INVERTEBRATE CONSERVATION IN GREAT BRITAIN

No. 3: EAST MIDLANDS REGION

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FOREWORD

Between 1988 and 1992 I was employed by the Nature Conservancy Council (NCC) to produce reports that summarised the information collated by the Invertebrate Site Register for each NCC Region of Britain. The aim was to draw attention to the key habitats and species of each Region and to highlight the more significant local sites for invertebrate conservation. The project required an extensive programme of site visits within each Region to discuss management issues, to gain an overview of biogeographical differences, and to take photographs of salient features to illustrate the reports. In the first three years of the project I visited almost 500 sites, covering every county in England and Wales (I didn't have time to get to Scotland), but then politics intervened. The dissolution of NCC, and its break-up into the Country Agencies of English Nature, Scottish Natural Heritage and the Countryside Council for Wales, meant that the project had to be curtailed and I spent the final year completing the writing up of the reports for the areas already visited. However, subsequent changes to the Regional structure in England had the effect of making the English reports less pertinent and English Nature decided to abandon their publication. The report for Wales was published in 1994 (Fowles, A.P. 1994. *Invertebrates of Wales: a review of important sites and species*. Peterborough, Joint Nature Conservation Committee).

Whilst the geographical focus no longer fitted with the new administrative regime, it was a great pity that all of this work had to be discarded and so, nearly a quarter of a century on, I've decided to resurrect the three original manuscripts that survive. Much has changed in our understanding of the priorities for invertebrate conservation in the 24 years since this draft was written, but many of the basic principles are just the same. There will be more information on a wider range of key sites in these areas nowadays and the conservation status (and nomenclature) of many species will be different, but as a general introduction to the invertebrate interest of England there is perhaps some value in making the drafts more widely available. My selection of images to accompany the text is much reduced and what remains is a handful of scans from twenty-five year-old slides that fail to do justice to the features and landscapes I saw, but I include them here as part of that historical record.

The Invertebrate Site Register was established by the Nature Conservancy Council in 1980 to collate information from a variety of published and unpublished sources, with the principal aim of identifying and evaluating sites of importance for the conservation of non-marine invertebrates in Great Britain. Whereas it is undoubtedly true that overall species-diversity is at its greatest in Southern England, chiefly due to climatic factors, it is also clear that other areas of Britain also contain nationally important sites or species as a result of regional

variation in land use, geology, climate or habitat distribution. These regional accounts are an attempt to describe the particular aspects of each area which are of major significance for the conservation of invertebrates, by drawing attention to species, communities or micro-habitats which exemplify the strengths, in invertebrate terms, of the individual regions. The following account of invertebrates and their conservation in the East Midlands is based upon the Regional information compiled by NCC for the Invertebrate Site Register. This was collated into a series of reports by Dr Peter Kirby:

Invertebrate Site Register - Report number 74. Review of Invertebrate Sites in England. Review of Northamptonshire.

Invertebrate Site Register - Report number 85. Review of Invertebrate Sites in England. Review of Cambridgeshire.

Invertebrate Site Register - Report number 86. Review of Invertebrate Sites in England. Review of Bedfordshire.

Invertebrate Site Register - Report number 89. Review of Invertebrate Sites in England. Review of Hertfordshire.

Invertebrate Site Register - Report number 92. Review of Invertebrate Sites in England. Review of Lincolnshire.

Invertebrate Site Register - Report number 93. Review of Invertebrate Sites in England. Review of Leicestershire.

Invertebrate Site Register - Report number 97. Review of Invertebrate Sites in England. Review of Nottinghamshire.

INTRODUCTION

This review is based upon information which was collated prior to the reorganisation of the Nature Conservancy Council and the subsequent amalgamation of the East Midlands Region and East Anglia Region. For reasons of consistency and convenience, the review discusses sites and species of particular significance for invertebrate conservation in the area corresponding to the former East Midlands Region of the Nature Conservancy Council.

East Midlands Region stretches for some 200 kilometres from the mouth of the Humber to Watford and, for much of this distance, is over 100 kms broad. Contained within these boundaries are the modern counties of Lincolnshire, Nottinghamshire, Northamptonshire, Leicestershire, Cambridgeshire, Bedfordshire and Hertfordshire. With little high ground, the Region is generally well-populated and most of the open countryside is farmed as arable land or permanent pasture. Much of the Lincolnshire coastline has retained a high degree of biological interest but most other habitat types have declined markedly through reclamation, agricultural improvement, pollution and canalisation of waterways, and management neglect. In particular, the past drainage of the Lincolnshire and Huntingdonshire fens was carried out on such a massive scale that peatlands of invertebrate importance are now extremely scarce. However, progress has undoubtedly passed by some exceptional sites and the Region boasts a fine series of National Nature Reserves, whilst the local conservation bodies manage a representative network of wildlife habitats.

The solid geology of the Region consists essentially of a series of parallel bands running from north-east to south-west. Chalk outcrops in the Lincolnshire Wolds and appears again, briefly, in Cambridgeshire and then rises to form the end of the Chilterns in Bedfordshire and Hertfordshire. Inland from this is Greensand with a scatter of dry heaths but, sadly, most have been afforested or lost through other pressures. The broad belt of the Oxford Clays through Northamptonshire is largely responsible for the preponderance of valuable woodlands in that county and parts of neighbouring Huntingdonshire (now subsumed into modern Cambridgeshire). Westwards again is a band of Oolitic Limestone which has been much quarried in the past and derelict sites can support rich calcareous grasslands. Beyond this, through much of Leicestershire and Nottinghamshire, are the largely acidic mudstones and sandstones of the Triassic, with outcrops of volcanic rock as at Charnwood Forest.

The Devensian glaciation is believed to have only touched upon the eastern fringe of Lincolnshire but boulder clays from older Ice Ages overlie many parts of the Region. Drift

deposits of sand and gravel also provide important habitats, particularly on the Lincolnshire Coversands and the gravel pits to the south of Peterborough. The accreting sand dunes at Gibraltar Point and Saltfleetby are important geomorphological features for wildlife, whilst on the alluvial silts of the Wash basin are vast areas of saltmarsh and occasional waterlogged marshes can still be found behind the sea wall. The blanket of fen peat laid down at the mouth of the valleys entering the Wash has all but disappeared beneath a sea of cultivation and only Wicken and Woodwalton Fens (and to a lesser extent Holme Fen) remain to provide us with a glimpse of the former landscape. These varied geological and geomorphological substrates form the basis for the calcareous grasslands, the acid heaths, wet woodlands, sand dunes, marshes and fens of the East Midlands. Taken across the whole Region, the degree of habitat loss is alarming but, nonetheless, there is still a profusion of rich wildlife sites of importance for nature conservation in general and for their invertebrates in particular. Site safeguard and conservation management of each and every one of these is important but a selection of some of the highlights will serve to introduce some of the regional qualities of the semi-natural habitats and their associated invertebrate faunas.

The two major dune systems of the Lincolnshire coast are of unquestioned significance and the developing saltmarshes of Gibraltar Point and the extensive dune slacks of Saltfleetby complement each other to provide a rich wealth of dune habitats with diverse and important faunas. The vast saltmarshes of The Wash are also of potential significance but as yet they are relatively unexplored and hold much potential for discovery. The region's woodlands are extremely varied in character, ranging from the majestic, acid oakwoods of Sherwood Forest to the heavy clay woodlands of Cambridgeshire and Northants, typified by the National Nature Reserve at Monks Wood. There are also numerous parklands with valuable invertebrate faunas and some of these, such as Donington Park in Leicestershire, are beginning to prove to be amongst the top national sites for the conservation of invertebrates associated with over-mature trees. Grassland habitats of high quality are much more localised and many of the better sites are located in abandoned quarries, such as Barnack Hills and Holes or Collyweston Quarry, or along disused railway lines. In the south of the Region, parts of the Chilterns in Bedfordshire, as at Dunstable Downs, and Thetfield Heath in Hertfordshire have retained unimproved chalk grassland with entomological value and further survey efforts should reveal that some of these sites are of national significance for their invertebrates.

Heathlands have declined considerably and only fragments of the classic Bedfordshire sandstone heaths still survive. Elsewhere, the windblown sands of Lincolnshire probably contain the best examples of heathland in the Region, as at Kirby Moor and Scotton Common, whilst the higher altitude moorland of Leicestershire's Charnwood Forest is an

interesting biogeographical outlier more typical of sites in northern and western Britain. The freshwater resource of the East Midlands Region is one of the area's strengths and rivers such as the Soar, Ouse and Nene support many nationally scarce aquatic and semi-aquatic invertebrates. Still water sites, like Saddington Reservoir, are also of importance for their marginal fens and many of the Region's flooded gravel pits, particularly in the Ouse Valley, are developing into rich wildlife habitats with populations of scarce dragonflies as conspicuous inhabitants. Peatlands have suffered widely from drainage and there are few remaining sites of interest but Wicken and Woodwalton Fens are of national importance and both sites support an extensive range of rare invertebrates dependant upon the continuation of high water-tables and the management of the vegetation structure of the fens.

Both of these sites have been regarded as entomologically-rich for a century or more and have a long tradition of invertebrate recording. The history of recording in other parts of the Region is patchy, with some areas still almost unknown today and others which have been regularly worked by invertebrate zoologists for a considerable period. Biological recording has largely been governed by the Watsonian vice-county system and these boundaries are still regarded by most naturalists as convenient geographical units in which to concentrate their studies. East Midlands Region covers the vice-counties of Hertfordshire (VC20), Cambridgeshire (VC29), Bedfordshire (VC30), Huntingdonshire (VC31), Northamptonshire (VC32), South Lincolnshire (VC35), part of North Lincolnshire (VC54), Leicestershire and Rutland (VC55), and Nottinghamshire (VC56).

Much of the early documentation of invertebrate faunas comes from Cambridgeshire and Hertfordshire, influenced by the activities of University zoologists in the former case and the ease of accessibility from London in the latter. The emphasis placed upon taxonomy in Victorian natural history meant that academics from the Universities, or institutions like the British Museum, regularly explored these two counties in pursuit of their studies. This aspect of zoology does not have such a high profile today and the influence of the scientific institutions on invertebrate recording has considerably lessened. To some extent this has been replaced by the activities of members of staff from organisations such as Rothamsted Experimental Station, the Institute of Terrestrial Ecology at Monks Wood and the establishment of the Nature Conservancy Council headquarters at Peterborough. However, for much of this century detailed recording has been the province of the amateur entomologist and vice-county coverage generally reflects the number and interests of such naturalists resident in each vice-county.

The local natural history societies and nature conservation Trusts have done much to foster the efforts of their invertebrate-minded members and several of their publications are, and continue to be, valuable sources for the historical documentation of the local fauna. Over the past couple of decades there has also been an increasing involvement with the major museums and several of these support biological record centres which are important foci for site-related information. There is a steadily growing enthusiasm for the study of invertebrates and their conservation in all of the counties of the East Midlands. Harnessing this interest to the practical applications of site assessment, safeguard and management through the development of expertise and the dissemination of knowledge is the challenge for the years ahead. As outlined above, there are many outstanding sites in East Midlands Region with faunas which are of national importance. Some of these have been comprehensively surveyed whilst others are scarcely known and offer much scope for rewarding fieldwork. There will always be threats to valued habitats but the continued co-operation between invertebrate zoologists and conservationists should ensure that the varied and interesting fauna of the East Midlands will survive.

COASTLANDS

East Midlands Region has a relatively short coastline at c.120 kilometres, all of which is in Lincolnshire, but this figure is somewhat misleading as it undervalues the expansive flats and saltmarshes of The Wash. Indeed, of all the vice-counties in Britain only Essex has a greater area of saltmarsh habitat than the 4,200 hectares in Lincolnshire. It is also interesting to note that, despite the aggressive urbanisation of the coastline between Mablethorpe and Skegness, almost two thirds of the Lincolnshire coast is of recognised biological importance and as such has been notified as a series of Sites of Special Scientific Interest.

Along the coast between the Humber and The Wash, the Cretaceous Chalk is entirely overlain by boulder-clay and windblown sands and hence there are no hard cliffs of the type found further north, at Flamborough Head for instance. 'Soft coast' habitats are, therefore, the only types of landform occurring on the Region's coastlands - sand dunes, saltmarshes and the occasional stretch of shingle beach. In conservation terms, four discrete areas of biological interest are identifiable as being of major significance for coastal invertebrates - the outer Humber from Tetney Haven to Donna Nook, the nature reserves between Saltfleetby and Theddlethorpe, the accreting dunes and saltmarsh of Gibraltar Point, and the vastness of The Wash. Of these, it is perhaps only Gibraltar Point, with its long tradition of natural history recording, that is at all well-known for its invertebrate fauna and

it is certainly true that there has been a curious neglect of the Lincolnshire coast by invertebrate zoologists.

This neglect is most marked on The Wash, where information is scant and patchy. A few stretches of saltmarsh have been visited by the entomologically inquisitive, but there has been no sustained survey effort and no records at all exist for most of The Wash. Piecemeal reclamation of the upper saltmarsh habitats over several centuries has undoubtedly limited diversity but, nonetheless, there are considerable areas of botanically-diverse and long-established saltmarsh worthy of investigation. Tantalising records of phytophagous rarities indicate the potential - with sea wormwood, for example, supporting such species as the scarce pug *Eupithecia extensaria* and the weevils *Phyllobius vespertinus* and *Polydrusus pulchellus*. The lepidopteran fauna of The Wash is also known to contain typical, but nationally scarce, species like the crescent striped *Apamea oblonga* and rosy wave *Scopula emutaria* moths. Little, however, is known of the ground-active fauna of beetles, bugs and spiders of these upper saltmarshes and the specialised Diptera of such habitats are almost completely unknown. This sheltered embayment, with its fine sediments (so suitable for burrowing invertebrates), rich flora, and unparalleled extent, is deserving of much more attention from entomologists. With British estuaries facing so many threats from such a variety of sources it is imperative that detailed information on the occurrence of invertebrates in The Wash is available. With knowledge of the importance of specific saltmarsh blocks to hand, decisions on site safeguard and management can be made with confidence and the conservation of this site of major significance for saltmarsh invertebrates can be assured.

As mentioned above, the embankment and reclamation of the upper saltmarshes is a sad legacy of the past, but some of the characteristic inhabitants of this transition zone have been able to survive in and alongside the brackish ditches and borrow-pits behind the sea wall. There are a number of such features around The Wash containing noteworthy assemblages of invertebrates and similar conditions occur elsewhere along the Lincolnshire coast where clay was dug to construct the sea defences and the resultant hollows subsequently filled with brackish water. Although the surrounding land is often agriculturally improved, some areas have developed marginal fens and these pits can support an interesting brackish fauna, as at the Lincolnshire and South Humberside Trust for Nature Conservation Reserve near Anderby. At present the aquatic invertebrates are best known, with a good range of breeding dragonflies and an important assemblage of water-beetles. This latter group contains a number of nationally rare species, such as *Oulimnius major*, *Gyrinus bicolor* and *Haliplus apicalis*. Additionally, there are interesting records of wetland flies from the marginal habitats of the pits and it is apparent that the coastal borrowpits as

a whole act as valuable refugia for some of the invertebrates that were displaced by the construction of the sea embankments.

At the northern end of the county, the fifteen kilometre stretch of coast at the mouth of the Humber is a rich mixture of saltmarsh, dunes, lagoons and brackish ditches. Casual surveys have produced a list of records which indicate that each of the various components contain significant elements of the coastal invertebrate fauna. However, as with The Wash, information is rather patchy and it is chiefly the nature reserves at Tetney Haven and Donna Nook that have attracted attention. Taken as a whole, this is likely to be an important stretch of coast, providing suitable conditions for a considerable diversity of 'soft coast' invertebrates. It is probable that the habitat components individually represent smaller versions of the three major sites to the south, but, nonetheless, the North Lincolnshire Coast is a lengthy span of little-modified habitats supporting valuable populations of dune, saltmarsh and brackish-water invertebrates.

The two remaining sites of notable importance for the conservation of coastal invertebrates in Lincolnshire share a number of similarities but also complement each other. The sand dunes and associated habitats of both Gibraltar Point and Saltfleetby-Theddlethorpe are the best recorded invertebrate sites in Lincolnshire. Both of these large systems are managed as nature reserves by English Nature and the Lincolnshire and South Humberside Trust for Nature Conservation and their invertebrate richness is a major consideration of their conservation. Two main areas of concern are addressed by management activities - the erosion of dune habitats by public pressure and the deterioration of the species-rich dune grassland by scrub invasion, particularly sea buckthorn.

Sea buckthorn is native to the Lincolnshire coast and is therefore an integral component of the dune succession. Although it occurs naturally on some other East coast dunes, here it is at its most abundant and hence of ecological interest in its own right. However, dense sea buckthorn scrub is of negligible value to invertebrates and is highly deleterious to the wildlife importance of yellow dune and dune grassland habitats. A balance has to be struck between the retention of representative areas of scrub and the maintenance of the open sand and herb-rich grassland stages of the dune succession. At both sites the reintroduction of the traditional practice of sheep and/or cattle grazing on the dunes is an attempt to achieve this balance, although manual control will also be necessary outside the areas of 'dune pasture'.

These dunes are actively accreting and the parallel dune ridges at each site show that this has been a continuing process for several centuries. The sand here is calcareous and the dune vegetation is correspondingly diverse with a rich fauna of herbivorous insects. Although the butterfly fauna is rather limited, the abundance of green hairstreaks *Callophrys rubi* at Gibraltar Point is perhaps due to the widespread occurrence of dewberry in the dunes. The moth fauna is particularly important at both sites with many coastal rarities recorded, including the micro-moth *Ethmia bipunctella* breeding on viper's bugloss. Elsewhere it is known as a resident species only on the Kent coast. Other plant-feeders of interest include the weevils *Cleonus piger* and *Hypera dauci* and the mirid bug *Trigonotylus psammaecolor*.

Sand dunes usually have a significant assemblage of predatory species amongst their invertebrate fauna and a high proportion of these favour areas of firm, bare sand for hunting. A sparse cover of marram tussocks can provide shelter or opportunities to lie-in-wait, and fore-dune zones which provide such a mosaic can support a rich fauna. Solitary wasps are often the most conspicuous members of such a community but the Hymenoptera are probably the least well-known of the major invertebrate Orders on these dunes - the Hemiptera-feeding sphecid *Astata pinguis* is the only interesting species recorded to date. Robber-flies and therevids are other aerial predators which regularly inhabit the fore-dunes and psammophilous carabid beetles are well represented. The marram tussocks also support predators which rarely leave the tangle of stems and dead leaves, such as the pseudoscorpion *Dactylochelifer latreillei* and the jumping-spider *Marpissa nivoyi*. For all these species, and the food-chain which supports them, the occurrence of patches of bare sand in the dune system is vital and the encroachment of sea buckthorn scrub threatens their survival. Fortunately, the continuing accretion of new dunes at Gibraltar Point and Saltfleetby-Theddlethorpe should ensure their future conservation but their needs must be taken into account when management strategies are devised.

The differences between the two dune systems lie in the relative strengths of their saltmarsh and dune slack habitats. At Gibraltar Point it is the linear band of saltmarsh, sheltering between the dune ridges at the north end of The Wash, that have yielded a host of records of scarce invertebrates. The reason for this must partly be due to recording effort but it is also true that these marshes are highly favourable, with a sandy substrate and a botanically-rich zonation through to the upper saltmarsh communities. In the sparsely-vegetated lower zones, the predatory larvae of rare muscid flies like *Spilogona biseriata* and *Lispe loewi* can be found under mats of the algae *Enteromorpha*. Higher up the saltmarsh, Diptera include the dolichopodid *Orthoceratium lacustre*, the picture-winged fly *Paroxyna absinthi*, and the rare estuarine horse-fly *Haematopota bigoti*. A diverse assemblage of ground-active beetles is also present with carabids such as *Pogonus*

luridipennis, *Dicheirotrichus obsoletus* and *Bembidion ephippium* and the rove-beetle *Bledius tricornis*. Rotting vegetation on the saltmarsh strandline is another important aspect of the habitat particularly where it gathers above the reach of all but the highest tides and hence can undergo a full cycle of decay. Such piles can support a succession of invertebrates as the cycle progresses and several of the scarcer species recorded at Gibraltar Point have obviously benefited from the undisturbed jetsam thrown up on the sheltered saltmarshes.

The expanse of saltmarsh to the south of Saltfleetby Haven has probably not been as extensively worked as Gibraltar Point but it does not appear to be significant for invertebrate conservation. This may be because it is more exposed but there is also some evidence from moth-recording that the fauna has declined over the past couple of decades and perhaps there are changes in the onshore currents and sediment deposition which are affecting the saltmarsh vegetation. Whatever the reason, there is still a valuable fauna present on this habitat at Saltfleetby but the outstanding feature of the site is the vast expanse of freshwater and brackish marsh which is sandwiched between the two main dune ridges. Reedbeds dominate the wettest part of this dune slack but in marginal areas, where the water-table retreats beneath the surface in the summer, there is a lush tall fen, rich in sedges and wetland plants. The macro-moths are the most comprehensively recorded group of invertebrates and they include the nationally rare marsh moth *Athetis pallustris*. This is essentially a fenland inhabitant and is best known from the Cambridgeshire and Huntingdon Fens but also occurs at several other localities in Lincolnshire, including Gibraltar Point. At Saltfleetby-Theddlethorpe it has been recorded abundantly but its usual foodplant, meadowsweet, is not common and neither the larvae nor their conspicuous and characteristic feeding-damage have been seen on this plant. Speculation suggests that dewberry may be the alternative host and it is important that the larval pabulum is discovered in order that the breeding haunts of this valuable population can be correctly managed.

Open water in the dune slacks supports scarce Odonata such as the hairy dragonfly *Brachytron pratense* and the variable damselfly *Coenagrion pulchellum* and there is an interesting range of aquatic Hemiptera present. Other wetland invertebrates that are indicative of a high-quality habitat include the spider *Crustulina sticta*, the whorl-snail *Vertigo substriata* and the soldier-beetle *Cantharis thoracica*. This large area of coastal wetland has considerable scope for other significant discoveries and would amply repay detailed survey. It has few parallels in other East coast dune systems and can justifiably be regarded as nationally important for invertebrate conservation.

Although the Lincolnshire coast lacks the hard cliffs and intertidal crevice habitats that add diversity to other stretches of the British coast, there is great variety amongst its landforms and there are several extremely valuable sites for invertebrates. It is unfortunate that there has been a historical neglect of invertebrate recording along this coast and all the major sites would benefit from detailed systematic recording over a range of Orders. An understanding of the occurrence and ecological requirements of invertebrates on coastal sites can, as elsewhere, provide a beneficial input to the fine-tuning of management decisions, but the information needs to be gathered before it can be deployed.

WOODLANDS

The woodland environment is a complex mixture of habitats in an extended three-dimensional structure that offers a plurality of niche-opportunities for invertebrates far exceeding any other habitat formation in our countryside. Many factors affect or contribute to the availability of microhabitats for invertebrates in woodlands but all semi-natural woods are capable of supporting a large fauna and the richest sites may be inhabited by several thousand species. Although some of these are conspicuous and relatively easily recorded (butterflies for example), the majority are difficult to observe because they are nocturnal, occupy inaccessible niches, occur at low population levels, have brief periods of adult activity, or are just too small to be found other than by specialised collecting techniques. Of course, some of these problems also exist in other biotopes but the problem is magnified in woodlands because of the immensity of the fauna and the complexity of the habitat. Even accounting for differences in species-composition brought about by habitat-change over time, no British woodland can be regarded as having a complete inventory of its fauna and the vast majority of site-lists only scratch the surface.

Given this background of incomplete knowledge, the task of evaluating the importance of a particular woodland for invertebrate conservation is a difficult one. Ideally, all woods should be subject to a broad selection of standardised sampling procedures which would provide

comparative information on a representative segment of the fauna, but this is clearly not feasible on either a county or Regional basis. Species lists for woodlands derive from a heterogeneous mix of recording methods and a compromise approach must be taken to enable workable value judgements to be made on the conservation importance of a particular wood for invertebrates. These judgements apply the familiar conservation criteria of naturalness, diversity, fragility, rarity, etc., but they also utilise specific knowledge on those elements of woodland habitats which are known to be of prime importance for rare or threatened invertebrate assemblages. Some invertebrate species can serve as "indicators" of a set of conditions, such as an undisturbed field-layer or the presence of over-mature trees, which may be beneficial to a wide group of species dependent upon such features. Their inclusion on any site list, based on relatively recent records, suggests that this aspect of the wood is probably of conservation value. The more indicator-species known from a site, the greater confidence we can have that the particular feature is extensive and/or of high quality.

There are a large number of woodland blocks in the East Midlands Region for which there is inadequate information on the resident invertebrate fauna. It is simply impossible to make a positive assessment of their contribution to invertebrate conservation and there is no alternative to greater survey effort. However, for those woods which have detailed habitat surveys it is possible to suggest likely candidates which would be worthy of priority investigation and the Invertebrate Site Register county reports made several recommendations. These recommendations are based on the presence of features of known importance to woodland invertebrates and it is our ability to recognise such features that governs our capacity to make sound judgements on the significance of an individual site for invertebrate conservation. With increasing research on the ecology of the woodland fauna, additional features will no doubt come into consideration and others will no doubt be fine-tuned by further knowledge.

For the present, there is a set of basic principles which can be easily recognised and widely applied. Woodland is the natural climax vegetation cover for most of Britain and the vast majority of the British invertebrate fauna is derived from species which inhabited the near-continuous tracts of forests with their glades and marshes, pools and streams, etc. Many forest species had evolved with low dispersal ability as there was no need to cross unsuitable land in search of breeding habitat. The fragmentation of the British forests which has taken place over the last one thousand years or so has inevitably caused problems for such relatively immobile species and hence large woods on ancient sites are particularly valued. Another important aspect is the continuity, within an individual wood, of certain phases in woodland succession. Clear-felling of a majority of British woodlands at the start

of this century, coupled with a subsequent neglect of management, has led to a nationwide preponderance of woods consisting of a uniform, even-aged canopy of trees. Without any other redeeming features, such woods are so widespread and common that they are unlikely to be of special significance for invertebrate conservation. On the other hand, woods with a historical continuity of the early (i.e. coppice) or late (i.e. over-mature) successional phases are likely to be of extreme importance because of their comparative scarcity. Some even-aged woodlands have retained elements of their early-succession fauna along a network of managed rides. By contrast, over-mature trees have survived in very few woodlands and it is generally the parklands of the country estates that have kept their older trees.

Beyond these basic considerations of size and site history, other characteristics such as soils, topography and underlying geology are major influences in defining local variation in woods. They give a Regional flavour to the range of woodland types present and, in conjunction with bio-geographical factors, add to the overall diversity of woodland faunas. Whilst there are undoubtedly notable exceptions, the major woodland-types in the East Midlands containing important invertebrate sites are - the Bardney Forest complex of limewoods in north Lincolnshire; the acidic oakwoods of Sherwood Forest in Nottinghamshire; the oak-birch of the siliceous Clays in Charnwood Forest, Leicestershire; the extensive Northamptonshire woodlands of Rockingham Forest, Salcey Forest and Yardley Chase; the ash-maple woods and neglected coppices of the calcareous boulder-clay in west Cambridgeshire; the oak-ash woodlands on Bedfordshire's Lower Greensand; and the oak-hornbeam woods of the London Clay in Hertfordshire.

Lincolnshire has a reasonable proportion of woodland on ancient sites but this has been extensively modified by coniferisation and most of the known interest is confined to the deciduous edges of the managed ride systems. Most attention has been paid to the distinctive limewoods of Bardney Forest to the east of Lincoln, in which small-leaved lime is a regular, and often dominant, component of the canopy. Many of these woodlands, which form a widely scattered group separated by arable land, were historically managed as coppice-with-standards and were traditionally rich for butterflies of wood-edge or woodland glade habitats. In common with woodlands elsewhere in Eastern England, the butterflies have declined markedly as a result of recent changes in management but a few sites still retain colonies of brown hairstreaks *Thecla betulae*. Lepidoptera are the most extensively recorded group in these woodlands and they have proved to be important for a number of the less-common larger moths. Two of the East Midlands specialities, the concolorous *Photedes extrema* and the mere wainscot *P. fluxa*, are locally established and both are here dependent upon stands of small-reed *Calamagrostis* spp. growing in woodland clearings.

Modern records exist for few other invertebrate groups, although in the past scarce canopy beetles such as *Cryptocephalus sexpunctatus* and *Zeugophora subspinosa* were present. Several of the woods are managed as Forest Nature Reserves by the Forestry Commission and coppicing has been re-introduced in trial plots. In future, the invertebrate interest of the Lincolnshire limewoods will depend on sustained coppice cycles in traditional areas and the sympathetic management of ride systems.

There seem to be few high-quality sites for the fauna of over-mature trees in Lincolnshire but Grimsthorpe Park in the south is clearly of national significance. This ancient deer-park has a substantial number of old oak trees which have been extensively surveyed for deadwood beetles. About fifty recognised ancient woodland indicator species are recorded, including the rare pselaphid *Batrisodes venustus*. A valuable feature is the wide age-range of trees, ensuring a continuous supply of old timber habitats into the future. This continuity is sadly lacking from many British parklands which currently support important faunas and poses serious problems for the long-term prospects of conservation. The timescales involved are often difficult to comprehend but provision must be made now in order to sustain the invertebrate-richness of our parklands in 2-300 years time. The balance at Grimsthorpe Park is currently healthy and with planning, taking due consideration of host-trees and nectar sources, its importance for invertebrate conservation should be assured.

Active regeneration is not a problem at Birklands and Bilhaugh, two adjoining areas which together comprise the finest surviving woodlands of Sherwood Forest. The open canopy woodlands of ancient oaks and senescent birches have a healthy age-range of trees, providing a succession of over-mature timber habitats for the exceptional fauna present. The acidic, sandy soils of the Forest support a poor flora and, correspondingly, the phytophagous insects of the field-layer are not regarded as being of particular interest. However, the venerable trees that give Sherwood Forest its distinctive and evocative character are of outstanding importance, making Birklands and Bilhaugh one of the top national sites for saproxylic invertebrates. Historical records extend back well into the nineteenth century and this tradition of recording has produced a long list of rare species, many of which are known from few other sites in Britain. In recent years there has been an unaccountable decline in the level of survey effort expended on the Sherwood Forest woodlands and modern investigations of the major invertebrate groups would be invaluable. Confirmation of the occurrence of some of the neglected aspects of the fauna is desirable but it is unlikely that many significant changes in the deadwood fauna will have occurred. Beetles and spiders are the most comprehensively recorded groups, together contributing about thirty Red Data Book species to the extensive list of rarities known from the Forest. A high proportion of the beetles are associated with micro-sites, particularly red-rotten heartwood, that occur naturally in trees of great antiquity, such as *Micridium halidaii*, *Plectophloeus nitidus* and *Procraerus tibialis*. The site has also been important in the past for rare leaf-beetles of the genus *Cryptocephalus*, including *C. coryli, C. nitidulus* and *C. querceti*. These species are found as adults on oaks and birches but it is possible that their larvae complete at least part of their development in ant's nests. Arachnologists have also found Birklands and Bilhaugh to be a valuable site for nationally rare species restricted to ancient woodlands with a high population of old trees, amongst which the money-spider *Lepthyphantes midas* and Britain's largest false-scorpion, *Dendrochernes cyrneus*, are of particular significance.

Few other remnants of Sherwood Forest have kept any of the old trees which are so vital for a rich deadwood fauna but similar habitats occur reasonably close-by at Clumber Park. This large estate contains substantial areas of ancient woodland amongst its varied habitats, supporting deadwood beetles like *Corticeus unicolor* and *Pyropterus nigroruber* which are more or less confined to this general area of eastern England. There are undoubtedly other woodlands of value to invertebrate conservation in Nottinghamshire, the ash-wych elm woods of the Magnesian Limestone for instance, but a general dearth of information hampers assessment. A great deal of recording for all groups remains to be done in the area and the historical precedents suggest that this could be richly rewarding.

Although Charnwood Forest in Leicestershire lacks the majestic trees of its Nottinghamshire counterpart there are similarities in terms of the largely acidic composition of its woodlands and in the richness of its historical fauna. There have been losses and modifications over the years but some of the woods and parklands still have a number of old trees and recent surveys have shown that an impressive range of uncommon woodland invertebrates is present. Bradgate Park, Buddon Wood and Swithland Wood are perhaps the best known sites and have been traditionally regarded as important localities for woodland beetles. Buddon Wood was the source of the first British record of the primitive weevil *Tropideres sepicola* and was famed for its myrmecophilous fauna of wood ant nests. Clear-felling and quarrying has seriously affected the interest of the site but recent moth surveys show that the regenerated wood retains considerable interest. A speciality of the Charnwood Forest woodlands is the spider *Tetrilus macrophthalmus* which is found under the bark of old trees and also under stones in company with ants. It does occur in several other parts of England and Wales but is so widespread here that it is sometimes known as the 'Charnwood Spider'.

Ongoing surveys of other wooded habitats in Leicestershire are beginning to demonstrate that the county overall has a good representation of valuable sites for invertebrate conservation and some, such as Leighfield Forest, have considerable potential. The most outstanding recent discovery is the presence of an exceptional assemblage of deadwood invertebrates at the thirteenth century deer-park at Donington Park. Relatively few visits have already determined that Donington Park supports more rare invertebrates than any other site in Leicestershire and it is clearly one of the most important pasture-woodlands in Britain. As with other parklands, this interest lies chiefly in the fauna inhabiting the decaying timber of ancient trees, in this case chiefly oaks up to 800 years old. The fauna compares well with Sherwood Forest, sharing several rarities including *Plectophloeus nitidus*, *Cryptocephalus querceti* and *Lepthyphantes midas*, and further surveys should strengthen this comparison. This is largely because of the abundance of rotten heartwood at Donington Park, a condition which only proliferates in the oldest of our trees and which is well-known to support a highly-specialised, and hence restricted, fauna. Surveys have so far concentrated on the Coleoptera but investigation of the parkland Diptera may also prove fruitful as the oak pollards will provide micro-sites likely to produce a comparative richness of ancient woodland flies.

Woodlands constitute the major habitat resource for invertebrate conservation in Northamptonshire and several areas of the county have substantial blocks of ancient woodland with demonstrated interest. A high proportion of these woods, however, has been modified by forestry activities through the planting of both deciduous and coniferous timber crops and the subsequent cessation of the traditional coppice cycles which were the

dominant form of management. The three south-eastern forests of Whittlewood, Salcey and Yardley Chase have all been affected in this way and there has been a conspicuous decline in the rich butterfly fauna that Northamptonshire once boasted. Although there will be obvious changes in the composition of the woodland fauna as a result of replanting, particularly where alien species replace the native cover, coppice woods on ancient soils can often continue to support a representative fauna during the early stages of the plantation. Major declines are experienced when the timber crop begins to mature and the growing trees shade out the ground flora and deprive invertebrates of the succession of open woodland habitats they would have utilised under a coppice regime. During this phase in the lifetime of a plantation, invertebrates can often survive, albeit in much-reduced numbers, along ride margins, but if the ride system is not maintained then the resultant shady environment can lead to the loss of practically all the former interest. This is a problem which has afflicted many ancient woodland sites in the county and it is only well-managed plantation forests that provide suitable invertebrate habitat alongside the timber crop.

One of the butterfly specialities that has survived in several woods is the black hairstreak *Strymonidia pruni*, chiefly because of its ability to thrive on neglected blackthorn thickets on the wood-edge. This scarce butterfly is restricted to the clay woodlands of the East Midlands forest belt between Oxford and Peterborough where its survival was favoured by the regional practice of long coppice-rotations of up to twenty years. Studies have shown that mature blackthorn is preferred for breeding and the abundance of the host shrub on the heavy soils of the district enables colonies to withstand the periodic loss of suitable thickets. Most British colonies are today found in Northants, Cambridgeshire and neighbouring Oxfordshire, and East Midlands Region is undoubtedly a stronghold for this beautiful butterfly.

Sadly, the chequered skipper *Carterocephalus palaemon* became a casualty of management neglect in its English localities and was last seen in 1975. Although formerly more widespread, by the early years of this century it was confined to the East Midlands counties, chiefly Northants and Cambridgeshire. The reasons behind its decline are no doubt complex but there are strong indications that a lack of management of woodland rides and clearings contributed significantly. Fortunately, we are now aware of strong populations in western Scotland and great strides have been made in our understanding of butterfly ecology in recent years. Other, less-conspicuous, species will have also suffered in the English coppice-woodlands and perhaps some may have become extinct without our knowing. Continuing research into the habitat-requirements of woodland invertebrates is essential but, in the meantime, we must aim to conserve traditional management practices and

ensure that important sites retain a balance to their structure which reflects their historical usage.

The National Nature Reserve at Monks Wood has become a major focal point for woodland research and much of our knowledge of ride management and shade-tolerance in butterflies has come from studies here by the Institute of Terrestrial Ecology. Cambridgeshire is not a well-wooded county but it does contain several valuable sites, most of which were intensively-managed as coppice-with-standards. The deadwood fauna of the county is naturally poor as a result, although two rare beetles, *Osphya bipunctata* and *Ernoporus caucasicus*, have their British strongholds in Cambs. and Northants. The decline of coppicing at classic localities like Monks Wood and Bedford Purlieus has led to the establishment of even-aged high forest and the special interest of these sites is generally associated with the ride systems. The base-rich soils generally promote a diverse ground flora and phytophagous insects are frequently an important component of sites with open clearings. The heavy clays are also responsible for the widespread occurrence of water-logged ground, as in sites like Hayley Wood and Brampton Wood. These areas, with their accompanying stands of pendulous sedge, are inhabited by many scarce invertebrates such as the dolichopodid files *Bathycranium bicolorellum* and *Hercostomus parvilamellatus*. Even temporary puddles or flooded wheel-ruts in forest tracks have their own special fauna, most notably the rather local water-beetle *Helophorus dorsalis*.

The familiar pattern of loss, neglect and modification has affected most woods in the southern counties of Hertfordshire and Bedfordshire, although both areas contain important sites which add to the geographical variation of the Region's woodlands. Maulden Wood has been significantly affected by plantation forestry but there are remnants of the ancient tree cover with a rich shrub layer which has been shown to support a good range of uncommon moths. In places, the broad sandy rides retain heathland elements which were once more widespread on the Lower Greensand. These rides are well-maintained and form an extensive network of wood-edge habitats which has yielded many scarce insects. The site is well-worked entomologically and records exist for a high proportion of the British fauna in groups such as the Heteroptera and certain families of the Hymenoptera. In contrast, Bedfordshire's oldest woodland, the 400 acres of oak/ash forest at Kings and Bakers, is virtually unknown in recent times because of difficulties of access. There are historical records of species such as the chequered skipper, high-brown fritillary *Argynnis adippe*, and the leaf-beetle *Chrysomela tremula*, but management neglect has probably brought about the extinction of many of the open woodland species. However, Kings and Baker Wood still has vast potential for supporting an extremely important woodland invertebrate fauna and its conservation is justly regarded with high priority by local naturalists.

Hertfordshire's woodlands on the London Clay are chiefly dominated by oak and hornbeam. These acidic woodlands are different in character from the rest of the Region and it is unfortunate that so many have been coniferised or lost to urban development. Lepidoptera are the best recorded group and, whilst the butterflies have characteristically declined, species such as the light orange underwing *Archiearis notha*, great oak beauty *Boarmia roboraria* and poplar lutestring *Tethea* or demonstrate that the larger moth fauna is still significant. As semi-natural habitats in proximity to London are under considerable pressure from damage and development, it is encouraging that one of the most interesting sites in the Region is administered as a Local Nature Reserve. Whippendell Wood on the outskirts of Watford is mainly oak-ash-hornbeam high forest, although birch is also dominant in places. Mature and over-mature beeches are also prominent within the canopy and they provide an abundant supply of deadwood habitats for invertebrates. Another feature of the wood is the flowery margins of the broad rides, providing ample nectar sources for woodland insects. This combination constitutes a balanced woodland habitat and it is no surprise that a diverse fauna, containing many rarities, is present. The hoverflies *Volucella inanis* and *Xylota abiens* are indicative of the wood's richness as they respectively require sunny, nectar-rich areas and over-mature timber. The tumbling flower-beetle *Tomoxia bucephala* and the clusiid fly *Paraclusia tigrina* are both nationally rare insects associated with decaying timber in open situations, at Whippendell favouring the fallen beech trunks along the main rides. More interesting discoveries are bound to be made in this valuable woodland and its sympathetic

management is a credit to Watford Borough Council and a model to other local authorities. The woods and parklands of the East Midlands are extremely diverse but they share a common need for forward-planning and continual management if they are to sustain and enhance their value for wildlife conservation. Many lessons have been learnt from the experience of woodland neglect in the middle part of the twentieth century and the opportunity is now there to put knowledge into practice and ensure a safe future for our native woodland faunas.

LOWLAND GRASSLANDS

The widespread loss of lowland unimproved grassland in England and Wales over the last fifty years is well documented and East Midlands Region has fared as badly in this respect as any other area. Outside nature reserves and traditionally-managed common land precious few meadows and pastures of conservation value have escaped agricultural improvement, development, afforestation, etc. and many of the richest sites are now found on the unproductive land of abandoned quarries and railway cuttings. Grassland invertebrate faunas have undoubtedly suffered as a result but there is a general paucity of information on which to base an analysis of declines and extinction. It is at least clear from past records of butterflies that species such as silver-spotted skippers *Hesperia comma* and Adonis blues *Lysandra bellargus* vanished from their sites in the Region as a result of changes in management. How many other invertebrates have become extinct as the quality and abundance of grassland habitats declined will never be known.

Pastures established on acidic substrates have probably always been comparatively rare as the Region's soils are chiefly derived from neutral or calcareous superficial deposits or underlying rocks. Free-draining acidic sands and gravels have tended to produce dry heath or sparse, sandy grassland, which are best considered as grass-heaths and as such are dealt with under 'Heathlands' in the following chapter. The Pre-Cambrian rocks of Charnwood

Forest in Leicestershire nowadays support the only significant concentration of acidic grasslands in the East Midlands. Much of the higher land on the Forest, around 200-250 metres a.s.l., is effectively moorland, being a mixture of wet heathland and poorly-drained sheepwalks dominated by purple moor-grass. At lower altitudes the best site is Ulverscroft Valley, a complex of little-modified habitats including a number of botanically-diverse meadows on the valley floor. The grassland aspects of this large site have not been studied in detail with regard to their invertebrates but species such as the forester moth *Adscita statices* and the weevil *Sitona cambrica* indicate the potential richness. Charnwood Forest is regarded as an 'ecological island' with its nearest counterparts far away to the north and west. It has no parallel in East Midlands Region and this is recognised in a comprehensive conservation strategy developed by local government and conservation organisations. Further attention paid to the invertebrates of the unimproved grasslands will assist management decisions and help to safeguard the scarcer elements of the fauna.

Formerly, much of the Region would have been covered by unimproved neutral meadows on the vast areas of boulder-clay deposits, but this agriculturally-productive land has been steadily improved by re-seeding or the application of inorganic fertilisers. Few examples have survived these treatments and those that have, such as the ridge-and-furrow grassland of Murston Meadows NNR, have hardly been looked at entomologically. The greater difficulties of installing adequate drainage on floodplain meadows has led to the survival of a large number of neutral grasslands on the alluvial soils, as at Loughborough Meadows on the banks of the River Soar and Sawbridgeworth Marshes in Hertfordshire. Several of these sites have valuable lists of invertebrate records but they tend to refer to wetland species of the river margins. Many of the surviving neutral grasslands are managed as a haycrop followed by autumn grazing. Although mowing will inevitably limit faunistic diversity, both as a result of structural uniformity and the removal of aerial parts of the vegetation on which some phytophagous species depend, an interesting fauna can co-exist on traditionally-managed sites. In these cases, timing can be critical and information on the invertebrates present may help to determine the optimal period for cutting hay. Whether pasture or meadow, there is a definite need for increased survey effort on the non-calcareous grasslands of the Region.

Limestone substrates are nationally limited in extent and as calcium-rich soils support distinctive plant and animal communities they have been historically revered for their wildlife value. In the East Midlands there are four main calcareous outcrops - the chalk of the Lincolnshire Wolds, the Magnesian Limestone of Nottinghamshire, the belt of Oolitic Limestone which runs longitudinally through the middle of the Region, and the chalk of the Chiltern Hills in Hertfordshire and Bedfordshire. Calcareous grasslands have traditionally

been popular with entomologists, malacologists, arachnologists, etc. and there is a wealth of information available compared to other grassland habitats. On the basis of these records there are no sites which can be currently regarded as of national importance for their invertebrate faunas but there are several sites which are significant in a regional context. Most of the better localities have a well-documented butterfly fauna but data on other groups often reflects the presence of a local specialist. This patchy coverage makes site-evaluation difficult and additional surveys involving the Hemiptera, Lepidoptera, Coleoptera, Hymenoptera, Diptera and Araneae would be welcomed.

Two of the areas of calcareous rocks are unlikely to contain sites of anything more than local significance for invertebrate conservation. The sheep-grazings of the Lincolnshire Wolds were almost entirely improved 150 years ago and nowadays are under intensive arable production. The only site with known invertebrate interest is the abandoned quarry at Red Hill, where species-rich grassland survives on a steep escarpment. A number of calcicolous moths which are uncommon in the county have been recorded but the only nationally scarce species is the pimpinel pug *Eupithecia pimpinellata*, the larvae of which feed on the flowers of burnet saxifrage. Very few details are available for the invertebrates of the Magnesian Limestone in Nottinghamshire. No extensive areas of grassland have survived in a semi-natural condition but there are a number of railway embankments and disused quarries which are of potential interest. The rare four-spotted moth *Tyta luctuosa* is known from Barnstone Cutting, where other typically calcicolous species include the ground-bug *Eremocoris podaricus* and the chloropid fly *Trachysiphonella scutellata*. The paucity of calcareous grassland in the county suggests that the fauna is unlikely to be of great significance but relict elements may still occur, particularly in the older quarries.

It may seem something of a paradox that artificial habitats are revered for supporting threatened species and typical communities of semi-natural grasslands but there are several good reasons for this. In the first place, it is chiefly sites which have been long abandoned that are of greatest interest as they have had a considerable period of time in which to develop representative faunas. Before sites became totally isolated, as they often are nowadays, there would have been adjacent grasslands of sufficient quality to act as reservoirs for colonisation. This would have been a slow process as calcicolous plants and animals took their place in the developing succession. Relatively mobile species would have been quick to exploit the new opportunities but only sites surrounded by suitable habitat would have been colonised by the more sedentary members of the fauna. Secondly, the steep faces of earthworks, cuttings and quarries are inherently unstable and there is usually a high proportion of bare or sparsely-vegetated ground with a talus of rubble beneath. Open conditions of this nature, particularly on south-facing slopes, are favoured by the strong

component of thermophilous species amongst the calcareous grassland fauna. Such features are now rarely found away from quarries and cuttings and hence they often represent the last remaining localities for a wide range of predators, ruderal phytophages, or burrowing Hymenoptera, in the Region. This is borne out by evidence from the Oolitic Limestone belt which extends from Lincolnshire through Leicestershire, Northamptonshire, Cambridgeshire and Bedfordshire. All of the known sites of importance for the conservation of invertebrates of limestone grassland on this geological formation are old quarry sites. The area to the west of Peterborough is particularly rich and includes important sites like the National Nature Reserve at Barnack Hills and Holes, the local Trust reserve at Collyweston Quarry, Ketton Quarry in Leicestershire, and the potentially significant quarry at Old Sulehay. Collectively these sites support several species which are otherwise scarce in the East Midlands, such as the marbled white butterfly *Melanargia galathea* or the ground-beetles *Licinus depressus* and *Brachinus crepitans*.

Quarrying was probably abandoned at Barnack Hills and Holes nearly 500 years ago and over the centuries the site has developed an outstanding flora. Its pockmarked topography presents a variety of aspects with different microclimates but, as the depressions are relatively shallow, there is little bare ground and scrub invasion has been a problem in the past. The grasslands were frequently burnt, which may have impoverished the fauna, but sheep-grazing has now been re-introduced as the traditional form of management. A small colony of chalkhill blues *Lysandra coridon* is present and rarities include the spider *Maso*

gallicus and the robber-flies *Machimus rusticus* and *Leptogaster guttiventris*. Level ground on quarry floors is always prone to scrub invasion in the absence of management and threatens the botanical richness of the limestone sward. Phytophagous insects are frequently prominent amongst the fauna of species-rich grasslands and many scarce beetles, bugs, etc. are dependent upon calcicolous plants in the herb-rich grasslands. Collyweston Quarries has an excellent phytophagous fauna which includes the weevils *Miarus degorsi*, *Smicronyx reichi* and *Sitona ambiguus* and the leaf-beetles *Mantura matthewsi* and *Aphthona herbigrada*. The prolific stands of dyer's greenweed are especially valuable as they contain a comprehensive range of insects associated nationally with this declining shrub of old pastures; the beetles *Micrambe lindbergorum* and *Meligethes bidentatus*, and the bug *Heterocordylus genistae*, for example. The quarries at Ketton and Old Sulehay contain a greater diversity of habitats, the former having considerable amounts of well-established calcareous scrub and the latter has valuable patches of bare sand and shallow pools. Both sites would benefit from further surveys and there are several other disused quarries on the Oolitic Limestone, which are currently underworked, with great potential.

Most of the chalk in southeast Cambridgeshire is masked by boulder-clay and the only extensive area of semi-natural calcareous grassland is at Newmarket Heath. This has a long history of intensive mowing and the short uniform sward is not favourable to the majority of the chalk invertebrates; accordingly little of interest has been revealed by surveys to date. The best sites in the county are found on the ancient earthworks of Devil's Dyke, Flean Dyke and Roman Road. In the past these embankments would have been grazed by sheep from adjoining pastures but the pastoral economy has given way to arable farming, leaving these sites largely unmanaged as linear islands. The cessation of grazing has led to widespread invasion by coarse grasses and scrub along the earthworks and it is only through the efforts of local conservation organisations that stretches of herb-rich grassland survive. Devil's Dyke has received most attention and in parts a valuable chalk grassland fauna still exists, although it is apparent from historical records that many species are now extinct. Elsewhere, the Gog and Magog Hills at the end of the Chilterns were formerly known for a rich selection of chalk invertebrates but the remaining area of unimproved grassland has been modified by the creation of a golf-course. There is little modern information available on which to judge the present quality of the site but it is likely that a representative fauna has survived in the fairway roughs.

Although recreational uses will obviously affect the value of grassland habitats, they can at least ensure that unimproved grassland is free from major development or agricultural change. This has certainly been the case at Therfield Heath in Hertfordshire, where some 300 acres of chalk grassland have been preserved as a golf course and rifle range. Perhaps

only seventy acres of this has escaped modification entirely but this is still the largest extant site in the county. Silver-spotted skippers were last seen in 1959 but chalkhill blues are still present and limited recording suggests that a decent fauna persists, including the pimpinel pug and the scarce chafer *Omalopia ruricola*. The steep north scarp of the Chilterns used to support vast tracts of sheep-grazed downland but by the 1930s it had been reduced to isolated pockets at sites such as Aldbury Nowers and Ravensburgh Castle. The removal of sheep from the chalkland had led to scrub invasion on many of these remnants but Aldbury Nowers in particular is still a good site for butterflies of the chalk, with colonies of small blues *Cupido minimus* and brown argus *Aricia agestis*.

The situation is very similar on the Bedfordshire chalk where habitat loss and the cessation of grazing has resulted in a significant deterioration of the downland fauna. Barton Hills NNR and the National Trust property at Dunstable Downs have been kept in the best condition and retain colonies of chalkhill blues, Duke of Burgundy fritillaries *Hamaeris lucina*, and the chalk carpet moth *Scotopteryx bipunctaria*. Dunstable also supports what is probably the only population of cistus foresters *Adscita geryon* in the Region and further surveys could well indicate that the fauna of the site is of national significance. Increased recording is also desirable at Barton Hills NNR, which has an excellent flora and is clearly of high potential, whilst management of other remnants, as at the convoluted escarpment of Sharpenhoe Clappers, will be of great benefit to the wildlife interest.

The encroachment of scrub onto open grassland has obvious disadvantages in that it smothers the herbs and fine grasses of the sward, but in moderation some scrub can be beneficial to invertebrates. The introduction of species associated with the scrub adds to species-diversity and scrub can support scarce species in its own right, such as the brown scallop moth *Philereme vertulata* which breeds on buckthorn. A patchwork of scrub can also provide valuable shelter on the exposed downland slopes and on windy days it is noticeable how many butterflies will congregate on the lee-side of bushes. Achieving the desired balance may be a difficult task but, if grazing can be introduced following scrub control, it should be possible to maintain blocks of scrub as shelter-belts without fear of further encroachment. Grassland invertebrates are often extremely sensitive to the microclimate of their environment and will respond rapidly to even minor changes. Sensitive management is, therefore, of critical importance and can bring about catastrophic population declines in a single year if the wrong action is taken. Studies have shown, some of them carried out at Barton Hills, that a mixture of turf-heights is necessary to sustain grassland faunas at their maximum diversity. Species-diversity is not the only criterion of invertebrate conservation but, in principle, grazing pressures which produce a mosaic of short sward and tussocky grassland should be the aim of management. There are now too few sites of quality in the

East Midlands to risk further extinctions from management neglect as the prospects for future recolonisation are negligible.

HEATHLANDS

With few exceptions the heathlands of Britain are anthropogenic, i.e. they owe their origins to the primitive agricultural practices which attempted to create rough grazings or sporadic crop-production on the infertile soils which underlie them. The natural coverage of scrub oak, birch, etc. was cut down and the ericaceous shrubs grazed, burnt or occasionally ploughed to maintain the limited productivity of the land. Although other land-uses, such as bracken-cutting for bedding and coppicing for firewood, have also played their part in sustaining open heath, it is the regular removal of nutrients from the upper soil horizons that has chiefly led to the formation and maintenance of the habitats we recognise as heathland. It is crucial to the understanding of heathland ecology that we appreciate the role such seemingly destructive events have traditionally played in their conservation. For centuries the plants and animals of lowland heaths have adapted to co-exist alongside the catastrophic changes that are periodically essential to hold the habitat at a particular point in ecological succession. Without such intervention the enrichment of the soil allows seedlings to develop and scrub woodland forms, shading-out the heathers and eventually allowing mature secondary woodland to become established.

Management, then, is necessary to keep heathlands in a condition where ling and other dwarf-shrubs are dominant amongst the plant community. However, management is also vital to ensure that the various microhabitats associated with the phases of heathland development are ever-present. In invertebrate terms, this means that conservationists must recognise that the characteristic heathland fauna has evolved to capitalise on the unique conditions that are created by heathland management. They are dependent upon, not endangered by, disruptive changes to their habitat. Although populations of some species will, for instance, be completely destroyed by fire, if the site is large enough to contain separate populations elsewhere then recolonisation should take place as soon as conditions on the managed area are suitable. Most heathland invertebrates are relatively mobile and can take advantage of habitat opportunities if there are no barriers to their dispersal. Of course, the modern decline of heathlands nationally presents two significant problems in that sites are often too small or too isolated to enable natural recolonisation to take place once suitable habitats have been restored. This inevitably leads to a deterioration of the typical heathland fauna, a sorry tale that has afflicted most of the areas of lowland heath in Britain. If this deterioration is not to continue the solution is a simple one even if its execution is problematic - we must ensure that there is no further loss of the heathland habitat and that existing sites are sensitively managed to maintain as wide a range of the stages within the heathland succession as possible.

The East Midlands Region once contained extensive tracts of lowland heath in most of its vice-counties. In common with much of southern Britain, heathland has been steadily destroyed in the Region through agricultural improvement, afforestation and mineral extraction. The remaining heaths are largely fragmented and many are threatened by scrub invasion of bracken encroachment. Although all of the best surviving sites have some form of conservation designation, heathlands require a major input of resources for management and few can claim the level of commitment required to safeguard their future and that of their invertebrate fauna.

The heaths of Lincolnshire are undoubtedly the best remaining examples of the habitat left in the Region and the Lincolnshire and South Humberside Trust for Nature Conservation is making valuable efforts to sustain their importance. Some of the most interesting heaths in the vice-county are on the Coversands of South Humberside. These are administered by English Nature's North-east England Region and are therefore described in the corresponding Review for that Region. This leaves five sites in the modern county of Lincolnshire which have a demonstrated invertebrate interest. Three of these - Kirby Moor, Moor Farm and Scotton Common - have sufficient records to indicate that their current fauna is of national significance for invertebrate conservation.

Scotton Common is the last decent remnant on the Coversands of northwest Lincs. Heathlands were formerly widespread over these deposits of windblown sand but agriculture and afforestation have accounted for most of them. Although Scotton Common suffers from the invasion of birch, bracken and conifers, to the extent that its small areas of wet heath are drying out, a valuable fauna still survives. Scrub control and the reinstatement of grazing is being carried out by the Trust and this should create the pioneer stages of heathland succession which are so important for the more threatened elements of the fauna. The mixture of wet and dry heathland on the common is reflected by the scarcer moths that have been recorded - the silver hook *Eustrotia uncula*, for example, feeding on sedges in wet heath as a larva, and the horse-chestnut *Pachycnemia hippocastanaria* breeding on ling on dry heaths in southern Britain. A management dilemma is provided by the richness of the moth fauna of heathland scrub - birch, willow and aspen being the most important species on heaths in general. Scotton Common, for instance, has the nationally rare, scarce vapourer *Orgyia recens* - a speciality of North Lincs and South Yorkshire - which is probably here breeding on willows, although it will feed on a variety of deciduous trees and shrubs. Heathland scrub can also support a number of scarce beetles and bugs, as well as providing nectar for many insects at certain times of the year. Scrub management should not aim to eliminate all of the bushes on a particular site but rather to confine the scrub to controlled areas where grazing and manual removal can hold encroachment in check.

Another interesting feature of Scotton Common is the presence of sandy pools which are inhabited by several uncommon heathland water-beetles. *Acilius canaliculatus* is particularly noteworthy as the heathlands of Yorkshire and north Lincolnshire represent its main stronghold in Britain. These pools will probably also support an interesting assemblage of invertebrates on their margins but they do not seem to have been fully surveyed to date. Sandy pools are scattered throughout the adjacent Laughton and Scotton Forests (large areas of afforested heath) and some of these have also been shown to contain representative water-beetle faunas. These Forests have remnant heathland along their ride systems and these offer additional areas of habitat for the fauna which may be of value as corridors for dispersing invertebrates. However, this is no compensation for the loss of the original habitat and continued management of the Scotton Common reserve is essential if heathland invertebrates are to thrive in the area.

Kirby Moor and Moor Farm are almost adjacent and, in essence, are detached parts of the same heathland block that was formerly more extensive on the glacial sands and gravels around Woodhall Spa. These two sites are the best recorded of the Lincolnshire heaths and invertebrate interest spans many Orders. The bulk of the area is dry heath, with heather and wavy hair-grass dominant over much of Kirby Moor and sandy acidic grassland prevailing on Moor Farm. There is no problem with scrub invasion but bracken is a problem and the reintroduction of grazing stock is proposed. Fortunately there is a good population of rabbits and they have served to keep open patches of bare sand and lichen-heath in the vicinity of their burrows. Many heathland invertebrates are thermophilous and bare sand presents a hot microclimate that can help to raise body temperature. Some of these species are also dependent upon open patches of firm sand for burrowing, particularly to construct cells for their larvae. A healthy dry heath is one with structural variety in terms of the presence of mature and 'building-phase' stands of heather and a small-scale mosaic of bare ground. Topographical features, such as banks, mounds and the cliff-faces of old sand quarries, can help to achieve this, but in level sites like Kirby Moor close attention must be paid to management in order to achieve a balance in which the full range of niche-opportunities is always present. Wet heath is also present to some extent on both sites and the bog bush-cricket *Metrioptera brachyptera* is found on each. Another interesting species which occurs commonly, although it has declined over much of Britain, is the forester moth *Adscita statices*, a scarce insect of unimproved grasslands where the larvae feed on sorrels *Rumex* spp. Other moths of note at Kirby Moor and Moor Farm include the small grass emerald *Chlorissa viridata*, the Portland moth *Ochropleura praecox* and Archer's dart *Agrotis vestigialis*. These latter two species are more typically inhabitants of coastal sand dunes and it is a feature of the Lincolnshire (and South Humberside) sandy heaths that several invertebrates which are usually regarded as having a coastal distribution have been

recorded. The colydiid beetle *Orthocherus clavicornis* is another example which has been recorded from Kirby Moor.

The grass-heath of Rauceby Warren in South Lincolnshire also has its 'coastal' invertebrates - the sulphur beetle *Cteniopus sulphureus* and the heteropteran bug *Chorosoma schillingi*. Although much of the site has been developed as a golf course, there is a local Trust reserve centred on an old quarry. Where the underlying limestone is close to the surface of the sand there is a mosaic of acidic and calcareous soils, an interesting combination which suggests that further invertebrate recording may be profitable. The same is also true of Linwood Warren, a mixture of woodland, wet and dry heath which suffered from neglect in the past but management has now been reinstated. There are few modern records for the site but it was well-known 30-40 years ago when such rarities as the leaf-beetle *Cryptocephalus coryli* and the dingy mocha moth *Cyclophora pendularia* were recorded. Both of these species feed on heathland scrub and it is quite possible that they have survived the period of neglect. It would be valuable to search for them and other scrub invertebrates in order to provide the local Trust with information on which to base management decisions.

On the Triassic Sandstones of the Bunter Beds around Sherwood Forest, Nottinghamshire, are several remnants of dry heath. Rainworth Heath to the south of the Forest is of potential importance, but two areas - Budby South and Clumber Park - are already known to hold significant populations of heathland invertebrates. These two sites are rather different in character as Budby has severe problems with birch invasion and Clumber Park is more of a grass-heath with a dominance of wavy hair-grass and patchy heather, although scrub is an ever-present threat at this latter site too. Entomologically, Budby is perhaps overshadowed by the neighbouring ancient oaks of Birklands and Bilhaugh, with visiting recorders understandably heading in preference for that exceptional woodland. However, the lepidopterists have shown that a good heathland moth fauna has so far survived the encroachment by birch and arachnologists have been richly-rewarded during their surveys of Budby South. Scarce species such as *Hypsosinga albovittata* and *Hygrolycosa rubrofasciata* are present and the rare theridiid spider *Steatoda albomaculata* of southern heaths has also been found. Clumber Park has been more comprehensively surveyed (although much remains to be done) and has produced interesting invertebrates amongst a range of Orders. Heathland moths are well-represented and include the dingy mocha mentioned above. One of the more outstanding rarities is the handsome yellow and black cranefly *Nephrotoma crocata* - this Red Data Book species has been recorded less frequently in Britain in recent years and is possibly experiencing a worrying decline. The record for Clumber Park is old and it may no longer occur but modern searches would be worthwhile.

The sandy grassland of Clumber Park has been shown to support a rich beetle fauna, examples being the very localised Adonis ladybird *Adonia variegata* and the weevils *Otiorhynchus raucus* and *Brachysomus echinatus*. These species will prosper in relatively herb-rich habitats and the tendency towards a coarsening of the grass-heath sward which is occurring at Clumber Park may threaten their existence. Nottinghamshire is not well-endowed with high quality wildlife sites and management is essential at both of the major heaths if their richness is to be preserved.

The heather-dominated habitats of Leicestershire are completely different from examples elsewhere in the Region as they approximate more to moorland than lowland heathland. This is because they occur at an altitude of around 200-250 metres above sea level in the area known as Charnwood Forest. Here rocky outcrops of igneous material protrude through siliceous clay soils and this acidic landscape was once clothed by an extensive waste of moorland and oakwoods. Remnants of the heaths still occur at sites such as Bardon Hill, Beacon Hill, Bradgate Park and Ulverscroft Valley but it is only at Charnwood Lodge that a large tract has survived. This reserve of the Leicestershire and Rutland Trust for Nature Conservation is a mixture of dry heath, with bilberry and heather, and wet heath dominated by purple moor-grass with heather and cross-leaved heath. Sphagnum pools on the wet heath have a typical assemblage of water-beetles, including uncommon species such as *Enochrus coarctatus* and *Helochares punctatus*. The scarcity of such acidic water-bodies in Leicestershire makes these pools of county importance. Moths recorded to date include a number of species, like the golden-rod brindle *Lithomoia solidaginis*, which are at the edge of their British range on Charnwood Lodge. This is clearly because of the absence of moorland habitats further south in central and eastern England and the conservation of this important site is of particular significance for its contribution to biogeographical studies.

There are several localities in Northamptonshire and Cambridgeshire known as 'Heaths' but they owe their name to the fascinating etymology of heathlands rather than their botanical composition and there are no ericaceous-dominated habitats in these two counties. A similar confusion also occurs in Hertfordshire and Bedfordshire but remnant 'true heaths' do survive on the gravel beds of the former county and the Lower Greensand of the latter. Heathland was once widespread in these areas but there has been a heavy toll from a variety of land-uses and what little remains has suffered from abuse or neglect. Only Bricket Wood Common is of known invertebrate interest in Hertfordshire and there has been a succession to scrub woodland on most of the wet heath. The restoration of management should improve the habitat in the future, although it is likely that the heathland fauna will be seriously depleted in such an isolated site. Little is known of the invertebrate quality of the

wet heath at Hertford Heath, whilst the dry grass-heath at Patmore Heath has extensive scrub invasion.

The entomologically-rich sandstone heaths of Bedfordshire were effectively ruined by coniferisation earlier this century but fragments of open heath have survived and some of the ride systems of the plantations have heathy margins. This is the case at Aspley Heath which formerly supported populations of rare Hymenoptera, such as the parasitic bee *Coelioxys quadridentata*, but invertebrate interest nowadays is restricted to wood-margins and heathy tracks. Coopers Hill was planted with Scot's pines in the nineteenth century but fortunately these were clear-felled in 1917 and heathland left to regenerate at a time when there were still possibilities of recolonisation from existing heaths. Scrub control, largely dependent upon accidental fires at present, is needed to maintain the importance of this site. A characteristic heathland fauna is present, with typical bugs including *Coranus subapterus* and *Rhacognathus punctatus* and the uncommon spider *Alopecosa cuneata*. Remnant heath at King's and Baker's Woods is in danger of being smothered by bracken and is in urgent need of management. This was formerly known as an excellent site for Hymenoptera, with records of such species as *Chrysis fulgida*, *Nomada argentata* and *Methoca ichneumonoides*. Modern recording has concentrated on the Lepidoptera of the adjacent woodlands but Archer's dart *Agrotis vestigialis* is known to occur in the area and detailed surveys of the heathland remnants would be a valuable aid to their subsequent management and conservation.

Heathlands form only a small fraction of the habitat-resource for wildlife in the East Midlands. Problems occur on practically all of the sites but these are not insurmountable and solutions needs to be taken in hand before habitat change proceeds too far. The scarcity of such sites in the Region should be reason enough to allocate their management as a conservation priority, but there is also an international obligation. Lowland heathlands and their distinctive invertebrate faunas have declined alarmingly throughout Western Europe. With increasing fragmentation the chances of species becoming extinct on neglected sites is very real. Heathlands owe their creation to regular bouts of management activity by Man and, if their interest is to be sustained into the future, land-managers must adopt these traditional methods. Whether this is achieved by site-disturbance (through burning, scarifying, etc.) or, particularly on wet heath, through controlled grazing, heathlands demand and deserve practical commitment from conservationists. The heathland invertebrate fauna includes a number of spectacular, colourful and interesting species that are threatened by the malaise of neglect, let us hope that our efforts can ensure a future for these dramatic creatures and the enjoyment they and their associates bring.

OPEN WATER AND ITS MARGINS

In the south of Cambridgeshire, hidden amongst the arable fields of the flat chalklands, are a number of shallow depressions formed by the melting of ice-lenses in periglacial conditions. At first sight they appear to be of negligible value to conservation interest, being little more than muddy puddles in winter or bare, dried-up hollows in the summer. In fact, these ancient seasonal pools represent an extremely rare habitat-type in the modern countryside and are of outstanding importance for their populations of the very rare annual plant, grass poly *Lythrum hyssopifolia*, and the delicate fairy shrimp *Chirocephalus diaphanus*. Seasonal pools challenge our understanding of what constitutes a freshwater habitat. They may retain water for only a few weeks each year and most of the time appear to be completely devoid of aquatic life. However, a fortuitous visit when the pools are full shows an abundance of invertebrates thriving in the warm shallow waters. This distinctive community of ostracods, cladocerans, crustaceans, fly larvae, water-beetles, etc. is dependent upon the regular occurrence of drought as each species has an adaptive strategy to survive these prolonged unfavourable conditions, usually as drought-resistant eggs. The benefits of such a life-style are chiefly the absence of larger competitors and predators, which necessarily require more stable aquatic conditions in which to complete their development to maturity. Fairy shrimps can reach maturity from hatching in just two weeks after the pools are flooded, allowing them to reproduce before the pools are temporarily

colonised by significant numbers of mobile predators, such as water-boatmen or dytiscid water-beetles.

The fairy shrimp is currently known from less than fifteen localities in England and Wales and has apparently declined markedly over the past century. One of the main reasons must have been the general disregard of seasonal pools, their destruction passing without comment as they were either infilled or deepened. With greater knowledge of the unique life-styles of their inhabitants we can perhaps look forward to a more sensitive approach to their conservation and an end to the dissatisfaction that has led to their excavation for 'wildlife ponds'. Seasonal pools are an extreme form of aquatic environment, with the fairy shrimp as an obvious symbol of their importance, and the conservation of their communities of drought-tolerant invertebrates (which can include several other national rarities) should be given the recognition they deserve.

A major cause for concern with all wetland conservation areas is the retention of high water-tables and this is particularly acute in districts with underlying porous rock, such as chalk. The proliferation of groundwater abstraction schemes directly threatens seasonal pools from the effects of draw-down and insidiously damages all affected wetlands by gradually cutting off water-supplies to fens, marshes, lakes, streams, etc. As the water-table falls, one of the most observable signs of damage is the disappearance of formerly permanent springs. Where the flow is unaffected, water emerges from deep within the rocks and is therefore, close to source, maintained at a fairly constant and relatively cold temperature, usually around 9-10oC. Assessment of the importance of such springs nationally is impossible because of the lack of survey coverage but several have been examined in Cambridgeshire and Hertfordshire. Two frequent members of the fauna are the coldwater flatworms *Crenobia alpina* and *Polycelis felina*, characteristic species of cold springs in northern and western Britain but of very local occurrence in southern England and considered to be glacial relicts. The springs at Ashwell, a source of the River Cam in Hertfordshire, and Cherry Hinton in Cambridgeshire are the richest so far known in the Region; the former containing three rarely-recorded ostracods, *Ilyodromus olivaceus*, *Potamocypris wolfi* and *P. fallax*, whilst the latter has the rare flatworm *Bdellocephala punctata*. Although the invertebrate interest of such sites is limited they are clearly significant in the East Midlands and can act as barometers of change with respect to the quality and quantity of water held within the aquifers.

Water quality is of critical importance to aquatic invertebrates and their value as monitors of pollution levels is now widely established. Although the Region has a profusion of rivers

and streams, many of these have been damaged by pollution of one form or another and bank-straightening has afflicted many more by the destruction of natural margins and the structural variety provided by meanders, shoals, riffles, fens and carr. Leicestershire probably has the best selection of relatively undamaged river sections in the East Midlands, amongst which the River Soar appears to be one of the richest. Full surveys of the invertebrates of aquatic and marginal habitats along an entire river are impractical and knowledge of the fauna is strongly biased by observer effort. None of the East Midlands rivers can be said to be comprehensively investigated but, with this in mind, the available records for the Soar suggest that the river has a good range of valuable marginal habitats supporting many uncommon invertebrates. The beetles are best-known, with species such as *Blethisa multipunctata*, *Lathrobium ripicola* and *Chlaenius nigricornis* indicative of the quality of the floodplain, and bankside willows support the impressive musk beetle *Aromia moschata*. The aquatic fauna is virtually unknown but slow-flowing or ponded stretches of the river have populations of white-legged *Platycnemis pennipes* and red-eyed *Erythromma najas* damselflies. With its areas of upland, hard geology, Leicestershire also has more fast-flowing, gravel-bottomed stretches of running water than any of the other East Midlands counties. Some of these, such as the River Gwash and Eye Brook, support species typical of upland Britain, like the beetles *Hydraena rufipes* and *Hydrosmecta thinobioides* and the beautiful demoiselle damselfly *Calopteryx virgo*. The Charnwood Forest streams are particularly noted for their stonefly fauna, including *Capnia bifrons* and *Nemoura erratica*, whilst the caddisfly *Tinodes pallidulus* is currently known only from this area following its extinction at its other British localities in Surrey.

Elsewhere in the Region gravel-bottomed rivers are scarce and hence aquatic invertebrates which are dependent upon the high levels of oxygen trapped by fast-flowing, effervescent waters are generally rare. In the sluggish, low-lying rivers that predominate in the East Midlands these conditions are frequently found downstream of weirs and it is interesting that one such site on the River Nene in Cambridgeshire has an established population of the rare riffle-beetle *Stenelmis canaliculata*. It is also known from the junction of two canalised rivers in the Lincolnshire Fens but otherwise is known to occur only in the River Wye (Powys) and on the shores of Lake Windermere. How a flightless beetle of western Britain came to be established in these rather atypical East Midlands localities is a puzzle.

The River Nene and its tributaries and the Cambridgeshire Ouse are amongst the better lowland systems in the Region and both rivers have retained representative lengths of their natural margins. Wadenhoe Marsh on the Nene is a good example, where a lush fen of reed sweet-grass flanks the river and there are pockets of alder carr and base-rich flushes. This is a good site for wetland flies, notably stratiomyids, which include *Vanoyia tenuicornis*,

Oxycera formosa and *Stratiomys potamida*. The Nene has been comprehensively surveyed for freshwater molluscs with 42 species recorded, including the nationally scarce pea mussel *Pisidium tenuilineatum*. This species is found in a number of slow-flowing rivers and canals with fairly clear water in the south of the Region. The snail *Valvata macrostoma*, which also occurs in clean drains and rivers in most of the East Midlands counties, is sensitive to pollution and disturbance and can be regarded as a good indicator of high-quality watercourses. The Cambridgeshire Ouse has several unspoiled stretches but is poorly-recorded and would benefit from invertebrate surveys. However, the Ouse is well-known for supporting strong populations of the nationally rare, scarce chaser *Libellula fulva*, suggesting that other aspects of its fauna could also prove interesting. The lowland rivers face many threats and invertebrate information can help to preserve important sections from canalisation and development.

It is impossible for us to envisage what the pattern of rivers and streams would have looked like in the lowlands of the Region before the drainage of the Fens. Innumerable watercourses have been changed beyond recognition, leaving behind an immense grid of arrow-straight drains in the flat landscape of arable crops and pasture. For these rivers the damage is done and their natural communities destroyed for ever. Despite this loss of naturalness, however, all is not lost and some drains can support relict populations of fenland invertebrates. Ditches that are to some extent buffered from the worst effects of eutrophication from fertiliser run-off or which have not suffered excessive herbicide treatments can still be significant for invertebrate conservation. Few areas have been looked at in any detail but the rare fenland water-beetle *Agabus undulatus* and the variable damselfly *Coenagrion pulchellum* are known from the Nene Washes and the riffle-beetle *Oulimnius rivularis*, once thought to be extinct in Britain, is probably widespread in the canalised rivers of the area. The Ouse Washes are virtually unknown but it is likely that they also contain important drain systems. In Nottinghamshire, the floodplain of the River Idle has numerous drains and borrow-pits of potential value. The marsh carpet *Perizoma sagittata*, a rare fenland moth which feeds on meadow-rue, occurs along the dykes and fifteen species of dragonflies have been recorded. Surveys of other invertebrate groups will be of great interest.

Greater attention has been paid to the vast network of drains on the arable land of the Lincolnshire fens but this has inevitably tackled only a fraction of the inestimable lengths of drain to be surveyed. From the results so far one site is particularly outstanding but it remains to be seen how many others are of comparable significance. Cross Drain runs for three kilometres through intensively-managed arable fields and yet has an excellent flora containing many relict fenland species. The drain is on the edge of the peat and silt fens and its richness may in part be due to its varied catchment. Whatever the reason, it is clearly an

exceptional site and demonstrates the possibilities that lurk in the most unpromising of environments. An extraordinary 58 species of water-beetles have been recorded, including a dozen nationally scarce species of which two are regarded as rare fenland relicts, *Agabus undulatus* and *Hydrochus ignicollis*.

The present-day value of the fenland drains lies in the fact that they were constructed in areas of existing wetland habitats and some invertebrates were able to survive in the new channels long after their original haunts had been destroyed. The same principle applies to the still-water habitats of the Region and we find that artificial pools and lakes which were excavated in traditional wetlands contain the richest faunas. This is an important consideration in the East Midlands where there are very few natural lakes of any size and yet there is a profusion of flooded gravel pits, brick pits, borrow pits and reservoirs. Sites with representative faunas are most likely to be within or adjacent to areas of existing or former wetlands.

Reservoirs are generally amongst the oldest artificial freshwater habitats and where they have retained varied, semi-natural habitats around their margins there is good potential for invertebrate conservation. Tring Reservoirs in Hertfordshire are a good example as they were built in the midst of a large area of marshland during the last century. It was a popular locality for Victorian entomologists and there is an impressive list of old records for fenland and woodland beetles in particular. Tring seems to have been largely neglected in recent years, although dragonflies and reedbed moths have been casually investigated. Some of the banks are now artificial and of little interest but remnant marshes and wet woodlands are still represented and worthy of present-day investigation. The majority of the reservoirs of current interest in the Region are in Leicestershire, where the topography of Charnwood Forest was suited to the creation of reservoirs for drinking water, and there are also feeder reservoirs for the country's canal network. Saddington Reservoir, a disused canal feeder, is the best of these, with a good range of quality marginal habitats including tall fen, sallow carr and ancient willow pollards. It has a fluctuating water level which produces broad silty margins inhabited by an important and diverse assemblage of wetland beetles. Ground-beetles are particularly abundant and include several scarce species such as *Agonum livens*, *Pterostichus gracilis* and *Bembidion fumigatum*. There has been a tradition of Coleoptera recording at Saddington and in 1949 large numbers of the aquatic weevil *Bagous lutosus* were recorded. It has been looked for recently at Saddington without success but several members of the genus are known to be elusive and *B. lutosus* may still occur in Leicestershire amongst branched bur-reed, its foodplant. Saddington Reservoir has not been surveyed in any detail for other invertebrate groups but the high quality of its margins suggests that there is much of significance still to discover.

The major still-water resource of the East Midlands is undoubtedly the proliferation of flooded pits and quarries that occur to a varying extent in each of the counties. This covers a wide range of substrates through sand and gravel or clay deposits to chalk, limestone, or ironstone. Chalk quarries are too porous to hold substantial areas of open water but two sites in Bedfordshire have shallow seepages, a rare feature in the Region, and both are inhabited by small populations of the scarce blue-tailed damselfly *Ischnura pumilio*. This is a great rarity in south-eastern England and it is dependent upon bare, shallow water-bodies where its larvae can presumably avoid competition with larger predators. In south-western Britain it frequently occurs in newly-dug ponds but soon disappears as the pond matures and other dragonfly species take up residence. There is little additional information for Houghton Regis Quarry but Upper Sundon Chalk Pit has been reasonably-well surveyed in recent years. The seepages and shallow pools here have produced a number of uncommon species which are characteristic of calcareous flushes, including a good selection of soldier-flies like *Oxycera morrisii*, *Stratiomys potamida*, *S. singularior* and *Vanoyia tenuicornis*. Their presence indicates the importance of this site as there can be few other localities in the East Midlands with a comparable assemblage.

The abundance of flooded gravel pits in the Region constitutes a major freshwater habitat resource whose significance has barely been realised so far. Dragonflies are the most comprehensively recorded group and it is clear from present information that several sites, particularly those which have been flooded for upwards of forty years or so, are of regional importance. Swanholme Pits in Lincolnshire, for instance, has seventeen species and is probably the richest dragonfly site in the county. The Ouse Valley gravel pits in Cambridgeshire are an extensive and varied group in terms of age and structure and a number of the older pits support an excellent range of dragonflies. The variable damselfly *Coenagrion pulchellum* is known from several, such as Fenstanton and Hemingford Grey Pits, whilst the scarce chaser *Libellula fulva* is known to be breeding in the Meadow Lane gravel pits. Few other invertebrate groups have been widely recorded in the area but casual surveys by various specialists have shown that, not surprisingly, many other wetland invertebrates of conservation value have colonised the open pits and their margins. As an example, Earith Pits has yielded a long list of rare wetland Diptera associated with bare patches of silt and sand at the water's edge. Dolichopodids, empids and muscids favour this type of habitat and the species recorded include *Hercostomus fulvicaudis*, *Melanostolus melancholicus*, *Spilogona scutellata* and *Microphorus anomalus*. The larvae of each of these species are almost certainly predators within the damp soil and the adults are also predatory on the surface. Their continued presence is dependent upon a degree of management preventing the establishment of dense vegetation around the entire periphery of the pits. However, as the pits cease to be worked there will have to be practical conservation input. It is, therefore,

important to carry out wide-ranging surveys of the existing pits in all of the region's counties to determine a list of priorities for conservation.

Gravel pit surveys are an important requirement for freshwater conservation in the East Midlands as they face increasing threats to their value from a variety of sources, such as infilling, development, recreation etc. Unfortunately, this is only one aspect of the Region's needs as increased recorder effort is desirable on all types of freshwater habitat. Little is known for instance, of the importance of the flooded limestone quarries, and brick-pits have generally received only cursory investigations. Rivers, ditches, canals, reservoirs and artificial lakes would also benefit from increased recorder-effort if the best sites are to be clearly identified, safeguarded and managed. This is undoubtedly a tall order and priorities will have to be defined if progress is to be made. It should be evident from the foregoing account that there is a wealth of freshwater habitats in the East Midlands with considerable importance for the conservation of invertebrates. The success of such conservation will depend largely upon the efforts of both professional and amateur zoologists to generate the information upon which realistic and pertinent decisions can be made.

WETLANDS

Peatlands today occupy only a fraction of the land surface of the East Midlands Region and yet four centuries ago much of north Cambridgeshire and south Lincolnshire would have been blanketed by peat which had formed in the low-lying river valleys surrounding The Wash. Together with the fenlands of East Anglia, this constituted the largest expanse of peatland in southern England, although peatland nowadays is the rarest of the habitat formations in the Region with only a handful of sites of sufficient size and quality to sustain representative invertebrate faunas. In 1848 a post was driven deep into the peat of what is now Holme Fen NNR, the top of which marked the existing level of the peat surface. Three years later, the installation of pumping machinery to drain the nearby Whittlesey Mere led to the intensive agricultural reclamation of surrounding land and the consequent decline in water levels and shrinkage of the peat body. Today the top of that post is almost four metres above the ground, standing as a silent but eloquent witness to the widespread changes that have been wrought on the Cambridgeshire countryside. The same experience can also be felt at both of the major fenland reserves in the Region - Wicken and Woodwalton Fens. These precious sites are now perched like islands above the neighbouring arable land, demanding considerable effort and ingenuity to try and maintain internal water-tables at a height which will continue to support traditional fen communities.

The scale of habitat loss tests the bounds of credibility and it is little wonder that the remaining sites contain so many rare fenland invertebrates and are now of national importance for their conservation. Prior to the drainage of the Fens many of these "rarities" would have been widely-distributed but now they linger on in the few sites where they can find suitable conditions to live and breed. Documented extinctions (e.g. the large copper butterfly *Lycaena dispar* and the rosy marsh moth *Eugraphe subrosea*) are few but many more species must have become extinct as their habitat vanished. Even those species which found refuge in the pockets of fen which survived the major phase of drainage will then have been dependent on favourable management regimes. Unfortunately, the present century has seen many changes in land-use on the remaining fens and there will undoubtedly have been further extinctions as a result.

The peatland fauna in the East Midlands today persists precariously. Some of the more mobile and less-specialised inhabitants can occupy the narrow margins of rivers, gravel-pits and other wetlands, but species restricted to deep peat habitats are isolated in their refugia and totally dependent upon the provision of suitable habitat each year to maintain their populations. A break in the continuity of management can spell doom as there are no adjacent populations available to provide a reservoir for recolonisation when sympathetic management is reinstated. The faunas of sites such as Wicken and Woodwalton are revered for their richness and rarity, but their rarity is essentially a sad by-product of the devastation that has occurred in the surrounding landscape. The diversity of the invertebrate community today must inevitably be only a shadow of the range of species which once inhabited the vastness of the Cambridgeshire and Lincolnshire Fens.

Given this history of extinction in terms of habitats and species it is perhaps surprising that Wicken and Woodwalton Fens have managed to retain such important invertebrate faunas, but this is due in no small measure to the fact that both sites were established as nature reserves in the earliest days of the modern movement of nature conservation. Indeed, Wicken Fen is one of the oldest nature reserves in Britain, land having been purchased for the purpose in 1897 and subsequently bequeathed to the National Trust in 1910, the same year that Woodwalton Fen was bought as a private reserve by the Hon. Charles Rothschild. Both sites had a prior history of entomological recording and were of known value for invertebrate conservation. Over the intervening years management has aimed, through many trials and tribulations, to conserve their considerable importance.

Superficially, there are many broad similarities between the two sites but there are also essential differences which make each reserve unique. Wicken Fen comprises about 250

hectares of open sedge fen, carr, tall fen and rough pasture. Fen carr, dominated largely by alder buckthorn covers much of the site and scrub encroachment has accelerated this century in response to falling water-tables and a decline in the harvesting of *Cladium mariscus*. Approximately half of the site is currently covered by scrub and there are less than fifty hectares of open fen. Many rare invertebrates were last recorded at Wicken in the 1950s when scrub encroachment was reaching a maximum and it is apparent that changes in fen conditions from increased scrub cover are responsible for these extinctions. Since that time there has been a significant increase in the management of the site, aimed at raising water levels and reducing the extent of fen carr, and the 'sedge' and 'litter' fens are now regularly cut to promote plant diversity.

Wicken is regarded as a nationally important site for many groups of invertebrates and the long list of rare fenland species reflects both the extensive recording history and the overall quality of the habitats. The richness of the flora contributes directly to the diversity of phytophagous invertebrates present on site, most notably amongst the moths and the plant-feeding beetles and flies. Of particular significance amongst the larger moths are populations of such species as the marsh carpet *Perizoma sagittata*, reed leopard *Phragmataecia castaneae* and flame wainscot *Senta flammea*, all of which have a highly restricted British distribution. Weevils and leaf-beetles do not seem to have been thoroughly surveyed for many years and there have no doubt been losses amongst this aspect of the fauna in the meantime, but it is likely that future investigations will reveal a considerable and valuable fauna in these beetle families. Stem-boring and leaf-mining flies are also well-represented and three species (the tephritid *Acinia corniculata* and the chloropids *Liparis similis* and its inquiline *Cryptoneura consimilis*) are known from only a small number of the best of the 'East Anglian' Fens.

Another important aspect of Wicken Fen is the profusion of open water habitats provided by the dykes and artificial meres. Where these have shallow sloping banks a very rich invertebrate community thrives, dominated in terms of conservation importance by species which require damp peat or mud for at least part of their life-cycle. When labour was available to maintain the full network of dykes this would have been an abundant microhabitat and this is indicated by past records of an outstanding range of soldier-flies, constituting one of the richest assemblages of any British site. Neglect in the middle part of this century led to a deterioration of the dyke margins and, whilst species like *Oxycera morrisii* and *Vanoyia tenuicornis* have lingered on, there are no records for many decades of *Odontomyia angulata*, *Stratiomys chamaeleon* or *Stratiomys longicornis.* Open peat margins are also beneficial to the snail-killing flies and, although the very rare *Pteromicra pectorosa* and the scarce *Pherbellia dorsata* still occur, much of the former richness in the family also

appears to have declined. The watercourses of Wicken Fen are now managed on a regular basis once again and the future for the remaining specialists of the dyke margins may be assured.

Despite the troubles that have besieged Wicken Fen in the past this is still an outstanding locality and, in addition to species mentioned earlier, provides a home for several invertebrates which are either only found at Wicken or else occur on only one or two other high-quality fens. Examples include the beetles *Oberea oculata*, *Microptilium palustre* and *Ptilium affine* and the spiders *Centromerus incultus* and *Neon valentulus*. As long as the present management vigour is harnessed to ecological research Wicken Fen will continue to be amongst the top sites of national importance for invertebrate conservation.

Extensive research has shown that Wicken Fen has probably always been based on alkaline sedge peat but Woodwalton Fen developed through this stage to become, at least in part, a raised mire of acidic moss peat. Much of this was cut for fuel in the nineteenth century but a relict area of acid mire is still present at the south end of the site where purple moor-grass and bog myrtle are the most conspicuous plant species. The rest of the reserve is a mixture of tall mixed fen and scrub, compartmented by an extensive system of internal dykes, and the whole site amounts to c. 230 hectares. Changes in land use and the lowering of the water-table through improved drainage of adjacent agricultural land led to familiar problems of scrub invasion and it is estimated that 90% of the reserve was occupied by a mixed scrub of sallow, blackthorn and buckthorn in 1954. This has been extensively controlled in recent years such that pockets of wet woodland and fen carr are now interspersed with open fen.

The complex management history of Woodwalton Fen, involving peat-cutting, grazing, cutting, winter-flooding and neglect, has meant that the invertebrate fauna has undergone numerous disruptive phases in the past. These upheavals will have had profound effects on the composition of the invertebrate communities such that, on present knowledge, the wetland fauna appears to be less rich than Wicken Fen. Some of this may be due to the greater recording effort experienced by the latter site but many of the differences can be explained by the historical discontinuity of fenland habitats. Nonetheless, Woodwalton Fen has its fair share of nationally rare invertebrates and is justly considered to be of outstanding importance for the conservation of several groups.

The most well-known species is unquestionably the large copper butterfly, represented by an introduced race, *Lycaena dispar batavus*, from Holland, which was established here in

1927 after the indigenous race had become extinct following the 'Drainage of the Fens' in the 1850s. A great deal of management effort is expended on this colony and some compartments are managed almost exclusively with its requirements in mind. Such care afforded to an introduced butterfly may seem to be unwarranted but, in fact, the knowledge gained from the experience of this research has wide applications. Not only is there a substantial contribution towards the conservation of this threatened species in its European biotopes, but lessons are also learnt which help to recreate fenland conditions in Britain which approximate to the habitats present in the East Anglian Fens prior to 1850. This will have benefits for other elements of the fenland fauna which coexisted alongside the large copper and which therefore represent a community of invertebrates that was once relatively widespread in the area. The full range of species will never be recovered but, in creating a viable replicate of former conditions, conservation will have succeeded in re-establishing a glimpse of the past habitats that formerly prevailed, and this can only be advantageous to our fuller understanding of the ecology of fenland invertebrates today.

The management requirements of fenland moths are also the focus of research at Woodwalton and investigations are under way to determine optimal cycles of reed-cutting which will sustain moth populations dependent on different growth-stages of reed. Other species which breed on fenland herbs may show a preference for hostplants growing in specific conditions and there are indications, for instance, that the marsh carpet favours large plants of meadow-rue growing in exposed situations, such as along the margins of dykes. Surveys on the reserve of invertebrates from groups other than the Lepidoptera tend to be of a more casual nature but the overall picture is of a rich fauna with many nationally rare members. The relict fenland water-beetles *Agabus undulatus*, *Helochares obscurus* and *Hydrochus elongatus* are indicative of the extensive network of dykes with good water quality and the presence of a range of scarce flies, such as *Phorbia longipilis*, *Chamaemyia paludosa* and *Phaonia atriceps*, serves to highlight the continuing importance of Woodwalton Fen for invertebrate conservation. There are also specialities amongst the spider fauna and the wolf-spider *Pardosa paludicola* has one of its strongest British populations here.

Woodwalton Fen represents one of the few known British localities for many of the species listed above (and several others not mentioned) and, along with Wicken Fen, provides a last major refuge for the threatened fenland fauna of the East Midlands. The only other significant area of peat occurs on the National Nature Reserve of Holme Fen a few kilometres away, but most of this is clothed in mature birch woodland and there are only isolated pockets of open fen. The invertebrate interest of the reserve is chiefly centred on the silver birch woodland which has developed over the last one hundred years on the 260 hectares

of drained peat. However, where fen vegetation persists in clearings in the wood, some elements of the fenland fauna have survived. The excavation of large meres has also allowed for recolonisation by many fenland water-beetles and as fen plants become established on the banks of the meres more characteristic invertebrates will be able to spread out from the woodland glades to strengthen their populations on Holme Fen.

Elsewhere in Cambridgeshire peatlands tend to be small and rather neglected but most contain at least some of the typical invertebrate species associated with the southern fens. A few of these do have the potential of supporting an interesting fauna, particularly Wilbraham's Fen, but none of them have received more than casual recording effort to date and detailed surveys could generate valuable results. One site which has been the subject of several entomological visits is Sutton Heath and Bog, a shallow valley fen which is spring-fed by flushes rising from the adjacent limestone grassland. The mossy seepages contain rarities such as *Oxycera morrisii* and *O. pardalina*, and the tussock sedges of the valley bottom support a healthy population of the whorl snail *Vertigo moulinsiana*. These small pockets of ancient wetland, despite their size and isolation, are clearly still capable of maintaining interesting faunas and invertebrate recorders could materially help with their conservation by providing information on the species present and their management needs.

Very few peatlands have survived in the southern part of the Region but Flitwick Moor in Bedfordshire is a notable exception. This is a large area of floodplain fen containing a variety of peatland habitats ranging from dense willow carr through to fen meadow. Historically, Flitwick Moor was well-worked entomologically and its fauna was distinguished by a number of species which are generally considered to be more typical of northern peatlands. Problems with declining water-tables in the recent past led to fears that much of the interest was severely threatened but, with restoration of a high water-table, it appears that the site has suffered comparatively little. The mixture of acidic and alkaline peats and the complex mosaic of fen habitats combine to provide an important site for invertebrate conservation and now that there is greater control over its management its future seems assured.

There are very few peatland sites in any of the remaining East Midlands counties that, on present knowledge, can be regarded as being of national significance for their invertebrates. Fens are generally restricted to the narrow margins of rivers and lakes and more extensive areas of peat are almost unknown. An exception is Lincolnshire where there are still a couple of quality sites left in the Wash basin and the floodplain of Calceby Marsh (although chiefly developed on alluvial silt) has considerable recording potential. The best of the Wash Basin fens are Thurlby Fen and Baston Fen, both of which are centred on flooded borrow-pits. Dragonflies are well-recorded and include populations of the variable damselfly *Coenagrion pulchellum* and the hairy dragonfly *Brachytron pratense*. The terrestrial fauna is less well-known but there are records of several scarce fenland flies and moths (e.g. the mere wainscot *Photedes fluxa* occurs at both sites) and the Hemiptera include the nationally-restricted bugs *Capsus wagneri* and *Tytthus geminus*. Lincolnshire also has one of the few completely acidic mires of any quality in the Region, on the local Trust reserve of Moor Farm. Lepidoptera records show the basin mire and adjoining poor fen to be of considerable interest, but there is very little information available for other invertebrate groups in the acid bogs on the reserve.

This summary of the East Midlands peatlands has naturally concentrated chiefly on the major Cambridgeshire reserves as they are unquestionably of greater significance than the remaining wetland fragments scattered throughout the rest of the Region. However, the importance of the other fens should not be dismissed as they represent the last remaining examples of a habitat-type which was once widespread and which has steadily been lost to reclamation. It would seem that the conservation of all the remaining viable areas of peatland in the Region is essential if we are to retain anything like a representative fauna of the countryside as it once was. It is unlikely that any major sites remain to be discovered and efforts should be concentrated on documenting the fauna and ensuring that management achieves the optimum conditions for sustaining typical peatland invertebrate assemblages.

Some of the Region's sites are nationally outstanding but all of them play their part in helping to conserve what was once so characteristic of the natural history of the East Midlands.

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APPENDIX 2: NOTABLE SITES FOR INVERTEBRATE CONSERVATION IN EAST MIDLANDS REGION

1. AVERSLEY WOOD (TL163819) - An ancient ash-maple woodland with broad herb-rich rides. Considerable amounts of deadwood are present, mainly as a result of Dutch Elm Disease, and this supports a number of scarce saproxylic beetles including the false darkling beetle *Osphya bipunctata*. Little information is available for other invertebrate orders and there would appear to be good potential for many significant discoveries.

2. BARNACK HILLS AND HOLES NNR (TF076047) - Ancient quarry workings for limestone have produced the distinctive topography of this large area of unimproved calcareous grassland. The slopes and hollows of the old pits provide microhabitat diversity in terms of aspect and humidity and this can be expected to be reflected in the richness of the invertebrate fauna. The limestone grassland is extremely rich floristically and phytophagous insects are well represented. This is one of the best butterfly sites in the Region, with marbled whites *Melanargia galathea* and chalkhill blues *Lysandra coridon* of particular note, and the robber-fly *Machimus rusticus*, a rare species of dry grassland in southern England, occurs commonly.

3. BARNSTONE CUTTING (SK740357) - An 800 metre length of disused railway cutting, supporting coarse neutral grassland on the banks and more open grassland, with some shallow pools, on the line of the former track. The invertebrate interest of the site lies chiefly in the inhabitants of the remaining areas of dry open ground, including a number of scarce species of Coleoptera, Diptera and Lepidoptera. Scrub invasion is threatening many of the more interesting areas and regular management is required to ensure that this valuable site retains its importance for invertebrate conservation.

4. BASSENHALLY PIT (TL286985) - Floristically-rich marshland adjoining a shallow pool which has developed in old gravel workings. Despite its small size, Bassenhally Pit has an exceptional wetland and aquatic invertebrate fauna which includes the rare water-beetles *Haliplus variegatus* and *Hydrochus elongatus* and a good range of other scarce invertebrates. Owned by Cambridgeshire Wildlife Trust.

5. BASTON FEN (TF145175) - Winter-flooded tall fen and grazing marsh on the banks of the River Glen. Old borrow-pits support a rich aquatic flora with marginal stands of

reedmace and bulrushes. This Lincolnshire and South Humberside Trust for Nature Conservation reserve is one of the last remnants of washland in Lincolnshire and contains an important invertebrate fauna typical of lush southern fens.

6. BEDFORD PURLIEUS (TL042995) - Two hundred hectares of ancient coppice woodland on the Jurassic Limestone. The rich soils and traditional management sustain a diverse woodland flora which is enhanced by the extensive network of rides that dissects the wood. Phytophagous invertebrates from many groups are well represented here and the maintenance of open rides and coppice systems is important for their conservation. Clay deposits overlie much of the limestone and many of the rides are damp and base-rich, providing ideal conditions for a range of scarce woodland invertebrates. Management neglect has caused the decline of some of the more light-demanding invertebrates but the reinstatement of coppice rotation should ensure that Bedford Purlieus maintains its considerable importance for woodland invertebrates.

7. BIRKLANDS & BILHAUGH (SK620683) - These two areas of ancient oak woodland and grass heath comprise about 550 hectares of the best remnants of Sherwood Forest. Much of the invertebrate interest is associated with the large population of ancient standing oaks which support an exceptional fauna of species restricted to microhabitats provided by over-mature trees, particularly amongst the Coleoptera and Arachnida. The acidic sandy heathland is also of interest, with records of nationally uncommon moths and spiders amongst its fauna. Sherwood Forest Country Park contains most of the woodland within the site and this is managed with regard to its importance for invertebrate conservation. However, problems caused by increasing public pressure may need to be addressed in the future.

8. BRADGATE PARK (SK535110) - An ancient deerpark containing a broad range of habitats which together support an important assemblage of invertebrates. The Park consists chiefly of dry acidic grassland but there is also a small area of wet heath with *Sphagnum* pools that are inhabited by several water-beetles, typical of such acid ponds that are otherwise rare in the Region. Groves of 300 year old stag-headed oaks are significant for their deadwood fauna, which includes many scarce beetles and the spider *Tuberta macrophthalma*.

9. BRAMPTON WOOD (TL180702) - Situated on a chalky boulder-clay, this wet ash-maple woodland is one of the largest remaining blocks of ancient woodland in Cambridgeshire.

Although parts have been adversely modified for forestry activities, most of the woodland is composed of neglected coppice with a variety of tree species. Broad rides with their lush flora are an important feature of the wood and the richness of the Lepidoptera and Diptera present reflects both the botanical diversity and the dampness of the woodland soils. Other invertebrate groups are under-recorded but Brampton Wood has considerable potential for a range of phytophagous and damp-loving invertebrates.

10. BRICKET WOOD COMMON (TL130010) - Bricket Wood Common is a large area of wet heath on boulder-clay (with pockets of drier heath on gravel capping) and stands of ancient pedunculate oak/hornbeam woodland. This was formerly an extremely important locality for invertebrate conservation but over the past forty years or so management neglect and road construction have led to a deterioration in habitat quality. The site undoubtedly still contains an interesting fauna but systematic surveys are needed to determine the management requirements of the remaining features of interest.

11. BROXBOURNE WOODS (TL335078) - Several square kilometres of ancient oak/hornbeam woodland and ancient replanted woodland. The extensive ride networks have a good marsh flora and, along with the open woodland of the recent planting, support a rich variety of butterflies and moths. Much of the old standing timber in the woods has been destroyed by forestry operations, although some pockets do survive. Comprehensive invertebrate surveys are highly desirable to ensure that future management takes account of the potential of Broxbourne Woods for invertebrate conservation.

12. BUDDON WOOD (SK560145) - Much of the interest of this historically-renowned birch/oak woodland was lost when the site was clear-felled during the Second World War. However, Buddon Wood was left to regenerate naturally and, although quarrying operations are a continuing threat, there is still a valuable woodland and moorland fauna present.

13. CALCEBY MARSH (TF398772) - Ten hectares of base-rich marshland on the north-west bank of Calceby Beck, a Lincolnshire Wolds chalk stream. The marsh vegetation supports a number of scarce wetland moths, including species such as *Athetis pallustris* and *Nascia cilialis* which are more or less confined to the East Anglian fens. Calcareous

marshland of this quality is a scarce habitat-type nationally and it can be anticipated that other elements of the invertebrate fauna will prove to be of considerable importance. Surveys of groups such as the Diptera, Coleoptera and Hemiptera are highly desirable.

14. CASTOR HANGLANDS NNR (TF119015) - A mosaic of semi-natural habitats on the Jurassic Limestone, consisting chiefly of ancient ash-oak woodland with broad scrub edges adjoining unimproved limestone grassland. A series of pools and associated fens on the superficial clays support an excellent dragonfly fauna, including Brachytron *pratense*, and these wetland habitats are an important feature of Castor Hanglands for invertebrates. The juxtaposition of woodland and grassland provides an extensive length of high quality edge-habitat, supporting a strong colony of black hairstreaks.

15. CENTRAL LINCS LIMEWOODS (TF094750) - A series of small woods which together form the largest concentration of woodlands dominated by small-leaved lime in Britain. The canopy varies with soil-type, sandy drift supporting acid sessile oakwood whilst gleyed clay soils have extensive tracts of neglected lime coppice. Plateau alder coppice occurs locally on waterlogged sands. Recent recording has been concentrated on the Lepidoptera and several nationally rare or scarce species are present. Older records of woodland Coleoptera indicate the potential importance of the woods for this group. The majority of the site is owned by the Forestry Commission and managed as a Forest Nature Reserve. Reinstatement of the traditional coppice regime should be seen as a management priority for invertebrate conservation.

16. CHARNWOOD LODGE (SK467153) - As the largest example of the moorland habitats which were once typical of the Charnwood Forest, this is a regionally-important locality for invertebrates associated with acidic wetlands and heathlands. Moths, spiders and water-beetles which typically occur in such habitats are well-represented here, although generally scarce in the East Midlands. Charnwood Lodge is a nature reserve of the Leicestershire and Rutland Trust for Nature Conservation.

17. CLUMBER PARK (SK622744) - This estate of the National Trust contains a wide variety of habitats, including extensive areas of grass heath and mature deciduous woodland. The fauna shows affinities with nearby Sherwood Forest and several scarce species have been recorded, particularly amongst the Lepidoptera and the deadwood Coleoptera. Habitat diversity is extended by an ornamental lake and its wetland margins. In view of

its large size and well-established habitats this is a site of great potential which would benefit from further invertebrate survey.

18. COLLYWESTON GREAT WOOD & EASTON HORNSTOCKS (TF013004) - This large area (150 hectares) of ancient woodland is dominated by small-leaved lime with varying mixtures of ash, oak, birch, maple and hazel. The woods have received little attention from entomologists but the few available records suggest that a valuable fauna is present, probably sharing many affinities with the adjacent Bedford Purlieus (q.v.). Increased recording effort is strongly recommended.

19. COLLYWESTON QUARRIES (TF004038) - A reserve of the Northamptonshire Trust for Nature Conservation, this is an area of unimproved grassland on the site of a former Jurassic Limestone quarry and is the best example of this habitat type in the county. The herb-rich grassland supports an extremely rich phytophagous fauna with several nationally uncommon weevils and leaf-beetles in particular. The abundance of dyer's greenweed is a notable feature of the site and this supports an important assemblage of invertebrates.

20. CROSS DRAIN (TF161136) - A three-kilometre length of fen drain in the low-lying arable landscape of south Lincolnshire. An outstanding assemblage of water-beetles is present (58 species recorded), including relict fenland species such as *Hydrochus ignicollis* and *Agabus undulatus*. Cross Drain is unusual in that its water-quality is little-affected by agricultural runoff and the clear, gravel-bottomed water supports an exceptionally diverse aquatic flora which also contains relict fenland elements.

21. DEVIL'S DYKE (TL568660) - A twelve kilometre length of ancient linear earthwork containing the best chalk grassland remaining in Cambridgeshire. The deep ditch and embankments were traditionally sheep-grazed but this ceased with the loss of adjacent pasture to arable crops. Scrub invasion is a major management problem but there are still extensive stretches of botanically-rich chalk grassland supporting a range of characteristic and scarce invertebrates. A disused railway line crosses the northern end of the site and the sheltered cutting has also developed a calcareous flora with an associated invertebrate fauna of note. Part of Devil's Dyke is a CAMBIENT reserve which is being managed to clear invading scrub and to reclaim the traditional chalk grassland habitat.

22. DOGSTHORPE BRICKPIT (TF213027) - A series of disused brickpits which are partly flooded and are colonised to a varying degree by aquatic and marginal plants. Only limited invertebrate recording has been carried out but an interesting fauna has been found in the pools and on the sparsely-vegetated surrounds. In particular, a number of nationally scarce water-beetles are known to occur, many of them associated with the silty margins of shallow pools.

23. DONINGTON PARK (SK414269) - Recent surveys have shown that this is undoubtedly the most important site in the Region for the conservation of invertebrates associated with over-mature trees. The deerpark dates from the thirteenth century and some of its ancient pollard oaks are at least 800 years old. These venerable trees provide a variety of conditions favoured by deadwood invertebrates and a long list of nationally rare species has been recorded. The fauna includes a number of beetles, spiders and pseudoscorpions which are known from very few sites in Britain and it is clear that Donington Park is nationally one of the most important localities for saproxylic invertebrates.

24. EARITH GRAVEL PITS (TL392758) - Flooded gravel workings with large open-water pits and several smaller pools with well-developed marginal plant communities on the edge of the Ouse Washes. Limited survey work to date has shown that an important invertebrate fauna is associated with the areas of bare silt and sandy spoil-heaps resulting from gravel-washings. Reed beds and mature willow scrub add further interest.

25. FENSTANTON GRAVEL PIT (TL304684) - This site consists of a large flooded gravel pit which was dug about 50 years ago and last worked in 1970. Lush marginal fens and substantial areas of willow carr provide shelter for the excellent range of dragonflies which have colonised the site, including a large population of *Coenagrion pulchellum*. Fenstanton is almost certainly the most important gravel pit site for dragonflies in the Ouse Valley. Associated reedswamp and carr habitats are also of importance, particularly for wetland flies.

26. FLITWICK MOOR (TL046354) - Approximately 50 hectares of eutrophic valley fen, the largest surviving area of wetland in Bedfordshire. There have been problems affecting the water-table in the recent past which has caused the invasion/extension of oak/birch woodland, but the Beds & Hunts Wildlife Trust, who manage most of the Moor, have

succeeded in maintaining water-levels in recent years. Historically Flitwick Moor has been well-studied in terms of invertebrate recording and the Hymenoptera particularly have been the subject of special attention. There are representative lists for many other Orders which together indicate that a rich wetland fauna is present but there is a need for continued recording to document the current fauna following the changes to the site resulting from past management neglect.

27. FOWLMERE FIELD (TL427462) - Ice-lenses which formed in the permafrost of the last glaciation melted to produce shallow depressions which today form part of a hummocky topography in the arable landscape of south Cambridgeshire. These hollows are seasonally flooded and the temporary pools support populations of the scarce fairy-shrimp *Chirocephalus diaphanus* at their only locality in the Region. Such ephemeral water-bodies are generally rare and their highly-specialised fauna, capable of withstanding long periods of drought, is dependent upon the continuance of the traditional management practices which have ensured their survival.

28. GIBRALAR POINT NNR (TF560580) - One thousand acres of saltmarsh, dunes and dune grassland at the northern tip of the Wash. Gibraltar Point is a Local Nature Reserve managed by the Lincolnshire and South Humberside Trust for Nature Conservation. The broad range of dune habitats supports an excellent coastal fauna with groups such as the Lepidoptera, Diptera and Coleoptera represented by many nationally uncommon species. Sea buckthorn scrub is a problem in the areas of fixed dune but the early stages of dune and saltmarsh succession are particularly well-developed.

29. GLAPTHORNE COW PASTURE (TL003905) - One of the strongest colonies of black hairstreaks in Britain breeds on the dense blackthorn scrub which proliferates amongst this ash-maple woodland. The wood is managed on a long coppice cycle by the Northamptonshire Trust for Nature Conservation to maintain suitable breeding habitat for this rare butterfly. There is little information on other aspects of the invertebrate fauna and surveys would be useful to help with management decisions.

30. GRIMSTHORPE PARK (TF022197) - An ancient deerpark, probably dating from the twelfth century, which contains the richest deadwood fauna in Lincolnshire. Mature and over-mature pedunculate oaks have provided most of the records of interest, with an impressive range of ancient woodland indicator beetles present. Little work has been done on other invertebrate Orders. The park is situated on boulder-clay and

limestone and the unimproved grasslands, although they have received far less attention, are also known to support a number of uncommon invertebrates. Grimsthorpe Park is a reserve of the Lincolnshire and South Humberside Trust for Nature Conservation.

31. HAYLEY WOOD (TL291529) - An ancient oak-ash woodland on heavy boulder clay which is one of the richest woodland invertebrate sites in Cambridgeshire. Areas of coppice are managed on rotation by CAMBIENT and the woodland also contains glades and an abundance of deadwood. The dipteran fauna has been well documented and several nationally rare species have been recorded but further surveys of other invertebrate groups are desirable.

32. HEMINGFORD GREY PITS (TL297709) - Available records for the Diptera and Odonata show that this series of disused gravel pits (c.50 years old) supports a rich wetland invertebrate fauna. The variable damselfly is present and there is a large population of red-eyed damselflies. The pits have a considerable extent of marginal and emergent vegetation and further surveys should confirm the importance of Hemingford Grey Pits for a broad range of wetland invertebrates.

33. HOLME FEN NNR (TL205895) - The nationally important silver birch woodland which covers most of the 266 hectares of the reserve has developed over the last 100 years on fen peat which was drained in the 1850s and subsequently converted to arable. Despite these major changes to the habitats and hydrology of Holme Fen, the reserve has a surprisingly rich woodland and wetland invertebrate fauna, presumably resulting chiefly from past colonisation when the surrounding landscape still held areas of semi-natural fenland habitats. New meres created by licensed peat-cutting have still to develop a characteristic fauna but eventually they should enhance the restricted pockets of open fen currently available. Holme Fen has been comparatively well surveyed for invertebrates but there are undoubtedly many other discoveries to be made.

34. KETTON QUARRIES (SK973056) - Herb-rich limestone grassland has developed on this large area of disused quarries and spoil-heaps. A characteristic fauna of calcareous grasslands is present, including several species which are otherwise uncommon in Leicestershire. Scrub encroachment threatens to reduce the value of Ketton Quarries for invertebrate conservation but, providing this can be controlled, the site will be a valuable locality for the range of restricted species it is known to support. Only a limited amount of invertebrate recording has taken place to date and further surveys would be of interest.

35. KING'S AND BAKER'S WOODS (SP925300) - The largest and oldest area of woodland in Bedfordshire, containing a mixed canopy with stand types varying in response to the underlying soils and their drainage. Oak/hazel coppice is dominant over large areas, with birch prominent on sandy acid soils, and an abundance of aspen as an important feature. The wood was entomologically renowned up to the 1950s but since then there has been management neglect and a degree of site disturbance which may have had detrimental effects upon some elements of the fauna. Recent recording has been restricted by access difficulties but there are indications that this is still a site of major significance for invertebrate conservation. Part of the wood is now a reserve of the Beds and Hunts Wildlife Trust, where management is being reinstated. King's and Baker's Woods and the remnant sandy heaths within its boundaries have considerable potential for wildlife conservation and surveys are urgently required to ensure that the needs of the invertebrate fauna are considered in future management.

36. KIRKBY MOOR (TF225625) - This reserve of the Lincolnshire and South Humberside Trust for Nature Conservation consists chiefly of dry heathland and acid grassland which has developed over glacial sands and gravels. This is the largest heathland remnant surviving in the county and as such is an important stronghold for heathland invertebrates. Only the Lepidoptera have been comprehensively surveyed and further recording for other invertebrate groups is recommended. Oak and birch scrub is locally established in the southern half of the site where there are also elements of wet heath and fen on peaty soils.

37. LITTLE PAXTON PITS (TL196631) - An extensive series of flooded gravel pits, varying in terms of size, depth, age and degree of colonisation by aquatic and emergent vegetation. The area has not been exhaustively worked for invertebrates but several nationally scarce species are recorded, particularly amongst the Diptera and aquatic Coleoptera. Patches of bare silt and the marginal fens are currently regarded as the

most important features of Little Paxton Pits but the site also contains a mosaic of grassland and scrub that is of potential interest.

38. LOCKINGTON MARSHES (SK486304) - On the floodplain of the Rivers Soar and Trent, Lockington Marshes contains a mosaic of fen meadow, freshwater marsh, pools and willow carr. There has been limited invertebrate recording to date but the species found so far indicate that a rich wetland fauna is present and there is also interest in the deadwood Coleoptera of the old willows and adjacent hedgerow trees. There are few other comparable wetland habitats in Leicestershire and in this respect the site can be regarded as of considerable significance.

39. MAULDEN WOOD (SP070390) - Maulden Wood is an example of the ability of ancient woodland sites to maintain a rich fauna after they have been converted to plantation forestry. This is due largely to management practices which keep open a network of sunny rides and provide an abundance of edge habitats. Although the deadwood component of the fauna is obviously lacking, Maulden Wood is an important locality for phytophagous insects and the Hymenoptera of its open, sandy rides. The wood is owned and sympathetically managed by the Forestry Commission.

40. MONKS WOOD NNR (TL200800) - One hundred and fifty hectares of ancient ash-oak woodland on heavy clay soils, most of which was traditionally-managed as coppice-with-standard. Monks Wood is one of the best studied woodlands in Britain and the extensive lists of rare invertebrates known from the site reflect both this high level of recording effort and the habitat quality of the present-day woodland. However, clear-felling during the First World War removed practically all of the mature timber and the deadwood fauna undoubtedly suffered as a result. The richest aspects of Monks Wood for invertebrates are the glade and wood-edge faunas which are dependent upon the maintenance of broad ride systems and the coppice rotation. In this respect, much valuable research work has been carried out on the conservation implications of management in Monks Wood, research which is of considerable importance for invertebrate conservation nationally.

41. MOOR FARM (TF223637) - The Lincolnshire and South Humberside Trust for Nature Conservation reserve of Moor Farm occupies 46 hectares of grass-heath and acid peatland habitats which were traditionally-managed up to 1960. There then followed a period of neglect until the site became a nature reserve and grazing was reinstated.

The sandy heath has close affinities with nearby Kirkby Moor (q.v.) and several scarce heathland invertebrates are common to both sites. Additionally, Moor Farm has important areas of poor-fen and acidic basin mire communities which are known to support an interesting Lepidoptera fauna and which are likely to be of wider importance for invertebrate conservation.

42. RAMSEY HEIGHTS CLAY PITS (TL245848) - This small CAMBIENT reserve shares many elements of its fauna with the adjacent Woodwalton Fen NNR. The disused brickpits have a series of flooded hollows with extensive marginal fens of reedmace and common reed and stands of mature willows. Several nationally rare water-beetles are known to occur and a good range of scarce wetland flies has also been recorded. Light-trapping has indicated that the moth fauna is also of interest but some of these records may represent wanderers from Woodwalton Fen and confirmation of breeding would be desirable.

43. ROCKINGHAM CASTLE PARK (SP860907) - An extensive area of old parkland with over-mature trees represented by a variety of species. The park also contains copses and spring-fed flushes and there is an abundance of dead standing and fallen timber. This is the best locality for deadwood Coleoptera in Northants, containing a large number of ancient woodland indicator-species and several national rarities. Surveys of other invertebrate groups, particularly Diptera and spiders, would be valuable.

44. SADDINGTON RESERVOIR (SP664912) - A former canal feeder reservoir with excellent marginal habitats, the site has an extensive band of tall sedge fen, expanses of bare mud exposed by fluctuating water-levels, and stands of ancient willow pollards. This is an outstanding locality for its wetland fauna and there is also substantial interest in the deadwood of the old willows. The assemblage of hygrophilous ground-beetles is particularly noteworthy and several other Coleoptera families have provided interesting records. It can be anticipated that the Diptera will also prove to be of great value when surveyed and Saddington Reservoir is undoubtedly one of the best wetland sites for invertebrate conservation in Leicestershire.

45. SALCEY FOREST (SP810510) - Although this is the largest remaining area of ancient woodland in Northamptonshire most of the site has been commercially re-afforested and consists of c.150 year-old oak-ash high forest. The management history has practically eliminated those elements of the woodland fauna associated with

over-mature timber and the chief importance of Salcey Forest lies in the wood-edge fauna of the ride grasslands. There has been a recent decline in butterfly interest but wood whites and black hairstreaks are still present and there is a good assemblage of scarce woodland moths. Part of the site is managed as a nature reserve by the Northamptonshire Trust for Nature Conservation.

46. SALTFLEETBY-THEDDLETHORPE (TF480910) - A seven kilometre stretch of coastline, extending more than a kilometre inland at its broadest point, which is partly owned by the Ministry of Defence and other sections are owned and managed as a National Nature Reserve. In addition, MOD leases further sections of their property to be managed as a nature reserve by English Nature and the Lincolnshire and South Humberside Trust for Nature Conservation. This site, with its accreting saltmarshes and fore dunes, and fixed dune ridges, shares many features with Gibraltar Point (q.v.) but has a much richer expanse of freshwater marsh. This expansive dune slack has large areas of fen and reedswamp and there are also valuable pockets of brackish marsh. An important assemblage of coastal and wetland invertebrates has been recorded but Saltfleetby-Theddlethorpe has been far from exhaustively worked and other important discoveries undoubtedly await.

47. SCOTTON COMMON (SK870985) - A fifteen hectare remnant of the once extensive Scotton Common, an area of wet heathland on the Lincolnshire Coversands. The Lepidoptera fauna is well documented and contains many scarce heathland species and sandy pools contain several nationally uncommon water-beetles. Drier areas of grass-heath provide additional interest and the site is owned and managed as a nature reserve by the Lincolnshire and South Humberside Trust for Nature Conservation.

48. SEA BANK CLAY PITS (TF530802) - A series of borrow pits on the Lincolnshire coast, most of which date from excavations undertaken in 1953. The slightly brackish pools are known to support a rich aquatic fauna with a number of scarce water-beetles. Extensive reedbeds and fringing wetland vegetation provide additional interest. The pits are either owned or leased by the Lincolnshire and South Humberside Trust for Nature Conservation.

49. STOW-CUM-QUY FEN (TL515627) - Four chalk marl pools surrounded by sallow scrub and calcareous loam pasture. The pools were formed by coprolite workings in fenland and the range of species currently present indicates that an important wetland fauna

has survived. Seventeen breeding species of dragonflies are recorded, an outstanding assemblage for the area, and the pool margins support many nationally rare Diptera. Surveys of Lepidoptera and Coleoptera would be of great interest.

50. SUTTON HEATH & BOG (TL091000) - "The Bog" is an area of base-poor valley fen which is fed by springs emanating from adjacent Jurassic Limestone grassland. The flushes support a rich wetland dipteran fauna which includes several nationally rare soldier-flies, such as *Oxycera morrisii* and *O. pardalina*. The valley fen contains stands of tussock sedge which are inhabited by the rare whorl snail *Vertigo moulinsiana*, a good indicator of undamaged wetlands. Other invertebrate groups are less well-known and a systematic survey is highly-recommended.

51. SWANHOLME LAKES (SK944685) - A complex of flooded sand and gravel pits surrounded by a patchwork of sandy heath, willow carr and fen. The assemblage of seventeen species of dragonflies is outstanding in a county context and includes such scarce species as *Coenagrion pulchellum* and *Sympetrum sanguineum*. There is little available information for other invertebrate groups but it is likely that this mosaic of habitats has a varied fauna with additional elements of interest for invertebrate conservation.

52. SWITHLAND WOOD (SK539123) - An ancient semi-natural oakwood on acidic soils overlying sandstone which is bisected by a number of gravelly streams. The wood contains a diversity of habitats which is reflected in the richness of the recorded fauna, including woodland moths, deadwood beetles, and water-beetles. Additional variety is provided by an area of unimproved neutral grassland and abandoned quarry workings.

53. THERFIELD HEATH (TL335400) - Most of the remaining unimproved chalk grassland in Hertfordshire is found on this site, which is a Local Nature Reserve partly managed by the Hertfordshire and Middlesex Wildlife Trust. It is best known for its butterfly fauna, including the only surviving colony of chalkhill blues in the county, and there is very little information available on other invertebrate groups present. The creation of a golf course on the Heath destroyed some of the best grassland but has also had positive benefits as the management of fairway 'rough' sustained the open plant communities following the cessation of grazing. Further surveys are required to adequately assess the importance of Therfield Heath for invertebrates but it is undoubtedly of considerable significance in county terms because of the widespread loss of similar habitats.

54. THE WASH (TF550400) - The broad expanse of The Wash, more than twenty kilometres wide, encloses more than 26,000 hectares of estuarine flats and saltmarsh. Approximately one-tenth of this is saltmarsh with a diverse flora and a well-developed creek system. Reclamation has reduced the extent of the upper saltmarsh communities but beyond the sea wall there are brackish ditches and borrow-pits which provide additional interest. Available records indicate a good saltmarsh fauna but only limited surveys have been carried out to date and there is clearly plenty of scope for valuable recording on such a vast site.

55. ULVERSCROFT VALLEY (SK500126) - A large site consisting of a number of separate habitats which together comprise a rich complex of grassland, woodland, marsh and heath. The underlying siliceous clay soils give rise to a range of acidic and neutral habitats and this diversity contributes to the variety of the invertebrate fauna. Invertebrate surveys are continuing but already it is clear that this is an important remnant of Charnwood Forest. Parts of the site are owned or managed by the Leicestershire and Rutland Trust for Nature Conservation and the National Trust.

56. UPPER SUNDON CHALK PIT (TL041268) - An extensive area of disused chalk quarries, incorporating a mosaic of habitats ranging from established calcareous grassland and dense scrub to bare chalk slopes and shallow pools. There is demonstrated invertebrate interest in all of these features but of particular importance is the presence of several mossy seepages which support a characteristic fauna of beetles, flies, etc. The scarce blue-tailed damselfly, a rare species in south-eastern England, occurs in the seepages. There are no comparable sites known in Bedfordshire and further recording may confirm that the invertebrate fauna of Upper Sundon Chalk Pit is at least of regional significance.

57. WADENHOE MARSH & ACHURCH MEADOW (TL008828) - Tall fen and flood-meadow with established carr woodland on the banks of the River Nene. The river fen is flushed by calcareous springs and the rich flora supports a variety of wetland invertebrates without parallel in Northamptonshire. In particular, the Diptera and spiders recorded to date include a number of nationally uncommon species and several scarce fenland beetles are present. There is much scope for further survey and the wide range of unimproved habitats suggests that there is a wealth of potential for significant discoveries.

58. WHIPPENDELL WOOD (TQ075978) - The varied structure of this Local Nature Reserve administered by Watford Borough Council presents a variety of high quality features of importance for invertebrate conservation. Much of the wood is composed of oak-ash high forest or stands of oak/hornbeam with old hazel coppice. The ground flora and shrub layer are diverse and the presence of several broad, sheltered rides provides a good range of nectar-rich, wood-edge habitats. Large numbers of mature beech trees occur, chiefly planted in the 17th century, and there is an abundance of deadwood which supports an associated fauna of considerable significance. Whippendell Wood has a combination of habitats from the early and late stages of woodland succession containing a large number of scarce woodland invertebrates in a broad range of invertebrate groups. There is a history of entomological recording but there is much still to be learnt about the fauna of this fine site.

59. WICKEN FEN (TL555700) - One of the best surviving examples of the East Anglian fens and undoubtedly of national importance for invertebrate conservation. The site has a long tradition of entomological recording and is regarded as a top national locality for many invertebrate groups. The extensive mosaic of sedge fen, carr, reedbed, pools and rough pasture supports an outstanding range of fenland invertebrates, including a number of species regarded as endangered in Britain. Wicken Fen is owned and managed by the National Trust with due regard taken of the needs of invertebrate conservation.

60. WOODWALTON FEN NNR (TL223835) - Established as a nature reserve in 1919, Woodwalton Fen has long been a centre for entomological research, reflecting the considerable importance of its fenland fauna. The site contains examples of acidic mire communities, mixed sedge fen and carr woodland, with a network of ditches and some open pools. The reintroduced colony of the large copper butterfly provides valuable research opportunities but the Fen also supports a great diversity of scarce wetland invertebrates that have long since vanished from the drained landscape that surrounds the site.

61. YARDLEY CHASE (SP850540) - There is demonstrated invertebrate interest in a range of habitat-types included within this large complex of woodlands, grasslands and unpolluted ponds. Survey effort has been limited to date but Yardley Chase is known to contain the best assemblage of dragonflies in Northamptonshire and it is also the

richest butterfly site in the county. The beetle fauna of the deerpark is also of considerable significance.