INVERTEBRATE CONSERVATION IN GREAT BRITAIN

NO. 6: NORTH-WEST ENGLAND

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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 North-west England draws extensively upon the Regional information compiled for the Nature Conservancy Council's Invertebrate Site Register. This was collated into a series of reports by Dr R S Key and M S Parsons, between 1986 and 1989:

Invertebrate Site Register - Report Number 67. Review of Invertebrate Sites in West Yorkshire.

Invertebrate Site Register - Report Number 76. Review of Invertebrate Sites in South Yorkshire.

Invertebrate Site Register - Report Number 96. Review of Invertebrate Sites in Merseyside and Greater Manchester.

Invertebrate Site Register - Report Number 98. Review of Invertebrate Sites in Lancashire.

Invertebrate Site Register - Report Number 102. Review of Invertebrate Sites in Cumbria.

Unfortunately, parts of the original manuscript have not survived the passing of time and hence there is no *Introduction* or account of the *Upland* habitats of North-west England.

INTRODUCTION

Text no longer available

COASTLANDS

In nature conservation terms, two main types of habitat dominate the coastal fringe of North West England, sand dunes and saltmarshes/mudflats. The Region's shoreline extends for almost 500 kilometres from the Welsh border at the mouth of the Dee to the Scottish border in the Solway Firth. In between are the major estuaries of the Mersey, the Ribble, Morecambe Bay, the Duddon, the Esk, the Waver and the Wampool. Between Hightown and Southport on the Sefton Coast in Merseyside are fifteen kilometres of sand dunes. These are matched on the Cumbrian coast by comparable systems on the Isle of Walney and at Drigg, Haverigg and Sandscale. The Lancashire coast is dominated by the Ribble estuary and Morecambe Bay, with urban development accounting for most of the rest between Lytham St Annes and Fleetwood. Cliff habitats of known importance are few and the stretches of rocky shore or shingle beach on the west coast of Cumbria are practically unexplored entomologically.

The Region is of national importance for its estuarine flats and saltmarshes, particularly for the outstanding concentrations of wildfowl and waders they support during the winter months. Indeed, it is estimated that some 8,500 hectares of saltmarsh occurs in North West England, representing approximately one-fifth of the total area of saltmarsh in Great Britain.

The majority of this is composed of short-sward *Puccinellia/Festuca* or *Juncus gerardii* grassland which has been traditionally sheep or cattle grazed. Although this is beneficial for over-wintering birds, grazing is detrimental to many aspects of the saltmarsh invertebrate fauna. Perhaps for this reason the Region's saltmarshes appear to have been rather neglected by terrestrial invertebrate zoologists. None of the sites documented by the Invertebrate Site Register can be regarded as adequately surveyed and this is unfortunate as there is likely to be much of interest to be discovered. Even the vast tracts of grazed saltmarsh will support characteristic or scarce invertebrates that favour open areas of sediment for hunting or burrowing and surviving ungrazed areas are potentially of great significance.

An ungrazed saltmarsh is inhabited by a surprising diversity of invertebrates that are capable of enduring regular flooding by saltwater. The tangle of grasses and herbs of the upper zones presents great structural variety amongst the foliage, stems, and leaf-litter that accumulates around the base of the plants. Spiders can be particularly abundant and there is also a host of predatory and scavenging beetles living amongst the debris. Plant-feeding beetles, moths, bugs and flies are also a major component of the fauna. Heavy grazing can quickly result in the extinction of many of these invertebrates from a site and the more sensitive species can, therefore, be expected to be generally scarce in the Region. Some of the phytophagous beetles, at least, can occur where their food plants are found in other coastal habitats, such as strandlines on shingle beaches. This probably accounts for many Regional records of the leaf beetles *Longitarsus plantagomaritima* and *Phaedon concinnus* or the weevils *Mecinus collaris* and *Polydrusus pulchellus*, for instance. Patches of ungrazed saltmarsh, as at Stanlow Banks on the Mersey and Holme Island in Morecambe Bay, should be considered as potentially important for invertebrate conservation and are strongly recommended for survey. Lepidoptera, Coleoptera, Hemiptera and Hymenoptera are the groups which are of most significance and Diptera can also be well represented on sites where there are freshwater seepages onto the transition zone at the top of the saltmarsh. Cumbria is reported to have some 500 hectares of transitional grassland around its estuaries, particularly at Drigg and on the Solway, and these areas should be the focus of specific surveys.

Whilst the diversity of saltmarsh faunas will be limited by the long tradition of grazing on these habitats in the Region, a rich fauna of considerable conservation value can still be present. Species that are able to tolerate grazing are dominated by beetles, flies and spiders that can either burrow into firm sediments to escape the rising tide, or else shelter in air pockets trapped in cracks in the mud of creek walls or on saltmarsh pans. Throughout the Region it appears that the rove beetles and ground beetles that fit into these categories have been better recorded on the major estuaries than all other groups. Coverage is still sporadic

and it is clear from the available information that there is plenty of scope for further recording on all of the major sites. However, it is possible to gain an impression of the range of species in these groups that inhibit the better sites.

One of the most important factors that governs the distribution of the burrowing species is the nature of the estuarine sediments. Mud is a poor substrate as it holds little of the oxygen necessary for the survival of the non-marine invertebrates during immersion by the tide. Pure sand can be of interest but a rich fauna is more likely to be present where there is a mixture of mud and sand in the sediment. This provides a firm, aerated medium in which rove beetles and ground beetles can dig semi-permanent burrows. The Wampool estuary in the Upper Solway has good examples of these conditions and as such has been a favoured locality for coleopterists since the turn of the century. Five species of *Bledius* have been recorded, including *B. atricapillus, fergussoni* and *germanicus*. These rather small rove beetles tend to form loose aggregations in areas where the sediments are suited to their burrowing ability and tolerance to immersion. Their life-history is not fully known but it appears that they emerge from their burrows to graze on algae growing on the mud and sand around the entrances. Associated with the *Bledius* are a suite of specialist ground beetle predators of the genus *Dyschirius*, most of which feed exclusively on *Bledius* adults and larvae. Four species have been recorded in recent years, including *D. nitidus* which is nationally scarce and *D. angustatus* was found at the beginning of the century but not since.

Another burrowing rove-beetle recorded from Wampool is *Carpelimus halophilus*, a scarce species which is widely distributed around the British coast but always very local. Its much rarer relative, *C. schneideri*, was found here in 1913 and was subsequently recognised from another two sites in Britain but was last recorded in 1934 until recent searches at Wampool and in the Lever estuary at Roudsea resulted in the rediscovery of *C. schneideri*. From the available evidence, it seems to be associated with colonies of *Bledius*, but the exact nature of this association is unclear. It is quite probable that such an elusive beetle is more widely distributed around the Region's coast, but probably limited to localised areas of favourable sediment.

Other saltmarsh ground beetles of interest include several species of *Bembidion*, such as *laterale, iricolor* and *maritimum* and *Agonum nigrum*. These are active predators that hunt for small arthropods on the saltings and retreat into cracks or hide under stones when the

tide comes in. The rove beetle *Quedius pallipes* is a more generalist scavenger and is usually found in strandline litter on saltmarshes, predominantly in southern and eastern England although it has been recorded at sites on both the Solway and Morecambe Bay. There has been very little investigation of the spider fauna of the Region's saltmarshes. Characteristic species such as *Erigone longipalpis*, *Halorates reprobus* and *Pardosa purbeckensis* have been recorded from a few of the estuaries but it would be very interesting to have more detailed information on the Region's saltmarsh spider fauna.

A large number of different species of flies are capable of inhabiting saltmarshes, the richness of the fauna reflecting the complexity of the vegetation and the physical structure of the marsh. As mentioned earlier, upper marsh seepages are particularly valuable, supporting a range of soldierflies, dolichopodids, empids, craneflies etc. The soldierfly *Nemotelus notatus* and the cranefly *Limonia ventralis* are typically found in such brackish conditions and the hoverflies *Platycheirus immarginatus* and *Tropidia scita* are also characteristic of brackish water bodies along the upper zone of saltmarshes. More widely distributed on the open saltmarsh are species like *Dolichopus clavipes*, *Hilara lundbecki* and *Limonia sera* whose larvae develop with damp mud, often at the margins of pools. The larvae of the horsefly *Haematopota bigoti* is a predator in saltmarsh soils. This rare species was recorded from the Ribble in 1952 but is generally considered to be a southern species in Britain. Confirmation of its continued presence in the Region would be of great interest.

A final aspect of the saltmarsh fauna worth considering is the assemblage of water beetles, many of them nationally uncommon, which can be found in the brackish pools of saltpans. Rich faunas appear to be able to co-exist quite happily with grazing stock and there are several sites in the Region that support a good selection of scarce species. Rockcliffe marsh and Burgh Marsh on the Solway are good examples with *Agabus conspersus, Haliplus apicalis, Helophorus fulgidicollis, Ochthebius auriculatus* and *O. marinus*. The Drigg coast marshes are known to support a similar fauna but Morecambe Bay, the Ribble and the Mersey are apparently unexplored and would be worthy of investigation.

In contrast to the estuarine flats and marshes, most of the major dune systems of the Region have been well-studied by invertebrate zoologists and there is a long tradition of recording on many sites. This is hardly surprising as the Region contains many exceptional areas of sand dune habitat, favoured by a diverse fauna containing a great number of rare species and hence naturally favoured by entomologists and their ilk. The Hightown-

Southport dunes of the Sefton coast have long held a reputation for rare insects, especially moths and beetles, but the Cumbrian dunes have perhaps been over-shadowed by the attractions of the mountains and lakes of the Lake District. Given a similar level of attention it is probable that sites such as North and South Walney, Eskmeals, Ravenglass and Sandscale will prove to be as significant for the conservation of dune invertebrates as their more southerly counterparts.

All around the coast of Britain there is a striking similarity amongst the major components of the dune fauna, familiar faces amongst the butterflies, beetles, moths, spiders, etc. that are encountered by the observant naturalist. There are certainly regional patterns governed by factors of climate, latitude, and the origin and supply of sand, for instance, but nonetheless there is usually a basic fauna which can be recognised throughout the country. This is chiefly because the species involved are successfully adapted to breed in sandy environments and to endure the rigours of drought, temperature extremes and instability that prevail. In these terms, dune systems are much the same from one end of the country to the other and the more significant elements of the fauna tend to be associated with the availability of specific microhabitats. Examples of such features are: undisturbed strandlines, the presence of bare pools in the foredunes, stabilised sandy banks with a southerly aspect, and dune slacks with

a relatively high summer water-table. Sites which have some, or all, of these features are likely to support a number of scarce invertebrates and the larger the dune system the richer the fauna is likely to be.

The dunes of the west coast of England and Wales are becoming increasingly recognised for their importance in the conservation of bees and wasps. The aculeate Hymenoptera are a group which are strongly represented in sandy habitats as many species nest in burrows constructed in firm but friable substrates. Most species are also dependent upon high summer temperatures and hence the richest bee and wasp faunas are typically found in coastal habitats and on the hot, sandy heaths of southern England. With the steady loss of heathland habitat and increasing pressures on many southern and eastern dune systems, the west coast dunes are becoming an important stronghold for many threatened aculeates. A speciality of the Region, which is shared with a few dunes in North Wales, is the mining bee *Colletes cunicularius*. These populations differ in a number of characteristics from European examples and may represent a unique subspecies, *celticus*. The bees nest on sandy slopes, forming dense but localised aggregations. In Britain the adults appear to only visit the flowers of creeping willow to obtain nectar and pollen. It has been recorded from several sites in the Region but is most abundant on the Sefton Coast dunes, as at Ainsdale NNR. Here it occurs in old blow-outs which have stabilised and also in open glades amongst the plantations of pine which occupy a substantial area of the dunes. In view of the scientific importance of the British populations of *C. cunicularius*, its conservation must be regarded as a high priority. A colony on the dunes at Lytham St Annes has been lost in the past to building development and, although still reasonably widespread region in the Region, other populations must be given maximum protection.

Ainsdale NNR is an extremely important site for aculeate Hymenoptera, and dune invertebrates in general. It is one of a suite of sand dune areas which are collectively administered under the Sefton Coast Management Scheme. This co-ordinated approach ensures that pressures facing this popular coastline are addressed in terms of the needs of all major interest - tourism, nature conservation, sea defences etc. In this way problems can be dealt with sensibly and not merely deflected from one site to recur at another. This ensures that sites of high nature conservation interest are given the maximum possible protection by considering the implications for the whole coastline of decisions made at any particular site. This is especially desirable as the Sefton Coast is extremely popular with holidaymakers and erosion is a real threat to many sites. The success of the Sefton Coast Management Scheme in directing public access to the less important areas and contributing

practical management to the better sites is to be heartily applauded.

One of the first zones of a dune system to suffer when there is excessive public access is the narrow strip of mobile dunes above the beach. Even on the most undisturbed sites there are only a relatively small number of invertebrates that can cope with the shifting sands of the fore dunes, but these tend to be highly specialist and hence restricted. Fore dune erosion is a natural problem on many of the Sefton Coast dunes and if this were exacerbated by trampling then many rare species of invertebrates would disappear. Examples include the mining bee *Colletes marginalis* and the solitary wasp *Psen littoralis*, both of which typically inhabit much looser sand than most of the dune Hymenoptera. Another denizen of the fore dunes, although also found on bare areas further inland, is the spectacular sand tiger beetle *Cicindela hybrida*. This is a national rarity which has declined considerably in Britain and is probably commoner on the Sefton Coast than anywhere else in the country.

Natterjack toads are an important aspect of nature conservation on the Region's dunes and attract a considerable amount of attention. Their fortunes on Merseyside and in Cumbria are related to the presence of shallow, sparsely vegetated pools in the semi-fixed dunes.

Maintaining suitable habitat for the natterjacks is almost certainly beneficial for a range of invertebrates that require damp sand to burrow into at various stages of their life-cycle. This would include several of the *Bledius* species to be found on sandy saltmarshes and their attendant *Dyschirius* predators. A number of predatory flies, including dolichopodids, empids and muscids, will also occur in such situations. Where the pools are at least of a semi-permanent nature they will have been colonised by a variety of aquatic molluscs and these provide a food source for snail killing flies, such as *Pherbellia grisescens* and *Colobaea distincta*. The attractive, black and yellow, ground beetle *Bembidion pallidipenne* is another characteristic species of the margins of dune water bodies.

A rich moth fauna is often present on dune systems and there are two particular specialities of the Region's coast. The belted beauty *Lycia zonaria* is now very rare in Britain and has gone from many of its former sites on the coast of North Wales and North West England. The reasons behind its decline are not entirely clear and it now seems to be more frequently found on waste ground, where its larvae feed on a variety of low-growing plants, than on the sandhills it formerly inhabited. There are still a few small colonies in the Region but its survival must be regarded as somewhat precarious. The sandhill rustic *Luperina nickerlii gueneei* has a similar distribution to the belted beauty, although its larvae feed on sea couch grass in the fore dunes. It is now probably confined to only one site in the Region, on the Sefton Coast, and has obviously suffered from the degradation of fore dune habitats. Several other localised dune moths are reasonably common in the Region. The Cumbrian dunes have been the subject of many surveys by lepidopterists and sites such as the Isle of Walney, Drigg and Sandscale have impressive lists of the 'macro' moths. Species of interest include the coast dart *Euxoa cursoria*, sand dart *Agrotis ripae*, shore wainscot *Mythimna littoralis* and Portland moth *Ochropleura praecox*, all of which are to be found in varying abundance on most of the larger dune systems.

Floristic diversity on dunes also contributes to the importance of these habitats for the phytophagous beetles, particularly weevils. They have been comprehensively surveyed on many of the Cumbrian dunes and impressive lists of scarce species are available. Eskmeals and Ravenglass Dunes on the Drigg Coast are important sites with *Cleonus piger, Hypera dauci, Ceutorhynchus hirtulus* and *Sitona ambiguus*. *Pelenomus zumpti* has recently been found here as an addition to the British fauna, feeding on sea milkwort growing along the junction of dune and saltmarsh. Although now realised to occur on several other sites around the British coast, it is likely to be confined to localities with an abundance of the foodplant.

Two species of beetle which appear to have become extinct in Britain during this century were associated with dung on the Merseyside dunes. Both *Paralister obscurus* and *Aphodius brevis* have been reliably recorded only from sites on the Sefton Coast, and the latter at least was regarded as locally common up until 1913. Their loss is perhaps due to changes in grazing practices on the sandhills, although *A. brevis* was chiefly associated with rabbits and perhaps myxomatosis in the 1950's caused its final demise. A related species *Aegialia rufa*, has a similar history, although it has once been found in Wales and the last Merseyside record was for 1963. Virtually nothing is known of its ecology and so the reasons for its extinction are unknown. *Hypocaccus rugiceps*, another dung and carrion feeder of west coast sandhills, is happily still frequent on several of the larger sites. There is always hope that some of these vanished species may be found in the course of time but their fate serves to remind us of the importance of the Region's dunes and the special nature of their fauna.

Apart from the dune systems and the saltmarshes, other types of coastal habitat make only a small contribution to the overall value of coastal sites in the Region for invertebrate conservation. The estuarine cliffs at Speke on the Mersey and Thurstaston on the Dee are potentially of some significance, but they appear not to have been investigated to see if they support a specialised fauna. The soft-rock cliffs at both sites could harbour interesting beetle faunas that are closely associated with such habitats and other groups worth surveying would be the Diptera, Hymenoptera and Hemiptera. As soft-rock cliffs are undeniably rare in the Region it would be worth regarding an assessment of the invertebrate interest of these two sites, and any others that are known, as a high priority.

Hard rock cliffs are confined to the North Lancashire and Cumbria coasts but few sites have been studied in any detail. Some, such as the limestone promontory of Humphrey Head in Morecambe Bay, are likely to prove to be of great interest for a variety of invertebrate groups. The stretch of coast between St Bees and Whitehaven is the best known cliff section at present. Much of this is Old Red Sandstone with a rich flora and the phytophagous beetles have been shown to be of considerable interest. Uncommon weevils include *Barynotus squamosus, Brachysomus echinatus* and *Trachyphloeus laticollis.* Dark bush crickets *Pholidoptera griseoaptera* are also present on the scrubby slopes, one of the northernmost sites in Britain for the species. The pill woodlouse *Armadillidium pulchellum* is also at the edge of its range here and sandstone rubble on the beach below the cliffs shelters two other interesting species of woodlice, *Trichoniscoides albidus* and *T. saeroeensis*. A rarer woodlouse, *Metatrichoniscoides celticus*, may also occur, but so far only

a single female of this tiny white species has been found and males are required to confirm the identification. Other cliffs of interest which deserve exploration are Far Arnside, Barker Scar and Skelwith Hill, where Carboniferous Limestone is exposed along the northern edge of Morecambe Bay.

There is undoubtedly plenty of scope for further survey work on the coastal habitats of North West Region. In the main this would serve to strengthen our knowledge of the status and distribution of coastal invertebrates but there is also potential for producing information which is of value for site management or safeguard. The determination of entomologically valuable stretches of ungrazed saltmarsh, the assessment of the soft-rock cliff faunas, and the recognition of important microhabitat features in dune systems are all

areas where the invertebrate zoologist can materially assist the processes of nature conservation. The Region has many outstanding coastal sites which support invertebrate faunas of considerable significance and efforts to improve our knowledge of that richness would be very worthwhile.

WOODLANDS

The present-day distribution of woodlands in the British Isles is the result of a long history of management and neglect, accident and design. This is well demonstrated in North-west England, where the percentage cover of wooded habitats is very variable across the Region. Woodland clearance has been most marked in lowland areas of Lancashire, Merseyside and Greater Manchester, where agriculture and urbanisation has denuded much of the landscape. By contrast, traditional industries in Yorkshire and South Lakeland have preserved lowland woods as they were an invaluable source of coppice timber, particularly for use in the smelting of iron. Sheep-grazing on the high land of the Peak District and the Cumbrian Fells has eliminated most of the upland woods in the Region, although much of this land was probably above the altitudinal limit for sustained tree growth anyway. Concentrations of deciduous woodland are now predominantly found in north Lancashire and on valley slopes in the Lake District. Here the terrain was either too steep or too rocky to encourage agricultural improvement and many fine woodlands have survived.

There are three main features of British woodlands that are of paramount importance for invertebrate conservation; the presence of over-mature trees, the occurrence of edge

habitats in the form of rides and glades, and the maintenance of high levels of humidity. The overall richness of the fauna associated with each of these conditions is determined by a number of factors but the prime consideration is ecological continuity. As with all habitats, invertebrates in woodlands are dependent upon their required microhabitats being present annually. Events which cause the loss of specialist microhabitats, even for one year, may lead to the local extinction of many of the more interesting species of invertebrates from a particular wood. Their ability to recolonise the wood when conditions are again suitable will depend on their mobility and the occurrence of nearby woods that contain a similar structure. Woods, therefore, which have a long, continuous history of management, of the same type and degree, are especially valued and are likely to support invertebrate faunas of conservation significance.

Unfortunately, there are now very few woods in Britain that can claim to have an abundance of over-mature trees. Before Man's intervention, the virgin wild woods that covered most of the country would have contained a high proportion of venerable trees and the woodland floor would have been littered with deadwood of all shapes and sizes. This is no longer the case as timber has been plundered for fuel throughout the centuries, even in the steepest valley woodlands. In North-west England the best areas of over-mature trees have survived on parklands associated with stately homes, where majestic trees fulfilled an important landscape and amenity role. There are often difficulties in gaining access to survey these private parks and our knowledge of even their number and distribution in the Region, let alone their potential for supporting representative deadwood faunas, is incomplete. From the available evidence it appear that North-west England has fewer suitable parks than the other English Regions, although further surveys could change this view. One site, however, is clearly of national importance; Dunham Massey Park on the outskirts of Manchester.

Dunham Park has been managed since medieval times as wood pasture, in which grazing animals browse beneath free-standing oaks and beeches. The estate is now owned by the National Trust and the area of prime interest consists of 190 hectares of parkland, woodland and ornamental ponds, grazed by a herd of fallow deer. Records of invertebrates, particularly beetles, span a period of some 140 years and the combined species list for the site far exceeds any other area of over-mature trees in the Region. Although the history of recording contributes to this position, the major reason is the quality and quantity of deadwood microhabitats that are present. Few invertebrates are capable of feeding upon healthy timber but, as a tree grows old, rot begins to invade the heartwood through natural cavities, perhaps

as the result of wind damage. Fungi are an important food-source for the saproxylic invertebrates that inhabit old trees. Some species are dependent upon the fruiting bodies of bracket fungi whilst others feed upon the hidden fungal mycelia that penetrate the heartwood. Fungal rot can also cause the formation or root-holes, cavities in the trunk or branches where debris accumulates and may become water-logged. This is another specialised microhabitat which supports its own suite of scarce insects.

One of the main causal agents of heart rot in oak trees is the fungus *Polyporus sulphureus*. This produces a characteristic crumbly red-rot which is riddled with mycelia. Red-rot generally only appears in oaks which are at least 150 years old and trees which are affected may live for another 2-300 years. There is a growing belief that such internal decay is, in fact, beneficial to the tree as nutrients from the dead timber in the centre of the trunk are broken down by the fungi and picked up through the root system to aid the growth of living wood in the outer layers of the tree. It is also likely that large, hollow trees are less susceptible to gales as they can absorb the force of the storm more readily than their younger, more solid, counterparts. As trees grow older they also become more gnarled and twisted and their bark grows thicker, offering more and more niches for specialised invertebrates to occupy.

When old age finally takes its toll a massive old tree may take a considerable time to fall and decay. On the ground, its sheer bulk acts as a protection against temperature extremes and hence many scarce insect species can carry on developing within the trunk for a long time. The rate of decay depends upon a variety of factors. Once the bark is removed a tree in a shaded, humid situation will rot down fairly quickly but trees in open, sunlit places become heat-sterilised and the fungal processes effectively cease. Such sun-baked trunks may contain moist red-rot within them for a few years but eventually they become too hard and dry to support most of the deadwood fauna. Old beetle emergence holes in these trees can be important for bees and wasps which utilise them as nesting burrows. However, the most valued trunks are those which lie at least in partial shade.

This succession from maturity, through senescence, to death and final decay is now rarely encountered in wooded situations in Britain and the same is true for much of Europe. As a result, the specialised fauna of these later stages is becoming increasingly scarce and already many saproxylic invertebrates have become extinct in Britain. There are only a handful of sites in the country which are of comparable significance to Dunham Park. A few, such as the New Forest, Windsor Great Park and Sherwood Forest, support richer assemblages of scarce

species but Dunham is certainly amongst the top tier of sites in Britain with regard to its importance for the conservation of deadwood invertebrates. So far, a total of 34 species of beetle that are regarded nationally as saproxlyic 'indicators of ecological continuity' have been recorded from the Park, an outstanding figure considering its geographical position and isolation. Some of the rarer species are no longer present, such as the attractive red-and-black *Bostrychus capucinus* which is now considered to be extinct in Britain, but many other rare and interesting species survive. Examples include *Rhizophagus picipes, Prionocyphon serricornis, Abraeus granulum* and *Tetratoma desmaresti*. Much less is known of other invertebrate groups at Dunham and a thorough survey of the Diptera would be of particular interest. The deadwood breeding fly *Megamerina dolium* has been found recently but there must also be a rich fauna amongst the craneflies, hoverflies, etc., many of which breed in rotting wood in old forest areas.

It is quite possible that a considerable number of invertebrates breeding in Dunham Park will be restricted to this one site in the Region and this number could increase substantially if the other deadwood sites in North-west England continue to be lost or damaged. There are two other parkland localities which are of particular significance and both face difficulties in the future. Stockton's Wood at Speke Hall on Merseyside is an eighteenth century plantation which now supports many ancient beech, oak and sweet chestnut trees. Recording here over the past ten years or so has revealed an exceptional fauna considering the history of the site. Saproxlyic beetles include *Silvanus bidentatus, Anitys rubens* and *Stenichnus godarti* and the hoverfly *Brachypalpoides lenta* is also present. Unfortunately, many of the best trees suffer from vandalism and pollution from a nearby chemical factory. Fires are often lit at the base of the oldest trees. This contributes significantly to the abundance of deadwood, and many of the more interesting species are associated with these damaged trees, but in the long term there will be a marked decline in saproxylic microhabitats and an equivalent reduction in the richness of the fauna. In West Yorkshire, Temple Newsam Park was discovered too late by entomologists to attempt to safeguard its importance. Old oaks supported a characteristic assemblage of deadwood beetles, such as *Anitys rubens, Aderus oculatus, Dorcatoma flavicornis, Mycetophagus piceus* and *Stenogostus villosus*. Other insects of note included the lacewing *Sympherobius elegans*, the flatbug *Aradus depressus*, and the soldierfly *Pachygaster leachii*. Sadly, a large part of the site was destroyed in 1979 for opencast coal mining. A good number of old trees still remain in the area and some of the deadwood insects will still occur, but it does appear that the county's richest parkland habitat was decimated before its full potential was realised.

The entomological value of these old parklands is only beginning to be widely recognised and perhaps other important sites will come to light in the future. Some of the parks in the City of Liverpool show promise and West Yorkshire has several, such as Branham Park, Harwood Park and Haw Park, that are likely to support representative faunas. Lancashire and Cumbria seem almost devoid of rich deadwood sites, although Levens Park in the Kent valley and Lowther Park near Penrith could be worthy of survey. South Yorkshire has been extensively worked and the beetle and fly faunas of a number of sites have been comprehensively documented. The oakwoods of Ford Valley are considered to be the best in the Sheffield District and contain the beautiful scarlet net-winged beetle *Pryopterus nigroruber*, which is a speciality of this part of the Region, Wharncliffe Wood has probably the best-known hoverfly fauna in the north of England and species of interest include *Brachypalpus laphriformis, Criorhina asilica* and *Megasyrphus annulipes*. Sandall Beat near Doncaster is another eighteenth century plantation that now supports an exceptional fauna, including *Pryopterus nigroruber* and also *Corticeus unicolor*, a nationally rare tenebrionid beetle which is more or less restricted to this general area of northern England. Other South Yorkshire sites of potential importance include Castle Park (one of a few known localities for the 'window midge' *Mycetobia pallipes*), Cawthorne Park, Kings Wood near Bawtry, and the large but little known deerpark of Wentworth Park.

Attitudes are slowly changing towards the presence of 'diseased' trees in open parklands and more land managers are now beginning to adopt an enlightened approach to the care of their venerable charges. There are still occasional areas of conflict where moribund trees are a potential hazard in parks open to the public but in many cases these can be resolved by judicious surgery. The treatment of fallen timber is also more frequently regarded sympathetically with regard to conservation. The task for the future is to continue to spread the message of the importance of over-mature trees and also to encourage the planting of new generations of replacement trees. Many of our parklands such as Dunham Park, have undergone decades where grazing has prevented the growth of new saplings and where no new plantings have been carried out by the owners. This had led to a worrying age-gap in that deadwood habitats will be extremely scarce on some of these sites when the present trees finally succumb. To maintain the importance of our best deadwood sites into the future we must plan ahead with a view to the composition of the parklands trees for the next century or two. Our oldest trees may live for 500 years or so, but not forever!

Although Lancashire and Cumbria, on present evidence, have few parklands of conservation importance, in both counties there are a large number of woodlands of great interest. The

most outstanding area is the series of hills and scars on the Carboniferous Limestone either side of the Kent estuary and adjacent parts of Morecambe Bay. These are predominantly ashwoods with an understorey of hazel coppice and a rich mixture of other shrubs and trees, including oak, small-leaved lime, wych elm, juniper and yew. The traditional coppice management of the past is no longer practiced and it is only on sites like the National Nature Reserve of Gait Barrows that hazel is still coppiced to any extent. This suite of sites around Silverdale and south Lakeland are of national significance for their butterfly faunas. The area is now one of the main strongholds for the high brown fritillary *Argynnis adippe*, a species whose rapid decline over much of Britain has given great cause for concern. Experimental management at Gait Barrows has demonstrated the link between coppicing and the fortunes of the high brown fritillary. By maintaining broad rides through neglected coppice on the reserve the population of this handsome butterfly has considerably expanded. It has managed to survive so successfully in this general area because many of the woodlands are classic examples of 'mosaic' habitats. The decline in coppicing might have caused their extinction here but for the fact that many of its populations occur in woods which contain an intimate mixture of coppice, scrub, open glades and limestone scree. The wood-edge habitats favoured by high brown fritillaries have probably become less common over the past forty years or so as scrub became established but there is still plenty of suitable habitat at present.

Along with the high brown fritillaries are widespread populations of pearl-bordered *Boloria euphrosyne* and Duke of Burgundy *Hemaris lucina* fritillaries, both of which also favour similar wood-edge and scrubby grassland habitats. The moth fauna is also diverse and contains a number of nationally uncommon woodland species, such as the satin beauty *Deilepteria ribeata,* brown scallop *Philereme vetulata*, barred tooth-striped *Trichopteryx polycommata*, chestnut-coloured carpet *Thera cognata* and juniper carpet *Thera juniperata*. Other wood-edge insects include the dark *Pholidoptera griseoaptera* and oak *Meconema thalassinum* bush-crickets, the robberfly *Dioctria oelandica*, and colonies of the wood ant *Formica rufa*, all of which are here approaching the northern limit of their British range. Little survey work appears to have been carried out on the beetle fauna of these limestone woods but the wood ant myrmecophiles *Cetonia cuprea* and *Clytra quadripunctata* are recorded and hazel supports the weevil *Apoderus coryli*. The curious oedemerid beetle *Oncomera femorata* is another more typically southern insect which occurs in several of the limestone woods. At Grubbins Wood below Arnside Knott the triangle spider *Hyptiotes paradoxus*, which builds its distinctive web almost exclusively on yew or box trees, occurs at one of its few known British localities.

The South Yorkshire analogue to the Silverdale/South Lakes Carboniferous Limestone woodlands are the Magnesian Limestone ash/wych elm/small-leaved lime woods in the extreme east of the Region between Doncaster and Worksop. There are several large and interesting woodlands in this area, most notably Anston Stones Wood, the Roche Abbey Woods, and Pot Riding Wood in Sprotborough Gorge. They have a characteristically diverse shrub and field layer, which accounts for much of the richness of their invertebrate faunas. A particular rarity is the picture-winged fly *Platyparea discoidea* which breeds in the stems of the giant bellflower and is known for certain in Britain only from a handful of woodlands in Yorkshire. The cranefly *Limonia masoni* and the house-fly *Fannia immutica* are scarce species which are usually encountered in stands of dog's mercury in calcareous woodlands and probably breed amongst damp soil, whilst wild garlic is the foodplant of the hoverfly *Portevinia maculata*. In a few sites common gromwell is the host plant for the uncommon flea-beetle *Longitarsus suturalis*. The white-letter hairstreak *Strymonidia W-album* lingers on in a few of these limestone woodlands and the dead and dying elms are a favoured haunt of the attractive net-winged beetle *Platycis minutus*. Although relatively uncommon nationally this is a fairly widespread species in the area and will have benefited from the ravages of Dutch elm disease. Many of these surviving Yorkshire woodlands are situated on valley sides that are uneconomic to clear-fell and improve agriculturally. This has been the saving grace of a high proportion of the remaining semi-natural woodlands on the Region and hence the associated fauna is generally well-represented.

On either side of the Pennines there are gills and cloughs supporting important remnants of woodland which contain assemblages of invertebrates suited to the dark and humid conditions of these narrow valleys. Oaks and birches are the dominant tree species whilst ash is frequent along flush lines and alder or willow carr occupies the wetter valley floor in many sites. Mossy stream banks are home to the rove-beetles *Stenus guynemeri* and *Dianous coerulescens* and the giant lacewing *Osmylus fulvicephalus* is also characteristic of these wooded streams. The Pennine Cloughs of Greater Manchester contain many good examples of this type of woodland but few sites have sufficiently detailed entomological information to be able to judge their relative importance. Some, such as Holden Clough, Cotteril Clough and Walker Fold, have provided enough records to indicate their potential. A number of Diptera families are particularly significant in these humid woods, notably the craneflies, fungus-gnats, dolichopodids and empids. The scarce craneflies *Dicramota guerini* and *D. robusta* have aquatic larvae that develop in the gravelly bottoms of upland streams. *Scleroprocta sororcula* and *S. pentagonalis* are rarer species which are found in wet woodlands, their larvae probably develop in fungal fruiting bodies. Cotteril Clough was well surveyed for Diptera in the 1940s

and species such as the mycetophilids *Exechiopsis magnicauda* and *Macrocera fascipennis*, the dolichopodid *Argyra atriceps* and the empid *Symballophthalmus dissimilis* were recorded. Surveys in Holden Cough during the 1950s and 1960s also produced impressive lists of wet woodland Diptera but there is little modern information on the present state of the fauna. It would be very interesting to carry out modern Diptera surveys in the better clough woodlands to determine priorities for site safeguard and management.

Recent studies have indicated that Cumbria has some 10,000 hectares of ancient semi-natural woodland left, representing about 1.5% of the total area of the county. Although this is scattered across the county, the highest concentration is present in South Lakeland where the wooded lower slopes of the Fells are a major part of the spectacular scenery of the Lakes. These are chiefly acid oakwoods on the Silurian slates that underlie much of the area and most are neglected coppices that used to fire the foundries of the Barrow-in-Furness iron industry. In many respects these woodlands are very similar to those of the upland areas of northern and western Wales and the invertebrate faunas are also remarkably alike. This is due largely to the similarities of climate, geology and land use which combine to produce humid, mossy oakwoods with rather even-aged canopies. Species which are characteristic of, and common to, both areas include the ancient woodland molluscs *Acicula fusca, Leiostyla*

anglica, Zenobiella subrufescens, Limax cinereoniger and *Limax tenellus.* Several beetles are also typical of the western oakwoods in Britain, such as *Pterostichus oblongopunctatus, Calosoma inquisitor, Dendroxena quadrimaculata* and *Xyloterus signatus*.

Another link between the woods of North Wales and the Lake District is the presence of the rare woodland plant, touch-me-not balsam. This is the foodplant of the Red Data Book moth, the netted carpet *Eustroma reticulatum*. Although it still clings on in one or two localities in Wales, its British headquarters are most definitely in Cumbria, where there are about twenty surviving colonies. Touch-me-not balsam grows along streambanks and at the edge of wet woodlands, particularly along lakesides. It is unable to thrive under dense shade and will require sensitive management of its woodland habitats to ensure that both the plant and the netted carpet prosper. A micro-moth *Pristerognatha penthinana*, which breeds inside the stems of touch-me-not, was found commonly around Windermere at the turn of the century but there have been no records in Britain since 1914. It is possible that a colony survives amongst one of the touch-me-not populations but presumably changes in woodland management after the First World War caused a drastic decline. Other invertebrates associated with touch-me-not in the Lake District are the leaf-mining fly *Phytoliriomyza melampyga* and the aphid *Impatieninum balsamines.*

On the southern edge of the Lake District National Park is the National Nature Reserve of Roudsea Wood and Mosses. This is a complex of basin mires, carr and deciduous woodland, the latter consisting of both ash/yew/small-leaved lime woods on limestone and acidic oakwoods on slate and shale outcrops. The resultant mosaic is an outstanding invertebrate site with a wide range of rare species recorded amongst groups such as the moths, hoverflies and beetles. There are wood-edge species like the high brown fritillary, the small eggar moth *Eriogaster lanestris* and the hoverflies *Cheilosia chrysocoma* and *C. nebulosa*; deadwood species include the false click beetle *Dirhagus pygmaeus* and the cranefly *Ctenophora atrata*; and a host of scarce moths feed on plants in the shrub and field layers of the established woodlands. Although lacking the over-mature trees of the Region's parklands, Roudsea contains most of the important elements of the woodland habitats of North West England. The richness of the fauna demonstrates the potential of the Region's woodlands for invertebrate conservation on sites where management can be geared to favour the strong points. With the variety of woodland types present in the Region, combined with altitudinal and meteorological differences, it is no surprise that so many rare and interesting species occur. The days of widespread woodland clearance are, thankfully, now only a memory but there is still a need to continue invertebrate surveys to assist with management decisions.

Most woods could be improved for invertebrates by management which is based on a detailed assessment of the habitats and microhabitats present. Now that woodlands are generally safeguarded by existing legislation it is time that we turned our thoughts to maintaining and enhancing the conservation value of our better sites.

LOWLAND HEATHS AND GRASSLANDS

The national decline in the quality and quantity of lowland heaths and grassland has been a major cause of concern for nature conservationists in recent decades. Post-War changes in agricultural practices have been responsible for many of these losses, but afforestation, urban development and mineral extraction have also taken their toll. Heaths and grasslands have been particularly vulnerable because these habitats have always been closely linked with Man, their existence depending chiefly on our intervention with natural succession through grazing, burning, turf-cutting and scrub removal, for instance. This association has developed over thousands of years and the fauna and flora of such habitats relied upon regular management to maintain suitable conditions for breeding and germination. Such management was often piecemeal and small scale, as the activities involved were related to the labour-intensive practices of pre-War agriculture. Technological innovations have upset that time-honoured balance and created a spiral of pressures which are extremely difficult to withstand. Improved drainage and the application of inorganic fertilisers led to increased stock levels on all but the wettest grasslands, causing catastrophic changes to the communities of plants and animals that had harmoniously co-existed with agriculture for millennia. Heathlands were either ploughed, reseeded and fertilised or else abandoned as uneconomic. Direct losses through the planting of conifers on heaths, the building of roads

and houses, or quarrying for sand, gravel, limestone or coal added to the overall picture of decline.

A high proportion of the surviving heaths and grassland in lowland Britain are now safeguarded as nature reserves or protected by statutory legislation. Coupled with this, there are growing trends towards providing compensation for sympathetic management to ensure that a representative selection of these habitats survives the modern pressures they face. Without such actions the eventual deterioration or loss of all examples of lowland heaths and unimproved grasslands, at least in England and Wales, was a real possibility. However, purchasing nature reserves and designating Sites of Special Scientific Interest is only the first step towards the conservation of the wildlife riches of heathlands and grasslands. We must not forget that dependent link between management and the existing plant and animal communities, nor must we underestimate how vital is the sustained nature of that management. Across the whole spectrum of heath and grassland habitats we need to recognise that similar environmental conditions have to be present annually if the full complement of the associated fauna is to survive. One of the side-effects of the widespread loss of semi-natural habitats is that remaining sites are more prone to experiencing local extinctions amongst their fauna and flora because there are few opportunities for recolonisation from the surrounding countryside. The luxury of a casual approach to site management is no longer possible if we are to be successful in conserving the fullest range of species that comprises the ecological make-up of a site.

Left to themselves, heaths and grasslands rapidly revert to scrub and then secondary woodland as part of natural succession. At each stage in this progression species will come and go, until mature woodland develops, and practically all of the invertebrates formerly present will have been replaced by different, generally ubiquitous, woodland species. Of course, subtle changes in community composition are always occurring in all types of habitats, but heaths and grassland are of particular concern because these changes can be so rapid. Vegetation structure and micro-climate are of crucial importance to the majority of invertebrates in such habitats, relating to their need for specific temperatures, humidity levels or shelter at different times of the year. Consider how catastrophic over-grazing can be for invertebrates that spend the winter inside the relatively stable environment of grass tussocks, or the effect on insects breeding in flower stems or seed-heads of introducing summer mowing to a herb-rich pasture. Botanically, there may be no measurable difference in site quality if this happened infrequently on a site. By contrast, the invertebrate fauna would be

severely, and perhaps irreparably, diminished. Such actions may seem innocuous because we cannot readily see the effect they can have, but they can dramatically reduce the importance of a site for invertebrate conservation almost overnight. The care we now take of the wildlife of the lowland heaths and grasslands entrusted to us has to be undertaken with an appreciation of the susceptibility of their invertebrate faunas. Management must be sustained at suitable levels and if drastic actions are absolutely necessary, such as burning or mowing to recover rank and neglected habitats, they should be carried out piecemeal over a period of several years and not implemented all at once.

These problems are familiar ones throughout lowland Britain and certainly apply to much of North-west England. The direct loss of heaths and grassland is inevitably more pronounced on fertile soils and near to centres of high population density, such as Merseyside and Greater Manchester, but even in the rural countryside of Cumbria and north Lancashire these habitats are under threat. In the south of the Region there are extremely few surviving sites of conservation significance and our knowledge of their invertebrate faunas is very limited. The most important sites are probably the heathlands of the Wirral, especially Thurstaston Common which is the largest remaining area on Merseyside. This is a mixture of wet and humid heath which grades into birch and oak scrub. The very local heathland bugs *Alydus calcaratus* and *Rhacognathus punctatus* are present and characteristic moths recorded include the grey scalloped bar *Dyscia fagaria* and the dotted border wave *Idaea sylvestraria*. This is potentially a very interesting site and further recording, amongst groups such as the bees and wasps, beetles and spiders, is likely to be very productive. The same is true for the expanse of dune heath at Freshfield, next to Ainsdale NNR. There are a few casual records from this site which indicate its potential but more systematic recording would be of great interest. The only other notable site on Merseyside, on current information, is the area of damp neutral grassland at Stanley Bank Meadow on the outskirts of St Helens. This is almost unknown entomologically but its mixture of shaded ponds, scrub, and herb-rich grassland is certainly of potential interest. Seepages along the edge of the site are known to support the uncommon soldierflies *Nemotelus nigrinus* and *Oxycera rara*. Several species of soldierflies, including these two, are regarded as indicators of good quality flushes and seepages and their presence can hint at a rich fauna of semi-aquatic Diptera and other invertebrates. Flushes can be an important component of a grassland habitat and they often support a diverse fauna of considerable conservation significance. They are so readily drained that they are becoming generally scarce on lowland pasture, a situation which is paralleled by their associated invertebrates. To maintain their value for invertebrates they need to be lightly grazed, which prevents them from becoming shaded out by rank grasses, and a degree of 'poaching' is

beneficial as trampling by grazing stock keeps open pockets of bare, peaty soil in which many insect larvae develop.

Across the Pennines in south and West Yorkshire there is a greater variety of grassland habitats and some excellent heathland sites. The backbone of Magnesian Limestone which runs along the eastern edge of the Region supports numerous important calcareous grasslands. These naturally have many affinities with similar habitats further north in Durham and North Yorkshire. A conspicuous feature of several of these sites is an abundance of common rockrose, which is the foodplant of a suite of scarce grassland insects. At Hetchell Wood in West Yorkshire all five of the characteristic rockrose beetles occur - *Meligethes brevis, M. solidus, Bruchidius cistis, Mantura matthewsi* and *Aphthona herbigrada. M. brevis* is a speciality of the Magnesian Limestone and is almost entirely restricted to North-east England, with just a couple of sites in the North-west Region and Wales. The Lepidoptera are another important plant-feeding group on calcareous grasslands and an extensive fauna can occur on favourable sites, utilising most of the plant species present. The pimpernel pug *Eupithecia pimpinellata*, feeding as a larva on burnet saxifrage, is a characteristic (though nationally uncommon) inhabitant and the six-belted clearwing *Bembecia scopigera* is known from a few sites containing a fair proportion of bird's-foot trefoil or kidney vetch in the sward. Grassy sites can also be of value, supporting the pyralid moth *Crambus pratella*, the rare stem-mining fly *Opmoyza punctella* or the snipe fly *Symphoromyia immaculata*, for instance. Short sward calcareous grassland is an important habitat for some of our less common snails and at Brockdale in West Yorkshire there is a small population of *Truncatellina cylindrica*. There are only two known sites which still support this species in Britain (the other is in Bedfordshire) and its conservation must be a major priority for the Yorkshire Wildlife Trust who manage this site.

Most of the surviving Magnesian Limestone grasslands in Yorkshire are either on steep escarpments, as at Brockdale, or associated with abandoned limestone quarries. Neither of these situations are profitable to improve agriculturally and the main threat they now face is from the shading out of grassland habitats by encroaching scrub. Old quarries can be particularly important as their thin soils support a varied flora with patches of open ground in hot, sheltered conditions. This is of great benefit for the many warmth-loving invertebrates of calcareous grassland. Dry heathland invertebrates can be similarly favoured by quarrying activities and there are several good examples of this in the east of the Region. One of the most conspicuous groups on sandy heaths is the Aculeate Hymenoptera, particularly the

solitary bees and wasps. Many species nest in burrows which they excavate in firm, but friable, soils and most prefer sites with high ground temperatures. Pompocali, east of Leeds, is a seventeenth century Millstone Grit quarry which has become covered with woodland in the centuries following its abandonment. The trees were cleared about fifty years ago and cattle grazing has maintained a cover of young heather and eroded paths on the sandy mounds of the quarry heaps. This has created a superb habitat for bees and wasps, with over sixty species present on the 1.7 hectare site; an excellent assemblage for such a relatively small area. Most of the species recorded are generally distributed in suitable habitats in lowland Britain but the solitary bee *Andrena humilis* is worthy of note as it is now much less common in Britain than it used to be as a result of the deterioration or destruction of its favoured sandy habitats.

The most important area of heaths in South Yorkshire are the remnants of Coversand heathland in the Trent valley. These are an extension of the Coversand sites of South Humberside and the two counties share a common reduction in the extent of valuable heathland habitat due to afforestation and reclamation for agriculture. In South Yorkshire most of the surviving heaths have been actively quarried for sand and only Rossington Bridge is unaffected by sand extraction. Much of the site consists of dry, herb-rich grassland but

there are also patches of heath and fen. A variety of scarce heathland and grassland invertebrates have been recorded, including (in 1967) the only British example of the ladybird *Exochomus nigromaculatus* this century. This is potentially an area of considerable importance which would benefit from a detailed survey of a wide range of invertebrate Orders. Active sand quarries present a considerable dilemma for nature conservation. Their value stems almost exclusively from the provision of bare sandy flats and cliff faces as a result of recent workings. The longer an area is left unworked, the greater is the cover of vegetation through natural succession and the important pioneer stages of the habitat are lost. Quarrying activities cannot be curtailed as they provided a continuous supply of suitable habitat, but in the long term the quarry is exhausted and the habitat lost. There is really no satisfactory solution to this problem. The only possibility would seem to be for conservation bodies to acquire partly-worked and abandoned quarries and instigate periodic management which would maintain the right conditions over a long timescale. Sand quarries usually have limited significance for birds and flowering plants and hence have tended to be rather neglected by conservationists. This situation will have to be addressed if the valuable invertebrate fauna of such sites is not to be lost altogether.

South Yorkshire's sand quarry fauna is best developed in the Finningley area where Blaxton Common and Crow Woods pits are of great importance. More than a hundred species of bees and wasps have been recorded here, including the nationally scarce mining bee *Andrena tibialis* and the solitary wasp *Psen bicolor* which has only been found in this general area and nowhere else in Britain for at least twenty years. Spider-hunting wasps are typically found in sandy habitats and local species found at Finningley include Arachnospila trivialis, *Anoplius infuscatus* and *Diopogon nitidus*. Crow Wood is regarded as one of the most important localities in Britain for the Dryinidae, a family of parasitic wasps that develop on leafhoppers. The status of this family is poorly understood in Britain but the presence of apparently rare species such as *Prenanteon frontalis* and *Neochelogynus rufulocollis* is certainly noteworthy. The sand quarries also have a suite of species that are more typically found on coastal dunes and are scarce nationally in inland situations. These include the weevil *Philopedon plagiatus*, the ground beetle *Broscus cephalotes* and the wolf spider *Arctosa perita*. Additional surveys of the ground active fauna are certain to reveal the occurrence of a much greater range of specialist inhabitants.

To the north of Finningley is Hatfield Moor, a once vast area of mossland overlying sand and gravel. Sandy heathland is present in a number of places around the edge of the Moor and is

an important component of the site that distinguishes it from the predominantly peatlands habitats of its neighbour Thorne Moors. Noteworthy heathland invertebrates recorded from Hatfield include the bugs *Globiceps woodroffei* and *Plinthisus brevipennis*, the ground beetle *Calathus mollis* and the heart and club moth *Agrotis clavis*. At Hatfield Lings the Aculeate fauna is characteristically rich with many of the Finningley species present along with *Podalonia affinis* and *Coelioxys quadridentata*.

Other heathland and grassland habitat types are less well known in South and West Yorkshire but are of potential interest and worthy of increased attention. Seckar Wood near Wakefield, for instance, has pockets of wet heath, whilst the low altitude moorland (220 metres a.s.l.) of Warncliffe north of Sheffield supports the local heather ladybird *Coccinella hieroglyphica*, a number of scarce heathland moths such as the grey scalloped bar *Dyscia fagaria*, and the sandy grassland cranefly *Nephrotoma crocata*. Neutral grasslands, on current evidence, are of minor significance for invertebrates in this part of the Region but the flood meadows at Edderthorpe Ings near Barnsley would repay detailed survey. The ground beetles *Agonum livens, Bembidion bipunctatum* and *B. fumigatum* are known from here and a rich fauna can be anticipated.

Knowledge of the heathland and grassland habitats for invertebrates in Lancashire is almost entirely limited to the Carboniferous Limestone grasslands in the north-west of the County. This series of sites around the Silverdale area, along with neighbouring localities in South Cumbria, is of national importance for invertebrates and certainly one of the region's highlights. Most are an intimate mosaic of scrub, scree and grassland and support a diverse fauna which reflects this habitat variety. They are perhaps best known for their extremely rich lepidopteran faunas and the recording of butterflies and moths predominates over any other group. There is a typical assemblage of species which can be found on most of the top quality limestone grasslands in the area, characterised by the least minor *Photedes captiuncula*, the northern brown argus *Aricia artaxerxes* and the Duke of Burgundy fritillary *Hamearis lucina*. The cistus forester *Adscita geryon* is also established on a number of sites and other interesting moths include the thyme pug *Eupithecia distinctaria* and the grass moth *Crambus ericella*. There are also at least two colonies of the Scotch argus *Erebia aethiops*, which is otherwise restricted in Britain, as its name suggests, to Scotland.

The recording of other invertebrate groups on these grasslands is patchy and more rare and

interesting species must be awaiting discovery. An example of this is the whorl snail *Vertigo angustior* which was found in mossy hollows on the limestone pavement of Gait Barrows NNR in 1981 and occurs elsewhere only in wetland habitats in southern England and Wales. The rare woodlouse *Armadillidium pictum* is a speciality of the area with few other populations in Britain and the leafhopper *Chlorita dumosa* was recently found at Scout Scar, comprising the first British record although it is now also known from Rhum in the Outer Hebrides.

As with all grassland habitats, management is vital on the Carboniferous Limestone to maintain faunistic richness. Some species will benefit from relatively short swards whilst others require the shelter and structural variety provided by longer turf. There is no simple prescription for management and each site should be assessed on its merits, bearing in mind that the fauna that will do best is that which has adapted to the conditions historically present on a particular site. Moderate levels of grazing will, in most cases, probably produce a mosaic of turf heights which will suit the greatest diversity of invertebrates, but swards which have been traditionally close grazed are best maintained as such. One species which can act as a barometer of the health of these calcareous grassland is the Duke of Burgundy fritillary. It naturally leads a precarious existence as it occupies transitional habitat on the wood edge and is prone to extinction as scrub encroaches upon open grassland. Balancing grazing pressure to hold scrub in check is a difficult operation but monitoring the fortunes of the fritillaries can give an indication of overall success. Duke of Burgundies have vanished from some sites through afforestation, scrub invasion and over-grazing and their remaining colonies need to be managed carefully if they are not to be lost forever from the area, and with them many other less conspicuous grassland invertebrates.

A similar situation occurs further north on the weakly acidic mesotrophic pastures of Cumbria where the fate of the marsh fritillary *Eurodryas aurinia* also hangs in the balance. It has perhaps never been a particularly common butterfly in the Region but it is now confined to just four or five colonies as a result of habitat loss and management neglect. Marsh fritillary populations are known to wax and wane naturally and to undergo local extinctions. Great care will have to be taken on these remaining sites if the species is not to be completely lost from the Region. As in Wales and south-west England, typical associates on these damp grasslands include small pearl-bordered fritillaries *Boloria selene* and the silver hook *Eustrotia uncula* and forester moths *Adscita statices*. No other invertebrate groups have been adequately surveyed but, considering the richness of the flora with plants such as saw-wort and dyer's greenweed, it is likely that the phytophagous insects in general could be worth investigating.

Shallow pools are a feature of some of the Cumbrian grasslands and a few of these are known to support the mud snail *Lymnaea glabra*. This semi-aquatic species has declined considerably in Britain through the destruction of its habitat as these ponds are so easily infilled or ploughed-out. It is tolerant of desiccation and favours water bodies on poor soils that are prone to drying out. Unfortunately, the practice of deepening seasonal ponds to make them more attractive to conspicuous forms of wildlife, such as dragonflies, is a serious threat to this snail. In this regard, caution must be exercised by conservationists to ensure that *Lymnaea glabra*, and the small but specialised assemblage of invertebrates that share this requirement, is not lost from sites through apparently good intentions. The dipteran families of the Empididae, Dolichopodidae and Sciomyzidae contain several species that prefer the margins of temporary pools and there are also many beetles and a number of predatory bugs that are characteristic associates.

Wet heathland is scattered across Cumbria but occurs mainly in the north and west of the county where it invariably occurs in conjunction with marshy grassland, scrub woodland and acid mires. Hallsenna Moor is one of the best examples of this kind of habitat mosaic and is likely to prove to be an important site for invertebrates when it receives the attention it deserves. At present only the phytophagous Coleoptera have been the subject of detailed surveys and noteworthy heathland weevils recorded include *Acalles ptinoides* and *Anthonomus brunnipennis*. Green hairstreaks *Callophrys rubi* are frequent, breeding on gorse and bilberry as they do on several of the county's heaths and mosses. Some of the lower hilltops that have not been too heavily sheep grazed, as on Lazonby Fell and Wan Fell to north-east of Penrith, support heather dominated communities at around 250 metres a.s.l. Both of these sites were popular with entomologists in the early part of the century and were clearly important invertebrate sites. Their moth faunas were particularly rich with records of Manchester treble bar *Carsia sororiata*, goldenrod brindle *Lithomoia solidaginis*, scarce silver Y *Autographa interrogationis* and dark tussock *Dicallomera fascelina* indicating a valuable fauna. Lying in the rain shadow of the Lake District mountains, these Fells supported a significant southern element in their fauna, including the ground beetles *Pterostichus lepidus* and *Amara equestris*, the spiders *Hypsosinga albovittata* and *Episinus truncatus*, and the bog bush cricket *Metrioptera brachyptera*. This is a remarkable fauna so far north and at such a comparatively high altitude, especially considering that the montane ground beetle *Leistus montanus* was also recorded several times on these Fells in the 1940's and 1950's. Whether any of these species have survived the increased grazing pressure that has afflicted so many of the Cumbrian hills in recent decades is unknown as there is no modern invertebrate

information available. They would seem to be priority areas to direct survey effort in the future. Indeed, there is scope for increased recording on lots of Cumbria's heathlands and grasslands in order to provide information on which to base sympathetic management in the future.

OPEN WATER and its margins

"*He with a smile did then his words repeat;*

And said that, gathering leeches, far and wide

He travelled; stirring thus about his feet

The waters of the pools where they abide.

'Once I could meet with them on every side;

But they have dwindled long by slow decay;

Yet still I persevere, and find them where I may'"

(Resolution and Independence, 1807)

William Wordsworth's leech-gatherer would be unable to make a living in the Lake District nowadays as another two centuries of decline have brought the medicinal leech *Hirudo medicinalis* to a position of extreme rarity. There are believed to be only two Cumbrian tarns which still support the species and perhaps as few as twenty localities in Britain as a whole now contain populations. A similar position exists over most of western Europe and as a result the medicinal leech has been given widespread legal protection, including coverage under Schedule 5 of the Wildlife and Countryside Act 1981. The reasons behind the leech's decline are unclear and many factors have been implicated. Certainly "leech-gathering" for the vast international trade during the nineteenth century will have had an impact but it is unlikely that this would have brought about the almost total extinction of the species in upland areas such as the Lake District. It is probable that changes in land use and pond management have had the greatest effect as medicinal leeches favour shallow, eutrophicated ponds with a substantial cover of aquatic macrophytes. Left alone, such ponds will eventually silt up and become marshes, perhaps then to be completely excavated to a depth unsuitable for medicinal leeches. Host-availability may also have changed over the decades as sheep have become more prevalent on the Fells instead of cattle. As sheep rarely stand around in water they offer fewer possibilities of attachment by leeches than horses or cattle do. Deer are the only probable mammalian hosts on the sheepwalks. Other hosts are also utilised, including amphibians, water-birds and small fish, but it is possible that they are only important for the younger stages of the medicinal leech's development. That Wordsworth could report on decline in abundance nearly two hundred years ago is of great interest but gives us no clues as to the cause behind the "slow decay". Ecological studies by the Freshwater Biological Association have given us a clearer picture of the requirements of the medicinal leech and we should now be able to safeguard the remaining populations in the Lake District. In the future it may be possible to re-stock old haunts, for the time being the protection and management of surviving populations must be a priority for conservation.

The presence of the Freshwater Biological Association (now the Institute of Freshwater Ecology) at Ambleside means that Cumbria's lakes, ponds, streams and rivers are amongst the best known in Britain for their invertebrate faunas. Not all of the FBA's information is currently available to the Invertebrate Site Register but, even so, there is sufficient data to support the expectation that this is an important area for the conservation of aquatic and semi-aquatic invertebrates. Of greatest interest amongst the lakes are probably the oligotrophic, relatively undisturbed, waters of Ennerdale, Buttermere and Wast Water with their limited, but characteristic faunas. Cold, nutrient-poor waters are dominated by aquatic insects, particularly mayflies and stoneflies, and these lakes also contain a number of

uncommon crustaceans. Ennerdale is especially important for the presence of three glacial relict species of crustaceans, two of which (*Mysis relicta* and *Limnocalanus macrurus*) are not known from anywhere else in Britain. The third, *Salminicola edwardsii*, also occurs in four Scottish lochs but there is some evidence that the Ennerdale population may actually be a different species from Scottish *Salminicola*. Unfortunately, only the latter species had been found in Ennerdale in recent decades and it is possible that *Mysis* and *Limnocalanus* became extinct there in the 1950s. Catchment afforestation, acidification, and use of the lake as a reservoir are possible causes of their decline, although *Mysis* has never been common and may still occur at low population levels.

As with our treatment of the oceans, there has been an ignorant belief that large lakes can absorb pollution with little apparent effect, but we are now beginning to recognise that this is clearly untrue. Some of the changes in the fauna of Windermere, the largest lake in England and Wales, appear to relate to the discharge of domestic sewage, with notable declines in the abundance of mayflies and stoneflies and increases in flatworm populations. Whether pollution was responsible for the extinction of the glutinous snail *Myxas glutinosa* from Windermere is unknown. There have been no records of this nationally rare species in the

lake since 1957 and recent searches have failed to refind it. Despite its many problems, Windermere is still an important locality for freshwater invertebrates, including substantial populations of the riffle beetle *Stenelmis canaliculata* and the caddisfly *Setodes argentipunctellus*. Both of these rare species favour shallow, stony lake shores (although *Stenelmis* also occurs in rivers) and this is an important feature of many of the Cumbrian lakes. The Lake District is a stronghold for several species of caddisfly that are associated with this type of habitat, including *Apatania wallengreni* and *Mesophylax impunctatus*. Many of the smaller tarns in the uplands are also important for this aspect of the fauna and Blelham Tarn, with *Cyrnus insolutus* and *Erotesis baltica* is regarded as one of the best sites in Britain for caddisflies.

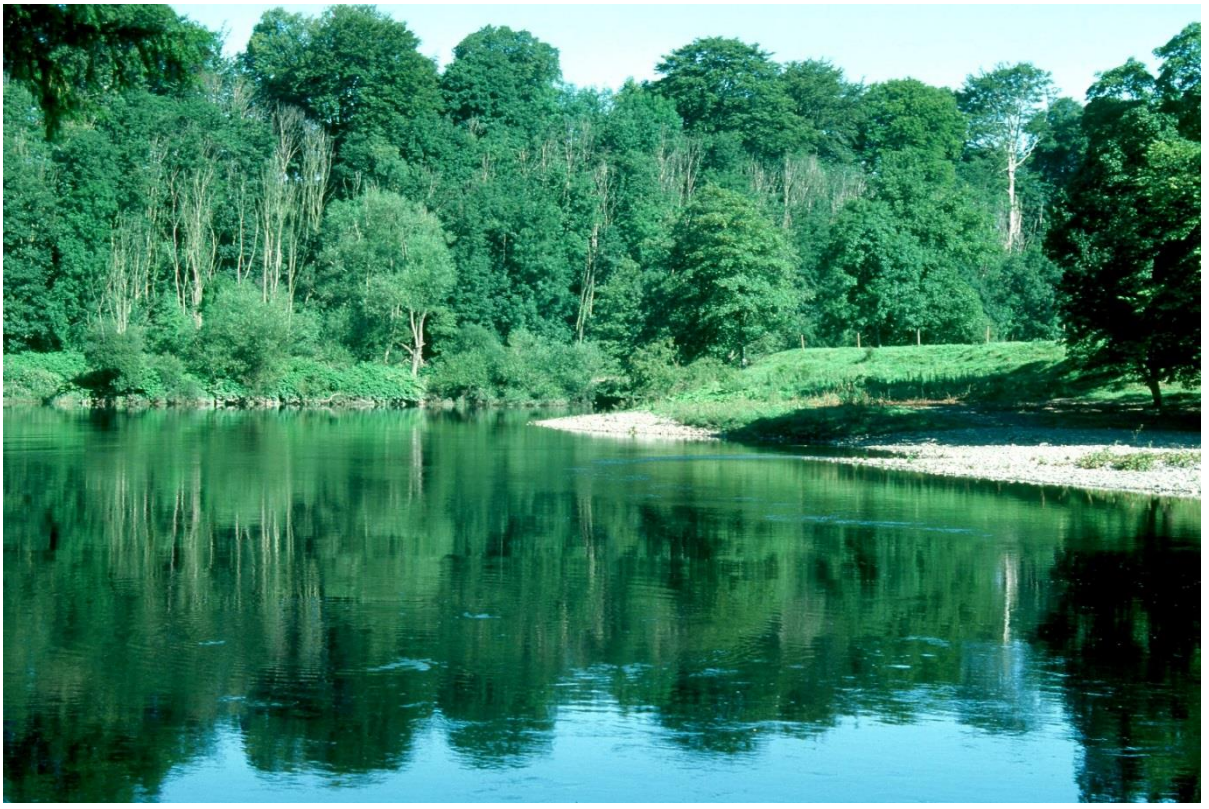
Blelham Tarn also has a substantial margin of fen around its perimeter and here, as at several sites in the Lake District, can be found the whorl snail *Vertigo lilljeborgi*. This species is most frequently found in fens which are subjected to a degree of seasonal flooding and is rarely found in marshes with a more stable water level. The Region's lake fens are also important for leaf beetles of the genus *Donacia*, with *D. aquatica* being a speciality of the area. It was formerly widespread in Britain but has declined considerably over much of England and Wales, largely due to habitat loss. At Tarn Hows it shares its habitat with *D. obscura* and *D. thalassina*, which are also nationally uncommon beetles, and the presence of the three together indicates the high quality of the marginal fens at this site. Several of the tarns and lakes have been shown to contain rich water beetle faunas, including species such as *Hygrotus quinquelineatus, Coelambus novemlineatus, Agabus labiatus* and *Helochares lividus*. One of the best sites in this regard is the kettlehole lake of Thurstonfield Lough in the north of the county. There are old records of an extremely important relict fen fauna which included *Hydroporus rufifrons, Hydroporus obsoletus, Agabus labiatus* and *Hydrochus brevis* along with several species of the aquatic weevil genus *Bagous*.

Recent searches have failed to locate these rarer species, possibly as a result of eutrophication, but it is still an important locality for aquatic beetles such as *Agabus unguicularis, Gyrinus caspius* and *Ilybius guttiger*, and investigations of other invertebrate groups in the lush and extensive marginal fens would be very interesting. In the southern part of the Lake District several of the standing water bodies support small populations of the downy emerald *Cordulia aenea*, a handsome dragonfly that favours small lakes with woodland nearby.

Inevitably, Cumbria's climate and geology combine to give rise to a profusion of rivers and streams, the largest of which is the Eden which flows north-west from the Pennines to empty into the Solway Firth. Major rivers originating in the Lake District Fells include the Dutton, Esk and Derwent, whilst the Lune and the Irthing are important rivers in the east of the county. They begin their descent to the sea as clear water streams, fast-flowing and rich in oxygen as they tumble over stony beds in the high mountains. In these upland section they contain characteristic assemblages of mayflies, blackflies and stoneflies, the latter including *Protonemura montana* as a typical and probably widespread inhabitant. A speciality of the middle reaches of these streams is the caddis fly *Glossosoma intermedium*, currently known from three localities in the Lake District and nowhere else in Britain. As the rivers broaden and become less frenzied more species of invertebrates appear amongst the fauna; freshwater crayfish *Austropotamobius pallipes* and freshwater pearl mussels *Margaritifera margaritifera* are notable examples. Cumbria's freshwater crayfish populations in the Eden catchment and the rivers of the southern Lake District are of considerable importance as they are still free of contamination from the devastating plague spread by the introduced signal crayfish *Pacifastacus leniusculus*. Considering the decline of this species over most of central and southern England, Cumbria's populations provide a significant plague-free refuge from which other areas may eventually be restocked if the disease is eliminated. The freshwater pearl mussel is now protected under Schedule of the Wildlife and Countryside Act as its numbers have dwindled through pollution and collecting for pearls. Its status in the Region is not entirely clear at present as it often lives in rather inaccessible rivers and it is possibly more common than records suggest. During the sixteenth century a pearl fishery was operated on the River Irt below Wast Water so the mussels were presumably common enough then.

Freshwater pearl mussels inhabit fast flowing rivers with a bed of sand or shingle. Where such rivers are relatively free of water-borne pollution and artificial disturbance of the channel and its banks there is quite likely to be a valuable invertebrate fauna. Base-enriched rivers of this nature are particularly important for riffle beetles, a small family of water beetles containing species adapted to clinging to stones and aquatic plants in strong currents. They are largely intolerant of pollution and hence they are generally indicative of good water quality; few species can be considered to be common in our rivers nowadays. Two outstanding sites in the Region are Kirk Beck, near Bewcastle, and Gowk Bank on the River Irthing. Species recorded include *Hydraena pygmaea, H. pulchella, H. rufipes, Riolus cupreus* and *R. subviolaceus* as well as the riverine water beetles *Deronectes latus* and *Helophorus arvernicus*. Further downstream, the Irthing deposits substantial banks of shingle and this is a feature of several of the larger Cumbrian rivers. Although superficially barren, river shingle banks support a

large community of specialised invertebrates that have adapted to the frequent floods, summer droughts and periodic destruction of their habitat.



River shingle sites on the Cumbrian rivers are comparatively well known as they were investigated by a number of Coleopterists in the early part of this century. The Eden near Great Salkeld is a famous locality as it provides the only English record of the rove beetle *Thinobius newberyi*. It is a small, subterranean species that is believed to be endemic to Great Britain and has only ever been found in a few localities in Scotland, England and Wales. It is probably overlooked on many rivers but it has been specifically searched for on a number of occasions at Great Salkeld and has not been seen since about 1909. Many of the shingle beetles are subterranean and only discovered when they are the subject of a particular search so it is difficult to evaluate the importance of individual sites. It does seem that dunging and trampling by grazing stock when they have access to water is very detrimental and the richest banks are those which are completely undisturbed except for the natural reworking of deposits by the river itself. On present evidence, the best Cumbrian rivers for shingle invertebrates are the Lune, the Eden and the Irthing. Species which are currently regarded as nationally scarce include the rove beetles *Lathrobium angusticolle* and *Stenus incanus*, the pselaphid *Brachygluta pandellei* and the ground beetles *Bembidion litorale*, *B. monticola* and

Thalassophilus longicornis. The stiletto fly *Psilocephala rustica* has recently been found on the barks of the Irthing but it is really only the Coleoptera that have been reasonably well surveyed. Spiders, bugs and several dipteran families also contain shingle specialists and it would be very interesting to have survey information for these groups from the Cumbrian rivers.

River shingle is an important invertebrate habitat in West Yorkshire, particularly along the banks of the Wharfe. This is quite a sandy river and the particle size of the bank sediments has a significant effect on the range of species occupying each site. In particular, coarse gravel, fine shingle and sand have different water-retention properties and hence species with specific humidity requirements will be restricted to shingle banks of the right kind of sediment. Subterranean invertebrates living amongst the gravel interstices and species which burrow into firmer deposits are also confined to banks containing a suitable range of particular sizes. The best surviving shingle site in the east of the Region is East Keswick Fitts, where the Wharfe deposits ridges of sand and fine shingle abutting onto backwaters and willow carr. Invasion by Himalayan balsam is a problem here, as on so many other lowland British rivers, but it still retains an important fauna. Amongst many scarce riparian insects known from the site are the nationally rare flies *Platypalpus subtilis* and *Thereva lunulata*, both of which are known from the sandy banks of only a few rivers in Britain. A speciality of the Yorkshire rivers which does not seem to occur elsewhere in the Region is the beetle *Aegialia sabuleti*, a nationally scarce inhabitant of sandy river banks. It occurs at a number of sites along the Wharfe but it quite localised as some of its sites, such as Castle Ford, have been destroyed in the recent past. *Bledius defensus,* a rove beetle which burrows colonially into sandy cliffs alongside rivers, is apparently restricted to the Yorkshire vice-counties and is locally abundant along the Wharfe.

The other significant aquatic habitats in West Yorkshire are artificial in origin, created either by gravel extraction or mining subsidence. The best example of the former is Elland Gravel Pits, a series of disused workings lying between the River Calder and the Calder and Hebble Canal. Only the terrestrial Coleoptera have been adequately surveyed here, revealing a very rich fauna associated with the marginal wetlands and including the very rare fenland ground beetle *Dromius sigma*. The indications are that the importance of the Elland Gravel Pits is due to the proximity of pre-existing wetland habitats in the Calder Valley. It would be very useful to carry out surveys of other invertebrate groups in the area to clarify the value of the site for invertebrate conservation.

Coal mining subsidence is responsible for the creation of the shallow pools, known as flashes, on the flood plain of the River Aire at Fairburn and Mickletown. The diversity of their flora and fauna is probably also due to the former existence of good wetland and aquatic habitats in the vicinity and both sites have interesting marginal fens supporting characteristic faunas. However, Mickletown Ings also contains an extraordinary assemblage of halophilic invertebrates that is quite possibly unique in Britain. The flashes at Mickletown vary in salinity with distance from the colliery spoil heaps at the western end of the site. Mineral salts leaching from the spoil have led to the brackish nature of these pools. Their aquatic faunas have been the subject of several investigations as they contain a remarkable range of invertebrates that are normally considered to be coastal in distribution, including the amphipod *Gammarus duebeni*, the ostracods *Cypridopsis aculeata* and *Heterocypris salina* and the rotifers *Brachionus plicatilis* and *Colurella atriatica*. It seems that the most likely explanation of their colonisation of these pools, which are about 30 kilometres from the nearest coastal waters, is that they have been accidentally transported by waterbirds. Other halophilic invertebrates are also present, such as the leaf beetle *Macroplea mutica* and the flies *Spilogona biseriata* and *Rhaphium antennatum*. The system itself is inherently unstable with changes in salinity bound to occur as a result of further subsidence and variations in run-off from the spoil heaps. Periodic surveys of the aquatic fauna will provide a fascinating insight into the tolerances of the brackish-water community and, as most of the flashes are less than fifty years old, additional halophilic species may colonise the site in the future.

South Yorkshire also has a number of subsidence flashes, notably Denaby Ings, Catcliffe Flash and Wilthope Marsh. The latter site has a good dragonfly fauna, with ruddy darters *Sympetrum sanguineum* breeding at one of the northernmost sites in the country for this scarce species. Denaby Ings, however, is the most important example of the South Yorkshire flashes for invertebrates but the interest of the site is mainly due to the extensive marshes around the flashes and is therefore best considered with lowland peatland habitats in the following chapter. Shipley Pool, north of Doncaster, is the best open water site in South Yorkshire. It is believed to have formed over 400 years ago in an area of Elizabethan peat cuttings and has been the subject of considerable entomological attention for the past one hundred years. The most extraordinary record for the site is the capture of a number of specimens of the scarce darter *Libellula fulva* for the period 1888 - 1911. This rare dragonfly is known elsewhere in Britain only from Cornwall, southern England and East Anglia. Sadly, there have been no further records of *fulva* from Shirley Pool, despite many searches, but the dragonfly interest of the site is still significant as the hairy dragonfly *Brachytron pratense* and

the ruddy darter have been recorded in recent times. Shirley Pool and the contiguous fenland habitats of Rushy Moor are also of great value for wetland invertebrates but, as with Denaby Ings, these will be discussed in the following chapter. The Pool contains an abundance of the local swan mussel *Anatina cygnea* and there are old records of the rare freshwater ramshorn snail *Segmentina nitida*. It appears that the aquatic fauna has been rather neglected, apart from the Odonata, for quite some time and such an interesting and ancient site would be well worth surveying in the future.

On current information there are few other open water habitats of invertebrate significance in South Yorkshire. Some of the small streams in the south of the county still hold populations of freshwater crayfish but the lowland rivers have suffered badly in the past from industrial pollution. Some of the ditch systems of the grazing levels around the confluence of the Ouse, Don and Trent do appear to be of potential value, particularly Bentley Common which has the fenland relict water beetle *Hydrochus elongatus*, for instance, and the long-disused Chesterfield Canal may repay investigation. It is likely that detailed surveys of aquatic habitats in the county will reveal other sites of at least local significance. This is also true of Merseyside, Greater Manchester and Lancashire, where our knowledge of open water sites is very limited. The subsidence flashes at Wigan would be worth investigating and the numerous clay ponds of the Wirral are also of potential interest. In Lancashire, Leighton Moss has the largest reedbed in north-west England and substantial areas of open water occur within the floodplain fen. The terrestrial fauna of the fen has been recorded by a number of specialists and there are a number of rare species associated with the fen pools. The cranefly *Limnophila pictipennis* probably breeds amongst submerged plant roots and detritus in the shallow margins whilst the larvae of the hoverfly *Sphaerophoria loewi* are predatory on the aphids of reed stems. Both of these flies are known from few sites in Britain and are not known to occur elsewhere in the Region. Not far from Leighton Moss is Hawes Water, a marl lake which is fringed by stands of common need, greater fen sedge, bulrush and bur-reed. The leaf beetle *Donacia clavipes*, whose aquatic larvae feed on the roots of common reed, has been recorded and there is some information on the Diptera of the marginal fens, but the site is generally underworked and should prove to be of considerable interest when it receives greater attention. Other aquatic sites in Lancashire, such as the Wildfowl and Wetlands Trust reserve at Martin Mere, are similarly under-recorded. Throughout the Region it is likely that much information exists on freshwater invertebrates that has not yet been collated by the Invertebrate Site Register but there is certainly plenty of scope for additional recording on all sites. There is potential for many interesting discoveries to be made and, in the process, useful information can be gathered which will help to assess the quality of individual sites and to

detect changes brought about by the many threats which face our lakes and rivers, ponds and streams.

LOWLAND PEATLANDS

The destruction of the peatland habitats on Thorne and Hatfield Moors in recent decades must rank as one of the most devastating losses for invertebrate conservation in Britain this century, matched only by the piecemeal, but extensive, deterioration of the shingle foreland of Dungeness in Kent. Thorne and Hatfield once consisted of almost 3,500 hectares of peatland but less than a third of this still survives and most of the remaining areas are threatened by the inevitable changes to the hydrology of the two sites. Hatfield Moors was more or less intact until relatively recently but some 80% of the total area has been excavated for the horticultural industry, mainly in the last ten years or so. By contrast, Thorne has been affected by agricultural reclamation and peat cutting for two hundred years. This was initially through the practice of 'warping', flooding marginal areas by cutting tidal channels and permitting the deposition of alluvial silts to improve the agricultural potential of the soils. This accounted for vast area of the peripheral peatlands during the nineteenth century, and was then followed by a variety of styles of peat cutting by hand up until the 1960's. It was then that a change to the mechanical extraction of peat for horticulture, based on post-war planning consents, accelerated the rate of loss and damage to the central core and began the controversy and campaigns that rage today. Peat-milling, which started on Thorne in about

1985, has exacerbated the problem as this methods of extraction requires extensive drainage to be undertaken which also affects surrounding areas. Whereas the more traditional forms of peat-cutting left a mosaic of pools and balks, milling creates a uniformly dry, flat and vegetation free surface which is eventually stripped completely bare of peat. It is a rapid and thorough process which leaves no refuges for plants and animals and offers no prospects of recolonisation, whilst also diminishing the significance of adjacent peatland habitats by an inevitable lowering of the water table.

The importance of Thorne and Hatfield Moors for invertebrate conservation lies both in their size and their geographical position. Occurring in an area of relatively low rainfall, they were our best examples of the continental type of raised mire and as such they contained an extraordinary mixture of northern bog and southern fen species, along with two beetles that are characteristic of such habitats in central Europe but known from nowhere else in Britain. In excess of three thousand different invertebrate species have been recorded from Thorne Moors alone, about 12% of the entire British fauna, including a very large number of nationally rare or scarce bog, fen or carr woodland species. There is no question that Thorne Moors was one of the most important sites for invertebrates in Great Britain and it is likely that Hatfield Moors, which has never been as comprehensively surveyed, was of comparable significance. The lamentable likelihood of recent developments is that Hatfield will be completely destroyed and Thorne's pockets of nature reserve will gradually suffer as the peat dries out through the destruction of the site's hydrological integrity. Some peatland species will survive these changes but it remains to be seen how much of the special interest of this unique area will persist.

Recent studies have already indicated a substantial contraction of range for the area's two specialities, the ground beetle *Bembidion humerale* and the pill beetle *Curimopsis nigrita*. Both of these species appear to be associated with pockets of open damp or wet peat on the Moors. In the case of *B. humerale*, established peatland vegetation is usually in close proximity whilst *Curimopsis* can be found locally distributed in more extensively open areas. *Curimopsis* spends much of its time within the peat, utilising natural crevices or its own burrows and is therefore less dependent on plant litter and tussocks for shelter. *B. humerale* is an active predator, hunting over the bare peat, but probably sheltering in tussocks and it is suspected that its larvae may inhabit vegetated areas where they are less prone to desiccation. Little was known of the specific habitat requirements of these two beetles before the recent surveys carried out by the Thorne & Hatfield Moors Conservation Forum. In particular, much has been learnt about the life history of *Curimopsis* and the discovery that

the adults feed largely on fine-leaved mosses, such as *Dicranella* or *Campylopus*, has been of great value in determining the distribution of this interesting species on the Moors. Both beetle species have undoubtedly declined as suitable habitat has been destroyed by peat extraction. Although more widespread in the past, the muscid *Phaonia jaroschewskii* is now believed to be confined to Thorne in Britain and it is also rare in the rest of Europe. There are strong indication that this fly has also declined on Thorne, even within the area designed as a National Nature Reserve. As an inhabitant of waterlogged *Sphagnum* it will be susceptible to changes in the water-table resulting from peripheral drainage and its fate may depend upon considerable efforts to maintain water levels in the remaining areas of raised mire.

The three species of insects mentioned above are all restricted to Thorne and Hatfield Moors in the British Isles and are therefore particularly important elements of their fauna. However, these sites are also of significance for the remarkable range of nationally rare species recorded. Other species worthy of mention include the ground beetles *Dromius longiceps* and *Dromius sigma*, the water beetle *Laccophilus obsoletus*, the micro-moth *Bankesia douglasii*, and the flies *Anagnota collini* and *Ormosia aciculata*. This is just a selection of the twenty-five species recorded that are considered to be of Red Data Book status. One of the reasons for this extraordinary richness of species is the diversity of habitats present on the two sites, incorporating raised mire, rich fen, carr woodland, dry heath, sandy grassland and brackish marsh. This variety also contributes to the unusual wealth of species at the edge of their geographic range in Britain. Northern species, such as the leafhopper *Struebingianella litoralis* and the shorebug *Teloleuca pellucens*, are chiefly characteristic of peatland habitats on the Moors whilst southern species at the edge of their range, including the ground beetle *Agonum sexpunctatum*, the bee-fly *Phthiria pulicaria* and the jumping spider *Bianor aurocinctus*, are more typical of heaths and dry grasslands. Thorne and Hatfield have undergone a dramatic change in recent decades from gradual modification to rapid destruction which threatened to totally eradicate their special significance for invertebrate conservation in a very short space of time. Past damage is regrettable but current initiatives at least offer hope for safeguarding a substantial proportion of that significance. There will undoubtedly be problems ahead but with a firm commitment to the conservation of the area they should not be insurmountable and hopefully Thorne Moors (and perhaps even Hatfield) will continue to be one of the most important sites in Britain for the conservation of peatland invertebrates.

Elsewhere in the Region the fortunes of raised mire habitats have mirrored developments on Thorne and Hatfield. The vast area of mossland in Lancashire and Greater Manchester is now

almost a memory, most having been drained and converted to arable land in the distant past. Only a few fragments survive, as at Winmarleigh Moss where some characteristic insects such as large heaths *Coenonympha tullia*, bog bush crickets *Metrioptera brachyptera*, black darters *Sympetrum danae*, and grass wave *Perconia strigillaria* and purple-bordered gold *Idaea muricata* moths still occur. The mossland subspecies of the silver-studded blue *Plebejus argus masseyi* sadly became extinct in Britain long ago. Other remnant mosses in the Region's south-west include Highfield Moss and Simonswood Moss, both of which are suffering from past damage but they are of potential interest and would be worthy of more detailed survey.

With more than 3,000 hectares, Cumbria contains some sixty percent of the lowland raised mires in Britain. Practically all of this has been damaged to some extent but a high proportion survives on the flanks of the Solway Firth and Morecambe Bay. In fact, the most extensive area of lowland raised mire in Britain occurs on the glacial till of the Solway Coastal Plain. The Solway and Wedholme Mosses have been extensively worked for peat but Walton Moss, to the north-east of Carlisle, has the largest area of active, ombrotrophic, lowland bog in the county. The familiar problems of drainage, scrub encroachment, peat extraction and afforestation afflict many of Cumbria's bogs but the better examples are still of great value for invertebrate conservation and this habitat type is certainly one of the Region's strong points in a national context.

Recent studies by the Nature Conservancy Council in Cumbria demonstrated some of the management dilemmas faced on raised mires. The invertebrate fauna of an intact, open mire is characteristically composed of a limited range of species containing a high proportion of ombrotrophic specialists. Deterioration of the mire's hydrology leading to invasion by scrub from the periphery increased overall species richness, frequently including a good diversity of carr woodland species which themselves are nationally scarce. Scaleby Moss is a good example of this, where the central core of mire vegetation supports populations of species such as the white-faced darter *Leucorrhinia dubia*, the ground beetle *Agonum ericeti*, the money spider *Glyphesis cottonae* and a rich assemblage of peatland water beetles including *Helochares obscurus*. Encroaching pine and birch scrub threatens to smother the open mire and must be held in check, yet the rare, northern birch-feeding weevil *Coeliodes nigritarsis* is present and there is a good range of wet woodland flies. Such habitats also frequently contain an interesting moth fauna, although this has not been investigated at Scaleby. The prime concern of management must be to preserve as much open mire as possible, although retaining a fringe of patchy scrub will be of benefit to carr invertebrates and also to some mire species as a source of prey and shelter.

Despite the problems faced by the Cumbrian Mosses there are still several sites of considerable importance where the retention of a high water table and the control of scrub encroachment should maintain their significance for invertebrate conservation. Known sites of importance include Cliburn Moss, Cumwhitton Moss, Dutton Mosses, Glasson Moss, Meathop Moss, Nichols Moss, Roudsea and the Rusland Valley Mosses. Others, such as Bowness Common, Drumburgh Moss, Oulton Moss, Salta Moss and Wedholme Flow, are virtually unknown in terms of their invertebrate fauna and would profit from detailed survey. The white-faced darter is known to have become extinct on Oulton Moss as a result of peripheral drainage but the weevil *Magdalis duplicata* has recently been found here in its only English station, an example of a scrub species benefiting at the expense of an open mire species. Many of these mosses are known to support a rich moth fauna, examples being the purple-bordered gold, grass wave, marsh oblique-barred *Hypenodes* humidalis, golden-rod brindle *Lithomoia solidaginis*, Manchester treble bar *Carsia sororiata* and grey scalloped bar *Dyscia fagaria*. Spiders are also well-represented with several sites holding nationally uncommon species such as *Hypsosinga albovittata, Singa hamata, Sitticus caricis* and *Tetragnatha pinicola*, whilst the rare money spider *Centromerus levitarsis* is known from two sites. Less is known of the Hemiptera, Hymenoptera and many Diptera families, for instance, but there are indications that the Cumbrian Mosses are also important for these groups. Whilst lacking the unique Continental character and fauna of Thorne Moors in the east of the Region, these western mires are extremely valuable for the increasingly threatened, and more typically British elements, of the lowland ombrotrophic bogs. The conservation of the maximum possible extent of this habitat is essential if this richness is to be maintained.

Although many of the mosses contain areas of poor fen, associated with former peat cuttings and in the peripheral lagg communities, richer fens are less common and more widely scattered throughout the Region. Fens differ from raised mires in that their hydrology is directly influenced by groundwater whilst the mires obtain water solely from precipitation. Mires are therefore invariably acidic as rain is lacking in nutrients, whilst fens encompass a range of trophic conditions depending upon the nutrient content of their groundwater, which is picked up from the mineral soils of the catchment or from sources of pollution such as agricultural run-off or sewage. The increase in nutrients results in a higher level of primary productivity and, usually, a greater degree of plant diversity. This affects the invertebrate fauna in a number of ways. Not only is there a broader range of different plants for phytophagous species to exploit, but the structure of the habitat differs markedly from that of the mires and fens are also frequently managed, by grazing or cutting, to take advantage

of the prolific plant growth. These factors influence the resident fauna as individual species respond to the presence or absence of their foodplants, the timing and regularity of cutting, or the specific micro-climate and structural diversity created by different levels of grazing. As with most other habitat types the richest fauna is usually found where sites have had a long tradition of similar management and the continuance of that tradition is necessary to maintain the significance of the site for invertebrate conservation.

Unfortunately, changes in farming practices have often led to the cessation of management on fens and many sites have become rank as a result of the withdrawal of grazing stock or the decline in cutting. Left alone, such fens will eventually turn to carr and then mature woodland, drying out the site and causing the local extinction of the fen fauna. As with raised mires, some scrub can be tolerated and will add to the diversity of invertebrates on a site, but scrub must not be allowed to spread unchecked at the expense of open fen. Several fens in Cumbria are in danger of losing much of their interest as scrub advances and remedial measures are probably required. One such is Newton Reigny Moss, a eutrophic kettlehole fen in the calcareous glacial drifts of east Cumbria. Peat cutting formerly maintained open fen conditions but this has long since been abandoned and willow carr now dominates much of the site. At the turn of the century this was an important locality for wetland invertebrates and was extensively worked for invertebrates, particularly beetles and spiders. There is little modern information but it appears that habitat quality has declined accordingly, certainly the variable damselfly *Coenagrion pulchellum* no longer occurs as it used to and many other nationally scarce species once known from here are now apparently absent. The same fate could also easily befall Biglands Bog, a valley fen complex of considerable importance which suffers from the dual threat of scrub encroachment and pollution from farm effluent. Amongst the water beetles of Biglands Bog are *Hydroporus scalesianus* and *Hydrochus brevis*, both of which are rare fenland relicts. They are likely to be very sensitive to changes in water quality and the population of *H. scalesianus* is already thought to have declined considerably in recent years.

Rich fen habitats in the counties of Lancashire, Merseyside, Greater Manchester and West Yorkshire are either completely unknown entomologically or else occur as peripheral bands around gravel pits, subsidence flashes, or lakes and are therefore mentioned in the preceding chapter. In south Yorkshire extensive fens occur on areas of subsidence at Denaby Ings and Potteric Carr, both of which are Yorkshire Wildlife Trust reserves. Potteric Carr is an interesting example of a site which is steadily improving in quality as poor drainage and subsidence increase the overall wetness of the reserve. Although comprehensively drained

and enclosed in the late eighteenth century, fen conditions developed as mining subsidence made the area too wet to farm. Plants and invertebrates which had become confined to the network of ditches began to spread back on to the reverting fen and over the past hundred years or so an interesting and valuable fauna has become established. This includes a variety of scarce water beetles, leaf beetles, weevils, spiders and moths characteristic of good fenland habitats. Amongst the more noteworthy species are the muscid fly *Phaonia atriceps* (whose larvae are probably predators in the stems of reedmace), the water beetle *Hydrochus elongatus*, and the hoverfly *Platycheirus perpallidus*. Subsidence also dictates the nature of the wetland habitats at Denaby Ings, although here the marshes of reed sweetgrass are threatened by the increasing areas of open water. This has also led to the demise of many of the old crack willows surrounding the fen and the future of their deadwood and foliage-feeding invertebrates is bleak. Denaby Ings is an extremely well-studied site and many invertebrate Orders have been comprehensively worked, revealing the presence of a considerable number of nationally rare and scarce species. Examples include the ground beetles *Agonum livens* and *Pterostichus gracilis*, the rove beetle *Philonthus atratus*, the snail-killing fly *Antichaeta brevipennis* and the micro-moth *Endothenia pullana*. Subsidence may eventually claim most, if not all, of the fens at Denaby Ings but for the time being conservation effort should be directed at preserving as much of this valuable habitat as possible.

The most important rich fen site in south Yorkshire, and probably the Region, is Shirley Pool and Rushy Moor, which is believed to have formed on the site of ancient peat cuttings over four hundred years ago. Much of the site consists of tall sedge fen with dense *Cladium* and there is a deep litter layer which harbours a rich fauna of ground-active predators. The area has received considerable attention from entomologists and an impressive list of rare and scarce fenland invertebrates have been compiled which includes several species at the northern limit of their British range, such as the beetles *Silis ruficollis* and *Psammoecus bipunctatus* and the froghopper *Aphrophora alpina*. Rushy Moor is one of few known British localities for the cranefly *Erioptera meijerei* and other noteworthy Diptera include *Stenomicra cogani, Oxycera morrisii* and *Platypalpus albicornis*. Unfortunately there have been problems in recent years with a reduction in the water table resulting from the drainage of surrounding land, but this has hopefully been rectified by the construction of sluices. It would be a tragic loss if this ancient site was damaged needlessly and the maintenance of a high water table is crucial to its future health and significance for nature conservation. The scarcity of rich fens in the Region as a whole demands that their conservation should be a priority issue. Indeed, as peatlands throughout the country deteriorate as a result of past damage, neglect, drainage, afforestation, pollution and the commercial extraction of peat we must endeavour to

safeguard as many viable examples as possible. These vulnerable habitats are rich in wildlife and their conservation should be uppermost in our efforts to protect our natural heritage.

UPLANDS

Text no longer available

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APPENDIX 1: SELECTED BIBLIOGRAPHY

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APPENDIX 2: NOTABLE SITES FOR INVERTEBRATE CONSERVATION IN NORTH-WEST ENGLAND

1. AGDEN BOG (SK2593) - An acidic more on the eastern edge of the Peak District National Park, managed as a nature reserve by the Yorkshire Wildlife Trust. A rich fauna characteristic of upland mires has been recorded, including several nationally scarce species of moths, beetles and flies. Adjacent moorland and valley woodland provides additional interest.

2. AINSDALE SAND DUNES N.N.R. (SD288106) - This National Nature Reserve encompasses almost 500 hectares of duneland in the middle of the nationally important dune complex of the Sefton Coast. All stages of the dune succession are represented and the extent and variety of the dune slack habitats are of particular significance. Many invertebrate groups have been comprehensively recorded and the fauna is expectedly rich with noteworthy assemblages amongst the Diptera, Lepidoptera, Coleoptera and Hymenoptera.

3. ALTCAR SAND DUNES (SD2804) - This area includes Cabin Hill National Nature Reserve and the Local Nature Reserve of Ravenmeols and, along with Hightown Dunes, marks the southern limit of the Sefton Coast dune complex. The Altcar section is not as well recorded as the dunes further north, but a typical fauna is present and it is likely that many of the scarcer invertebrates of the Sefton Coast also occur. Ravenmeols and Hightown Dunes are managed by Sefton Borough Council.

4. ANSTON STONES WOOD (SK5382) - The steep-sided valley of Anston Brook cuts through Magnesian Limestone and the slopes are clotted with calcareous woodland and open grassland. This is a well-studied site and there are interesting records for a wide range of invertebrate groups, including the millipede *Stygioglomeris crinita*.

5. ARNSIDE KNOTT (SD4577) - A low-lying limestone hill with a variety of scrub, woodland and calcareous grassland habitats. This is an important locality for

butterflies and contains one of only two English localities for the Scotch argus *Erebia aethiops*. Several scarce moths are recorded and there are a number of other nationally uncommon species present amongst groups such as the molluscs, woodlice and Diptera. Arnside Knott is managed by the National Trust.

6. BEETHAM FELL (SD4879) - A small area of unimproved limestone grassland which is sheltered by adjoining woods. There is a rich butterfly fauna present and the nationally rare least minor moth *Photedes captiuncula* has been recorded. This is potentially an important locality and surveys of other invertebrate groups are desirable.

7. BIGLANDS BOG (NY2553) - A small valley mire containing both eutrophic and acidic peatland habitats, part of which is managed as a nature reserve by the Cumbrian Wildlife Trust. This is an important site for relict fenland water beetles with species such as *Hydroporus scalesianus* and *Hydrochus brevis*. The rare money-spider *Centromerus levitarsis* is also present but there is little information available for other groups of invertebrates.

8. BLAXTON COMMON (SE6801) - A large area of actively-worked sand quarries. Abandoned workings contain a variety of habitat-types, ranging from deep pools to extensive areas of ruderal vegetation. The sandy heathland which once covered much of the site has been almost entirely destroyed but some patches of heath are regenerating and there is much birch invasion on the oldest abandoned workings. Blaxton Common is considered to be the richest site for bees and wasps in Watsonian Yorkshire and there is also an interesting component of invertebrates present which are more typically associated with coastal and sand dunes.

9. BLELHAM TARN AND BOG (NY3600) - Blelham Tarn is regarded as one of the most important localities in Britain for caddisflies and the outstanding assemblage of species includes *Cyrnus insolutus* at its only British site. A rich spider fauna has been recorded from the wetland habitats surrounding the Tarn but there is little

information available on other terrestrial invertebrates. The site includes the National Nature Reserve of Blelham Bog. Blelham Tarn is owned by the National Trust.

10. CLAIFE TARNS AND MIRES (SD3797) - A mosaic of small streams, mires and tarns on the ridge of Claife Heights between Esthwaite Water and Windermere. The assemblage of dragonflies recorded is outstanding for northern England and includes a population of the white-faced dragonfly *Leucorrhinia dubia*. Several other scarce acidic mire invertebrates have been recorded but the site is generally under-worked and further surveys would be of value. Part of the site is owned by the National Trust.

11. CILBURN MOSS (NY5725) - This basin mire contains a mixture of poor-fen and bog communities, some of which are established on old peat cuttings. There is a diverse peatland fauna of beetles and flies present and there are old records of several scarce wetland moths. Although reasonably well recorded, the site would benefit from additional surveys in a wide range of invertebrate groups.

12. CLINTS QUARRY (NY0012) - An abandoned limestone quarry with a rich calcareous flora and scattered scrub woodland. Only the beetles have been surveyed but the diverse flora supports several uncommon weevils and leaf-beetles and other phytophagous groups should also be well-represented. Clints Quarry is a reserve of the Cumbrian Wildlife Trust.

13. CUMWHITTON MOSS (NY5151) - There is a mixture of fen and mire communities present on Cumwhitton Moss and parts of the site have been encroached upon by birch and Scot's pine. Only limited modern information is available but this site was well recorded in the past and used to support an important peatland fauna. Whilst there have undoubtedly been some losses, this is still a potentially valuable site and priority should be given to detailed invertebrate surveys.

14. DENABY INGS (SE4900) - Coal-mining subsidence continues to extend the area of open water in this rich area of marshland on the floodplain of the River Dearne. The

marginal fen is dominated by reed sweet-grass and there are many fine, old, crack willow trees around the edge. There is a diverse and important invertebrate fauna associated with this fen and its old trees, including several nationally scarce species. Future subsidence threatens much of this interest as the area of fen is reduced, but currently this is certainly a valuable site for invertebrate conservation. Denaby Ings is managed as a nature reserve by the Yorkshire Wildlife Trust.

15. DODGSON WOOD (SD3092) - Alder and oak woodlands are mixed with ash, yew, holly, hazel and birch for three kilometres along the eastern shore of Coniston Water. High ground above the wood supports juniper scrub. Limited recording indicates that a fairly typical western oakwood fauna is present and detailed surveys of this extensive site should produce a more substantial list of scarce and characteristic invertebrates. Dodgson Wood, which is owned by the National Trust, is a locality for the nationally rare netted carpet moth *Eustroma reticulatum*, which feeds on orange balsam.

16. DRIGG COAST (SD0696) - The dunes and salt marshes on either side of the River Esk are a superb complex of coastal habitats. The Coleoptera have been extensively sampled and an impressive list of coastal rarities has been recorded. Most other invertebrate groups would benefit from further surveys. Eskmeals Dunes are a nature reserve of the Cumbrian Wildlife Trust, Ravenglass Dunes is a Local Nature Reserve.

17. DUDDON MOSSES (SD28) - A series of raised mires at the head of the Duddon estuary, all of which have been cut-over for peat in the past. The peatland moths have been comprehensively surveyed on Little White Moss and include such species as the Manchester treble-bar *Carsia sororiata* and the purple bordered gold *Selidosema brunnaria*. There has been some recording of beetles on Arnaby Moss but generally the Duddon Mosses are poorly worked for invertebrates and such an extensive area of good quality peatland deserves further study.

18. DUNHAM PARK (SJ740870) - An ancient deer park on the outskirts of Manchester which is owned and managed by the National Trust. The site contains a large number of ancient oak and beech trees and is of national importance for the conservation of invertebrates associated with over-mature timber. The beetles have been the subject of most entomological surveys and 34 species regarded as ancient woodland indicators have been recorded. Ornamental ponds and adjoining wetlands add further interest.

19. EAST KESWICK FITTS (SE350461) - The south bank of the River Wharfe at this point is composed of a broad band of shingle and sand forming a mixture of ridges and hollows. There is a mosaic of open ground amongst stands of dense vegetation, including pockets of willow carr. Sandy habitats support an important fauna, including

the stiletto fly *Thereva lunulata* and the chafer *Aegialia sabuleti*. There is also a rich assemblage of beetles associated with the old willows and the banded demoiselle *Calopteryx splendens* is common along this stretch of river.

20. EAVES WOOD (SD4676) - An area of mixed woodland on Carboniferous Limestone with a rich ground flora. There are small populations of several of the scarcer butterflies which are typical of the Silverdale area, such as high brown *Argynnis adippe* and pearl-bordered *Boloria euphrosyne* fritillaries and northern brown argus *Aricia artaxerxes*. Management has been undertaken to widen existing rides and this will be of benefit to many wood edge invertebrates. Eaves Wood is owned by the National Trust.

21. ELLAND GRAVEL PITS (SE1222) - This series of disused gravel pits in the Calder Valley supports an exceptional fauna of wetland beetles, including the rare ground beetle *Dromius sigma*. This is an important site for invertebrate conservation and must be regarded as threatened by a variety of land use proposals. Surveys of other invertebrate groups would help to confirm the value of the site and support the argument for its conservation as a nature reserve.

22. ENNERDALE WATER (NY1114) - Ennerdale is the westernmost Cumbrian lake, occupying four kilometres of a steep-sided valley inland from Whitehaven. It is an important example of a nutrient-poor lake and is relatively undisturbed. Two species of rare freshwater crustaceans were found in Ennerdale up to the 1950's, but have not been recorded since. Both *Mysis relicta*, a freshwater opossum shrimp and *Limnocalanus macrurus*, a planktonic copepod, are thought to be glacial relics and are not known to occur anywhere else in Britain. Despite the absence of modern records, it is quite possible that both species still occur in Ennerdale, although changes in water chemistry from catchment afforestation must be considered as a potential threat to the importance of the site.

23. FORD VALLEY (SK4180) - This mosaic of valley oak woodland, scrub and unimproved

grassland straddles the county boundary between South Yorkshire and Derbyshire. It is regarded as containing the best example of lowland valley habitats in the Sheffield Metropolitan District and the recorded fauna certainly reflects this assessment. Hoverflies are represented by a rich assemblage of 'old woodland' indicators and there is also an important deadwood beetle fauna present.

24. FORMBY SAND DUNES (SD2707) - Lying immediately to the south of Ainsdale NNR, the Formby Dunes share a similar diversity of habitats and many of the more interesting elements of the invertebrate fauna are common to both sites. Formby Point receives a great deal of visitor pressure but despite this the dunes, which are owned by the National Trust, support a rich variety of invertebrates.

25. GAIT BARROWS N.N.R. (SD4876) - The reserve contains a complex mixture of habitats but most of the known invertebrate interest is connected with the open deciduous woodland and the undamaged limestone pavement. This is an important site for butterflies, with a strong population of high brown fritillaries *Argynnis adippe* of particular significance. Coppicing and the maintenance of a network of rides provides suitable habitat for this rare species. The whorl snail *Vertigo angustior* is present in hollows on the limestone pavement and the rare wood louse *Armadillidium pictum* has also been recorded. Several other invertebrate Orders are represented by nationally rare species and Gait Barrows is clearly of national importance for invertebrate conservation.

26. GLASSON MOSS N.N.R. (NY2360) - A small fragment of a once extensive lowland raised mire, most of which has been cut for peat. A typical raised mire fauna is present, with species such as the grand beetle *Agonum ericeti* and the large heath butterfly *Coenonympha tullia*, and a good range of scarce peatland moths has been recorded. The rare money-spider *Centromerus levitarsis* occurs at one of only four known British sites. Part of Glasson Moss is a National Nature Reserve.

27. GRUBBINS WOOD (SD4477) - This reserve of the Cumbrian Wildlife Trust is a coastal yew and ash wood on the limestone slopes north of Arnside Knott. The spider *Hyptiotes paradoxus*, a specialist inhabitant of yew foliage, occurs but otherwise information is limited to the Diptera. The fly fauna includes several nationally scarce species associated with marshes and seepage, notably the rare dolichopodid *Hercostomus fulvicaudis*. Surveys of other invertebrate groups are recommended.

28. HALLSENNA MOOR (NY0600) - Twenty-nine hectares of lowland wet heath, poor fen and basin mires with dense pockets of birch and willow scrub. Hallsenna Moor is the largest surviving lowland peatland complexes left in West Cumbria and its variety of wetland and heathland habitats is likely to support a diverse and important fauna. Only the phytophagous Coleoptera have been adequately surveyed to date, including species such as *Ceutorhynchus viduatus* and *Donacia crassipes*. Surveys of other invertebrate groups are likely to reveal many other species of conservation significance.

29. HATFIELD MOOR (SE7000) - The extent and range of high quality habitats on Hatfield Moor are of national importance for invertebrate conservation. These include remnants of the original raised mire vegetation, dry sandy heathland, reedfen, grazing levels ditches and a variety of woodland types. Despite the history of peat extraction, the mire fauna still contains many rare species, including the beetles *Bembidion humerale* and *Curimopsis nigrita*. National rarities have been recorded from all of the major habitats and there are obvious similarities with Thorne Moors (q.v.), but there are also notable differences which make the two sites

complementary. A particularly important feature on Hatfield Moor is the abundance of mature aspens. This tree can support a very rich fauna but old stands are now scarce in Britain as a whole.

30. HEATHWAITE/ARNSIDE PARK (SD4476) - A mixture of deciduous woodland and unimproved limestone grassland to the west of Arnside Knott. A nationally important population of the Duke of Burgundy fritillary *Hamearis lucina* occurs on south-facing slopes. The butterfly fauna generally is diverse and of considerable significance but other invertebrate groups are almost unknown. Further surveys are desirable. Part of the site is owned by the National Trust.

31. HETCHELL WOOD (SE3742) - This site contains a variety of habitats which are established on Millstone grits and a capping of Magnesian Limestone. Acidic oak woodland dominates most of the area, although there are also exposed cliff faces and pockets of rank calcareous grassland. At the southern end is an area of dry heath, known as Pompocali, which has developed over the last sixty years on an ancient quarry. This heath has a diverse fauna of bees and wasps nesting in the sandy soils. Invertebrate interest is present throughout the mosaic of habitats, most of which is managed as a nature reserve by the Yorkshire Wildlife Trust.

32. HOLDEN CLOUGH (SD940013) - A narrow, steep-sided valley containing scrub oak woodland, alder carr and numerous flushes. There are several similar 'cloughs' in this area and it is difficult to determine their relative value for invertebrate conservation due to variable levels of recording. Holden Clough was well studied in the 1950's and 1960's when a number of scarce Diptera were recorded but there is little modern information available. Most of the uncommon species known from the clough are characteristically associated with wet woodland habitats.

33. HUTTON ROOF CRAGS (SD5578) - An impressive area of limestone pavement with unimproved grassland and scattered scrub, including stands of juniper. Park Wood, on the eastern side of the hill, is a National Nature Reserve and Lancelot Clark Storth

on the west side is a reserve of the Cumbrian Wildlife Trust. Only the Lepidoptera have been adequately surveyed, although there is also some information on the molluscs and flies. Further surveys should confirm Hutton Roof Crags as a very important locality for invertebrate conservation. Rare species recorded to date include the high brown fritillary *Argynnis adippe* and the northern snail-killing fly *Ectinocera borealis*.

34. JENNY DAM (SD462955) - A small upland tarn which contains one of only two remaining populations of medicinal leeches *Hirudo medicinalis* in Cumbria. This species is protected under Schedule 5 of the Wildlife and Countryside Act.

35. KIRK BECK, BEWCASTLE (NY5674) - Sampling of the water beetle fauna in this base-rich stream has revealed the presence of an exceptionally rich assemblage of species

associated with running water. Together, these indicate good water quality and a lack of disturbance to the channel. Both species of *Riolus* occur and the four scarce species of *Hydraena* recorded include the national rarity *H. pygmaea*.

36. LARKRIGG SPRING (SD5187) - An area of coppice woodland and pasture adjacent to the River Kent. Surveys of the Diptera have revealed a diverse fauna of species associated with shallow ponds in both woodland and grassland habitats. Of particular interest is the assemblage of snail-killing flies, which includes the national rarities *Pteromicra leucopeza* and *Tetanocera freyi*, but other families, such as the Empididae, are also well-represented. Recommended for survey of other invertebrate groups.

37. LEIGHTON MOSS (SD4874) - A nationally important wetland site, owned and managed by the Royal Society for the Protection of Birds. Leighton Moss contains the largest area of reed bed in North West England and there are also important areas of calcareous grassland, mixed fen and scrub woodland. The richness of the fauna reflects this diversity of habitats and several national rarities have been recorded. Lepidoptera and Diptera have been the subject of most surveys and further recording amongst other invertebrate groups would be of great interest.

38. LINDRICK COMMON (SK5582) - This site consists of Magnesian Limestone grassland, mixed deciduous woodland and a disused limestone quarry. The invertebrate fauna is representative of good quality calcareous woodland and dry grassland and there is demonstrated interest amongst a wide range of Orders.

39. LOW CHURCH MOSS (NY0105) - Low Church Moss is an area coastal fen associated with an open pool. There are pockets of acidic vegetation as well as tall fen and willow carr. There is a rich diversity of wetland plants growing on this site and recording has demonstrated the presence of an exceptional weevil and leaf-beetle fauna. Surveys of other invertebrate groups should confirm the importance of this site for the conservation of wetland species.

40. LYTHAM ST. ANNES (SD3130) - The best surviving dune system on Lancashire's Fylde coast, most of which is managed as a local Nature Reserve. Only the Lepidoptera have been studied to date but they include a number of scarce species typical of the west coast dunes and it is likely that other invertebrate Orders are also represented by species of conservation interest.

41. MALTBY COMMON (SK5491) - A woodland and grassland mosaic on Magnesian Limestone, with a small area of fen and neutral grassland on waterlogged Mid Permian Marl. This latter (Low Common) is a reserve of the Yorkshire Wildlife Trust. The diversity of habitats present on this complicated site contributes to the richness of the fauna. The Diptera are particularly well-known but most groups have been surveyed thoroughly and more than a thousand species are recorded.

42. MEATHOP MOSS (SD4481) - Managed as a Nature Reserve by the Cumbrian Wildlife Trust, Meathop Moss contains a substantial area of lowland raised mire surrounded by birch and pine woodland. This is a well-studied site, at least for some invertebrate groups, and is particularly noted for its peatland moth fauna. Meathop Moss is the southernmost British locality for the saxon moth *Hyppa rectilinea* and bog bush crickets *Metrioptera brachyptera* and large heath butterflies *Coenonympha tullia* are also present.

43. MICKLETON INGS (SE403275) - A series of flashes (or lagoons) created by the subsidence of colliery workings. Leaching from adjacent heaps of mining spoil has affected water quality and there is a marked salinity gradient. Pools nearest to the spoil heaps are brackish and support an associated halophilous aquatic fauna of considerable ecological interest. There are extensive marginal fens dominated by reedmace and a number of scarce wetland insects have been recorded.

44. MIDDLEBARROW PLAIN (SD4576) - Another of the Silverdale mosaics of limestone grassland and scrub woodland with examples of the rich butterfly fauna that occurs generally on such habitats throughout the district. In particular, Middlebarrow has a

strong colony of the northern brown argus *Aricia artaxerxes*. As with many of the sites in this area, surveys of groups other than butterflies would be of interest.

45. MOOR HOUSE N.N.R. (NY73) - This vast National Nature Reserve covers some 4000 hectares of Pennine moorland and has been the subject of a long tradition of ecological study. Its fauna is probably the best known of any upland site in Britain and this is reflected in the long list of rare and scarce species recorded. One speciality is the rove beetle *Olophrum assimile* which is known from only one other mountain top in Britain.

46. MORECAMBE BAY (SD466) - A vast expanse of intertidal sand and mud flats with discontinuous stretches of saltmarsh. Sheep grazing is prevalent in many parts of the Bay and this will have affected the importance of some of the sections of saltmarsh. Casual recording has produced records of a good range of scarce saltmarsh flies and beetles but there is scope for much more useful fieldwork. The Royal Society for the Protection of Birds reserve of Carnforth Marsh is included within the site.

47. NEWTON REIGNY MOSS (NY4730) - This is the best example of a eutrophic basin fen in east Cumbria, having developed in a kettlehole in calcareous glacial drift. There has been comparatively little modern invertebrate recording but this was known as a very important locality for wetland beetles and spiders at the turn of the century. The moss has deteriorated since then, but is still of potential importance and would seem to be an ideal candidate for detailed invertebrate surveys. Newton Reigny Moss is a reserve of the Cumbrian Wildlife Trust.

48. NICHOLS MOSS (SD4382) - Adjacent to Meathop Moss, and presumably once part of the same peatland unit, Nichols Moss shares many of the same noteworthy invertebrates. Nichols Moss is bounded to the west by hills supporting acidic oak woodland, and is bordered to the east by a line of low limestone cliffs with ash, yew and hazel woods. The range of habitats present on this woodland and peatland complex contributes to the variety of scarce invertebrates present. There are recent

records of many scarce species of Coleoptera and Lepidoptera but this site would certainly benefit from increased recording effort.

49. NORTH WALNEY N.N.R. (SD1772) - The northern tip of the Isle of Walney is an extensive sand dune system overlying a shingle spit. There is a good range of dune slacks and dune heath is also present. The shingle ridge of the foredunes has a well-developed strandline flora. Saltmarsh pools on the east side of the dune system contain the scarce, brackish water beetles *Ochthebius auriculatus* and *O. marinus*. Recording to date suggests that a typically rich western dune fauna occurs but North Walney appears to be relatively under-worked for such an important dune system and further interesting discoveries can be predicted.

50. POTTERIC CARR (SE5900) - Yorkshire Wildlife Trust manage this rich area of fenland and willow carr. Open pools and oak/birch woodland add to the diversity of habitats. The site is well-studied and the extensive species list contains a number of national fenland and woodland rarities. The original fen is known to have been drained over 200 years ago, but recolonisation by a characteristic plant community was successful. The invertebrate fauna is perhaps not as rich as some of the less disturbed fens in the county but is nonetheless of regional significance.

51. RATHER HEATH (SD4895) - Alder woodland and marshes at the edge of Rather Tarn. The wetland Diptera fauna contains several scarce species but modern information on other invertebrate groups is lacking. The medicinal leech *Hirudo medicinalis* was recorded from the Tarn in 1952 but there are no recent records.

52. RIVER IRTHING (NY67-NY45) - Casual recording along the Irthing and some of its tributaries over the past 150 years has resulted in an exceptional list of scarce invertebrates for this river system. The Irthing is a gravel-bottomed river with shingle banks and much of the known interest is associated with these two habitats. The water beetle fauna is indicative of a clear, fast-flowing river and the shingle fauna also suggests the high quality of the site. Information to date is concentrated on a number

of sub-sites, such as Gowk Bank (NY6873) and Irthing Gorge (NY6369). It seems likely that much more of the river and its margins is of importance for invertebrates and a full survey of the river would be invaluable.

53. ROCHE ABBEY WOODS (SK5489) - Magnesian Limestone woodland composed of a mixture of ash, elm, lime and yew. Calcareous grassland and small areas of marsh occur between the individual woodland blocks which make up this composite site. A diverse woodland invertebrate fauna has been recorded with deadwood inhabitants and phytophagous species particularly well-represented.

54. ROUDSEA WOODS AND MOSES N.N.R. (SD3382) - Woodland occupies most of this large National Nature Reserve, varying from ash, small-leaved lime and yew on limestone through to oak high forest on slate and shale outcrops. There is an important deadwood fauna associated with these woodland habitats and the wood-edge fauna is also of significance. The basin mires within the reserve have suffered from scrub encroachment but these are being managed to improve their condition and a representative acid mire fauna is still present. The site is well-worked entomologically but there is still potential for further surveys on such a large and varied area.

55. RUSLAND VALLEY MOSSES N.N.R. (SD3388) - A series of raised valley mires which have been partially drained and cut-over for peat in the past. This has led to invasion by birch and Scot's pine woodland over most of the existing peat surface but an important fauna still survives, including a population of large heaths *Coenonympha tullia*. The established woodlands also support an interesting fauna and there are substantial areas of wet pasture on the edge of the mosses.

56. SAINT BEES HEAD (NX9413) - Dramatic sandstone cliffs forming the most westerly point on the Cumbrian coast, most of which is managed as a Nature Reserve by the Royal Society for the Protection of Birds. The phytophagous beetle fauna is particularly rich and includes the weevil *Trachyphloeus laticollis* at the northern limit

of its range in western Britain. The assemblage of woodlice records at the foot of the cliffs is also exceptional this far north.

57. SANDALL BEAT (SE6103) - Sandall Beat is a 200 year old plantation woodland with a mixture of deciduous trees, although oak, beech and birch are the commonest species. The plantation was established on an area of open heathland which adjoined an ancient woodland that was eventually felled some forty years ago. The important old woodland fauna now present in Sandall Beat has presumably been able to colonise the site because of the long period of time that the plantation was contiguous with ancient woodland. This well-recorded site has demonstrated invertebrate interest throughout the woodland habitats and also in the small area of surviving reed fen. Sandall Beat is a Local Nature Reserve owned by Doncaster Metropolitan Borough Council.

58. SANDSCALE HAWS (SD1974) - An extensive dune system opposite the north end of the Isle of Walney which is owned by the National Trust. Sandscale Haws is particularly important for its impressive assemblage of scarce coastal moths, including the coast dart *Euxoa cursoria* and the shore wainscot *Mythimna littoralis*. With further surveys there is potential for this site to be regarded as being of national importance for invertebrate conservation.

59. SCAFELL MASSIF (NY20) - The six kilometre long series of peaks comprising the Scafell range is the largest montane block in England with several peaks above 900 metres OD. Scafell Pike, at 977 metres, is the highest mountain in England. The summits consist of frost-shattered boulder fields with *Rhacomitrium* heath. The site also contains a large area of high moorland and there are numerous tarns, streams and bogs. The rare montane ground beetle *Nebria nivalis* occurs on the summit and the mountain ringlet butterfly *Erebia epiphron* is widespread. There is relatively little documented information in recent times on other aspects of the fauna but a number of scarce montane spiders were recorded in the early part of this century and are presumably still present. Most of the site is owned by the National Trust.

60. SCALEBY MOSS (NY4363) - A large peatland complex consisting of acidic mire vegetation with open pools, birch and pine scrub, and marginal fens. There is an outstanding assemblage of dragonflies which includes a population of white-faced darters *Leucorrhinia dubia* and the water beetle fauns is also of considerable interest. The invertebrate list for the site contains a good range of scarce beetles, moths, flies and spiders and Scaleby Moss would appear to be one of the best mossland sites in the north of the Region.

61. SCOUT & CUNSWICK SCARS (SD4890) - Together these sites represent a four kilometre stretch of limestone scar just west of Kendal. There is an extensive area of unimproved calcareous grassland and scrub woodland. This is an important site for limestone grassland and wood edge Lepidoptera. The leafhopper *Chlorita dumosa* breeds here, probably on wild thyme, in its only known site on the British mainland. Part of Scout Scar is owned by the National Trust.

62. SHIRLEY POOL & RUSHY MOOR (SE5612) - A wetland complex consisting of calcareous pools, tall fen and carr woodland. Drainage surrounding land has caused problems with the hydrology of the fens and sluices now control the water table. This is an important site for fenland invertebrates with several species such as the beetles *Silis ruficollis* and *Psammoecus bipunctatus* approaching the northern limit of their British range. The dragonfly fauna is outstanding in a regional context, including modern records of *Brachytron pratense*, *Coenagrion pulchellum* and *Sympetrum sanguineum*.

63. SKIDDAW FOREST (NY3030) - A vast area of remote moorland which includes a number of high peaks. The summit of Skiddaw has been eroded by trampling and is now of reduced interest, but the area is still important for montane invertebrates. There are old records of an impressive range of scarce upland species but little modern information is available. This is one of the few English localities for the northern dart *Xestia alpicola* and the rare ground beetle *Leistus montanus* has been recorded in the past.

64. SMARDALE GILL (NY7206) - This diverse limestone valley is a reserve of the Cumbrian Wildlife Trust and contains one of only two English populations of the Scotch argus butterfly *Erebia aethiops*. The variety of woodland, grassland and wetland habitats present in the valley suggests that a rich invertebrate fauna can be expected to occur amongst other groups and wider surveys are recommended.

65. SOUTH WALNEY (SD2265) - Surprisingly little invertebrate information is available for this vast complex of sand dunes, saltmarsh, shingle and lagoons. The richness of the moth fauna parallels that of North Walney (q.v.) at the other end of the Isle of Walney but other invertebrate groups appear to have been entirely neglected. The Cumbrian Wildlife Trust manages two parts of the site as nature reserves.

66. SOUTHPORT SAND DUNES (SD3015) - This area encompasses the northernmost section of the Sefton Coast dune complex, stretching from Ainsdale N.N.R. to Southport. Included within this composite site are the Local Nature Reserves of Ainsdale Hills and Birkdale Hills, both of which are managed by Sefton Borough Council. There is a full range of dune habitats present and it is likely that the fauna is similar to that of the other dune sites on the Sefton Coast. Modern records which can be localised to this site are comparatively uncommon, however, and detailed recording would help to confirm the importance of the site.

67. SPROTBOROUGH GORGE (SE5301) - This is a complex of habitats centred on a rich valley system on Magnesian Limestone. Part of the site, Sprotborough Flash, is a wetland reserve of the Yorkshire Wildlife Trust and there are also important areas of limestone woodland and calcareous grassland. Each of these major components contains a diverse invertebrate fauna with many nationally scarce species. Although the ancient woodland of Pot Riding Wood is perhaps the most significant habitat in terms of overall species richness, the value of the site lies chiefly in the juxtaposition of a range of high quality habitat-types.

68. STOCKTON'S WOOD, SPEKE HALL (SJ4182) - The woodland here dates from the eighteenth century and consists chiefly of oak with smaller numbers of beech and sweet chestnut. The fauna associated with deadwood microhabitats (particularly beetles) is outstanding and is clearly the best site for these species on Merseyside. Vandalism to dead trees is widespread and the woodland flora is also disturbed by motorbikes. Although the fauna has survived this level of damage so far, it must obviously affect the long-term availability of suitable microhabitats. Stockton's Wood is owned by the National Trust and managed on their behalf by Merseyside County Council.

69. SUNBIGGIN TARN (NY6707) - Base rich flushes entering the Tarn are of national importance for the conservation of molluscs. The whorl snail *Vertigo geyeri* occurs here at its only known British site and the sand bowl snail *Catinella arenaria* otherwise only survives on Braunton Burrows in Devon. Several scarce beetles and flies have also been recorded from the adjoining moorland. Sunbiggin Tarn is a reserve of the Cumbrian Wildlife Trust.

70. TARN HOWS (NY3300) - An upland block lying between Coniston and Windermere, consisting of a mixture of moorland, oak woodland and acid mires surrounding the lake of the Tarn itself. The marginal fen of the Tarn is an important site for reed beetles of the genus *Donacia* and the woodland fauna includes a colony of the netted carpet *Eustroma reticulatum*. Part of the site is owned by the National Trust.

71. THORNE MOORS (SE71) - Considered to be the most important single site for invertebrates in northern England, Thorne Moors is an estuarine raised mire complex which has been the subject of entomological study for many decades. The peatland fauna is threatened by the effects of drainage and peat-milling for the horticultural industry but, at present, there is still an outstanding assemblage of rare species inhabiting the remnant pockets of ombrotrophic mire. This assemblage includes three species (the beetles *Bembidion humerale* and *Curimopsis nigrita*, and the fly *Phaonia jaroschewskii*) which are apparently confined in Britain to Thorne and Hatfield Moors.

Peripheral areas of Thorne Moors contain fenland vegetation as a result of past land use and flooding from brackish-water drains. These fens support a different fauna to that of the raised mire remnants and the species assemblage includes many elements more characteristic of fenland in southern and eastern England, such as the rare ground beetle *Dromius longiceps* and *Dromius sigma*. Indeed, the bio-geographical aspect of the invertebrate fauna of Thorne Moors is of considerable importance as the site supports a high proportion of species at the northern or southern limits of their British range. Part of Thorne Moors is managed as a National Nature Reserve.

72. THRANG END (SD4976) - A large area of limestone pavement with calcareous and acidic grassland and patches of scrub. The Lepidoptera fauna is typical of the habitats present here and on a number of similar sites in the Silverdale area. Further surveys on other invertebrate Orders are desirable.

73. THURSTONFIELD LOUGH (NY3256) - A large lowland lake formed in boulder clay and fringed by an extensive zone of lush fen which grades into established willow and alder carr. Thurstonfield Lough is known to be of exceptional importance for its water beetle fauna with many nationally scarce species recorded. The rich fen habitats are likely to support a semi-aquatic and terrestrial invertebrate fauna of considerable significance also. Comprehensive surveys of other invertebrate groups than the water beetles is strongly recommended.

74. UPPER SOLWAY FLATS AND MARSHES (NY16) - A composite site consisting of extensive mudflats and saltmarshes with some areas of sand dune and marginal woodlands. The Cumbrian site of the Solway Firth has received little attention from entomologists in recent times and would certainly repay greater study. The saltmarshes tend to be heavily grazed by sheep, although pools on the upper saltings support several scarce brackish water beetles. Sites of potential interest include the National Trust property of Cardurnock Flats (NY1760), the shingle spit at Grune (NY1456), Mawbray (NY0486) and Silloth Dunes (NY1052), the Cumbrian Wildlife Trust reserve at Rockcliffe Marsh (NY3264), and the Wampool Estuary. This latter site, owned by the National Trust, is one of only few British localities for the rove beetle *Carpelimus schneideri*, an inhabitant of muddy sand flats.

75. WARTON CRAG (SD4973) - Calcareous grassland and mixed woodland occupy much of this carboniferous limestone hill, which rises above Morecambe Bay. This is an important site for grassland and wood edge butterflies, but there is very little information available for other invertebrate orders. This site would seem to have considerable potential for supporting a diverse and significant fauna and further surveys are recommended. Part of Warton Crag is designated as a Local Nature Reserve by Lancaster City Council and part is managed by the Royal Society for the Protection of Birds.

76. WHARNCLIFFE WOOD (SK3193) - Owned by the Forestry Commission and managed commercially for timber, Wharncliffe Wood is a mixture of deciduous and coniferous plantations with scattered remnants of over-mature woodland. It is the largest surviving block of woodland in South Yorkshire and there has been extensive recording amongst a range of invertebrate groups. The hoverfly fauna is outstanding for northern England and there is also considerable interest amongst the Lepidoptera, Aculeate Hymenoptera, and deadwood Coleoptera.

77. WHITBARROW (SD4487) - A limestone ridge containing a variety of woodland and

grassland habitats. There is a strong population of high brown fritillaries *Argynnis adippe* present and several scarce Diptera associated with wet base-rich woodlands have been recorded. A typically rich molluscan fauna occurs and a number of interesting beetles and moths are known from this site. Part of Whitbarrow is a nature reserve of the Cumbrian Wildlife Trust and part is a Local Nature Reserve.

78. WINMARLEIGH MOSS (SD4447) - Along with the adjacent Cockerham Moss, this is the last remaining fragment of lowland raised mire on the Lancashire coastal plain. Drainage of surrounding land is affecting the water table and the moss is slowly drying out and becoming invaded by birch scrub. However, there is still a representative peatland invertebrate fauna present, including a strong population of large heath *Coenonympha tullia* butterflies and bog bush crickets *Metrioptera brachyptera* at their only site in Lancashire.

79. YEWBARROW (SD4384) - Only the Lepidoptera have been surveyed on this limestone hill which supports scrub woodland and unimproved calcareous grassland. The butterfly fauna is typically rich with several nationally scarce species and the moths include the least minor *Photedes captiuncula* and cistus forester *Adscita geryon*. Yewbarrow would appear to be a good example of the characteristic limestone habitats of South Cumbria and information on other invertebrate groups would be of great interest.