Saw-wort							X														2	7
Sparganium natans Least bur-reed													X								3	7
Spiranthes spiralis Autumn lady's-tresses							X														3	8
Thelypteris palustris Marsh fern	X										X										5	6
Trichophorum cespitosum Deergrass										X		X									1	8
Ulex minor Dwarf gorse										X											2	8
Utricularia minor Lesser bladderwort											X	X									2	8
Valeriana dioica Marsh valerian											X										3	8
Veronica scutellata Marsh speedwell											X		X								3	8
Viola canina Heath dog-violet								X		X											2	8
Viola lactea Pale dog-violet										X											2	7
Viola palustris Marsh violet											X			X							2	7
Wahlenbergia hederacea Ivy-leaved bellflower											X			X							3	6
101 taxa																						

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