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Conservation of Invertebrates in England: a review and framework

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English Nature Science

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Aims and Objectives of this Framework

This document reviews and suggests developments for the current thinking on the role of invertebrate conservation in England, particularly within, but certainly not exclusively, the statutory conservation agency for England, English Nature. It aims to identify areas of work which will benefit biodiversity in general and invertebrates in particular, largely through better integration of invertebrate conservation with other conservation priorities. It covers terrestrial and freshwater biotopes and invertebrates of terrestrial or freshwater origin inhabiting the maritime fringe.

Our goal is to achieve effective conservation of the native invertebrate fauna of England, maintaining and, where necessary, restoring natural distribution of species and the diversity of assemblages. Especially, our aim is to secure the future of rare and threatened species and their habitats.

The main aim in producing this framework is to provide information on the current direction that invertebrate conservation work is going in England and guidance and suggested future direction for all working in wildlife conservation in England, especially through the implementation of the UK and Local Biodiversity Action Plans. There are far more suggested developments of existing and new areas of work than ourselves at English Nature or any other one organization could hope to address. Our intension is to promote ideas that may be new to some individuals and organizations (including our own), and to stimulate communication and partnership between organizations to bring the conservation of this fascinating group of organisms more into the mainstream of wildlife conservation in England.

The Special Significance of Invertebrates

Invertebrates comprise the greatest diversity of species of all larger life forms in England and on Earth generally. They are major secondary energy consumers, the largest component of animal biomass and impact upon all aspects of global ecology. They are vital in the functioning of all ecosystems and are of great economic significance, a few as pests, parasites or vectors, but many more as beneficial pollinators, control agents and nutrient cyclers. They are the target of much pure and applied research, ranging from the identification of environmental indicators to the investigation of their potential as sources of biochemicals and pharmaceuticals. They are also important culturally and educationally and some hold a special place in our perceptions of biodiversity and the countryside.

Nutrient cycling

Invertebrates are crucial in nutrient cycling, especially in decomposition processes, working with fungi and bacteria to break down all forms of dead plant and animal material. They are also major herbivores of living plants and fungi. In turn they form the exclusive diet of large numbers of species of birds, mammals and other invertebrates.

Pollination and plant ecology

Invertebrates, especially flying insects, are vital for the pollination of a majority of species of wild and cultivated plants and, as such, are vitally important to the industries of food production and horticulture. Some species play important roles in the distribution of plant seeds and fungal spores and their role as seed predators and grazers makes them a major determining factor in vegetation dynamics.

Biological control

Invertebrates play a major role in controlling numbers of other species of plants and animals, especially other invertebrates and this role is increasingly being developed commercially as an alternative to the use of pesticides. They affect and control the numbers and balance between species and hence help to determine the structure of the plant and animal communities of which they are an integral part. As such they are important bio-control agents of crop pests and may indeed prevent some species from ever becoming pests.

Indicators

With mainly annual or sub-annual life cycles, invertebrates show rapid response to environmental change and this, coupled with high levels of specialisation to individual microhabitats, complex life cycles and some with poor powers of dispersal and recolonisation, many have great potential as indicators of current environmental quality and past continuity of stable environmental conditions. They are routinely used in assessment of pollution levels in freshwater ecosystems and certain groups are used in the assessment of the efficacy of conservation management of habitats. They are increasingly used in the evaluation of sites for conservation purposes.

Economic potential

Although a few terrestrial freshwater invertebrates or their products are harvested directly for human economic benefit in the UK, for example the freshwater crayfish as a specialist food and pearls from river mussels, they are much more important as research subjects and have told us much about genetics, embryology, neurophysiology, biomechanics etc., with very important spinoffs in science and industry, from the understanding of gene-switching to the development of efficient aerodynamic surfaces. Organic molecules produced by invertebrates have an enormous potential as useful sources of pharmaceuticals which are only just starting to be investigated. Valuable products are often particularly derived from defensive secretions and include hormone analogues from water beetles, glues from centipedes and hypertoxins from rove beetles. Other valuable products include anticoagulants from leeches, antibiotics from fly larvae, bioluminescents from glow-worms and potential anti-cancer and HIV drugs from a wide variety of invertebrates.

Aesthetic appeal

Some groups of invertebrates, notably the butterflies, some moths, dragonflies, grasshoppers, ladybirds and bumblebees have been regarded affectionately and valued by the British public because of their attractive appearance, positive associations, literary connotations etc. With the greater coverage of invertebrates in the media, the publication of better identification literature and increased profile via the Biodiversity Action Plan, the number of species and groups regarded sympathetically by the general public is already growing.

England's Invertebrates

Britain, and especially England, has had the most intensively studied invertebrate fauna in the world, with a history of amateur study dating back two and half centuries. Consequently, the distribution and status of individual species is better known for the English fauna than any other country. Amateur societies exist to cover a high proportion of groups of invertebrates and there are recording schemes and databases on the occurrence of British species covering a significant proportion of groups, with varying levels of coverage. Most, but not all, are coordinated through the Biological Records Centre and atlases of the distribution of individual species have been produced for many groups.

There are approximately 30,000 species of invertebrates in the United Kingdom, thus far out-numbering species in all other groups of macro-organisms except perhaps the fungi. No analysis has ever been made of England's fauna separately from that of Scotland and Wales but, out of an analysis of 14 sample groups based on published distribution atlases (box), we estimate that 98% of the total British fauna, as many as 29,500 species, occurs in England. Within that analysis around 22% (range 8%-40%) seem to occur *only* in England within the UK. This would indicate that as many as 6600 British species may be restricted to England.

Although we have a somewhat depauperate fauna when compared with mainland Europe, England's fauna includes a unique biogeographical mix of species, including elements of boreal, Baltic, central European, Atlantic Fringe and Lusitanian species. Some species are better represented here than on mainland Europe, notably some Atlantic fringe species, and also the fauna of ancient trees, of which we have high proportion within Europe.

A very large number of species of invertebrate have the edge of their British or European range in England and are therefore particularly vulnerable to climatic and ecological perturbations.

Number of species within sample groups occurring in England, Scotland and Wales (number of species thought to be restricted to particular country bracketed)

	England	Scotland	Wales	GB
Dragonflies	37(9)	20(3)	26(0)	40
Grasshoppers/crickets	27(11)	7(0)	16(0)	27
Ants	41(13)	19(1)	26(0)	42
Bumblebees	25(2)	19(0)	20(0)	25
Ground beetles	331(108)	159(5)	221(1)	337
Click beetles	75(29)	37(2)	38(0)	77
Snail killing flies	66(7)	46(0)	57(0)	66
Lesser dung flies	27(5)	22(0)	18(0)	27
Butterflies	54(13)	29(1)	38(0)	55
Noctuid moths	303(46)	210(7)	254(3)	313
Leaches	16(2)	13(0)	14(0)	16
Harvestmen	23(2)	17(0)	31(1)	24
Millepedes	48(14)	26(0)	32(0)	48
Molluscs	171(32)	118(0)	138(2)	174

after English Nature, 1994

One species of English invertebrate may have recently become globally extinct and at least 156 that were known only from England in Britain have become extinct here; two have become extinct in England but still occur elsewhere in the British Isles and a further 17 species are thought to be extinct in England where the status in other parts of Britain is unclear (Sheppard, 1994).

Red Data Books for insects (Shirt, 1987) and other invertebrates (Bratton, 1991) have been published as well as analyses of the wider status of many groups of invertebrates (Appendix 1). A database of species of conservation concern, the Invertebrate Site Register (ISR), is held and maintained by the country conservation agencies.

Priority Invertebrate Species

A series of priority categories have been identified for targeting effort to conserve individual species and assemblages. Rarity and threat are currently the main criteria used in the assessment of these priorities. There are limitations in the approach, but they are likely to remain the most useful criteria for some time. JNCC currently has a Species Status Project which aims to cover this area of work.

Continual Review of Priority Species

There is a need for regular re-assessment of all lists of priority species and eventual re-examination of the criteria used in species qualifying for inclusion in those lists.

Internationally important species

International status

Better knowledge of species international status would allow better prioritisation of work on individual species and assemblages in England that are of pan European concern. Knowledge of the global status of species and that in Europe is poor for most groups and Britain led Europe in evaluating species status within its national boundaries. A number of other European nations have similarly undertaken domestic analyses of invertebrate species' status. There is therefore the opportunity to coordinate methods and compare results so that we can target effort to conserve species of greatest concern. The Council of Europe's Committee of Experts and the European Invertebrate Survey have undertaken some work in this direction and a start in this direction has been made with a collaborative project between English Nature and Butterfly Conservation in the production of a European Red Data Book for Butterflies (Swaay & Warren, 1998).

International Status of Species

A project is needed to coordinate and summarise work on cross- border assessments of species' status in Europe in order to set the context of England's invertebrates, eventually leading to more pan-European Red Lists of invertebrates.

European Union Habitats and Species Directive

There are 123 species of invertebrates listed in the H&SD, of which 18 still occur in England, 2 of which are extinct but have been re-established (Appendix 2). The UK's main vehicle for the implementation of positive conservation measures for species listed on the Directive is the declaration of Special Areas of Conservation and inclusion on the Biodiversity Action Plan.

The statutory conservation agencies are in the process of designating Special Areas of Conservation for species listed under this Directive. However, the selection criteria for habitats for consideration as SACs were based largely on the CORINE classification of European vegetation types and did not take into account structural features necessary for some invertebrate assemblages, for example exposed river sediments, ancient trees or habitat mosaics. It is hoped that, at a future date, the annexes of the Directive will eventually be reviewed and include additional key invertebrate habitats.

Habitats & SACs H&SD Listed Species

Future development of the H&SD annexes is needed in order adequately to represent invertebrates and their key habitats in the selection of SACs.

The Berne and Bonn Conventions

The Berne Convention was partially implemented by the Wildlife & Countryside Act 1981 and by The Conservation (Natural Habitats, &c.) Regulations 1994. It is now effectively subsumed in the H&SD. The Bonn Convention was ratified by the UK in 1985 but lists among the invertebrates only the monarch butterfly, which is a rare vagrant in England.

Endemic invertebrates

Endemic species

Endemic species are those which occur nowhere else in the world. Either they evolved here or British populations represent relicts of a wider distribution for a species which has subsequently gone extinct elsewhere. Endemic species are of high priority as the UK has sole responsibility for maintenance of their populations. Although as many as 285 species of

invertebrate are known only from Britain, most species are in relatively obscure groups and few can be considered to be truly endemic - they have probably simply yet to be discovered elsewhere or have been described separately under a different name. English Nature has commissioned taxonomic and genetic analysis by the Natural History Museum and Leeds University of possible endemic species within certain taxonomic groups has cast doubt on the true endemic nature of several of them (Hammond, 1996, 2000; Henshaw & White, 1997; Piper and Compton, 2000). However, a small number of species 'survived' this analysis and are considered to be true endemics, for example the Lundy cabbage flea beetle *Psylliodes luridipennis* and the creeping corydalis weevil *Procas granulicollis*.

Endemic species are given priority within the BAP. At least some possibly endemic species are relatively common in the UK and do not warrant specific conservation action other than monitoring their status.

A small number of species of invertebrate, for example the fern weevil *Syagrius intrudens*, are only known from Britain and yet is certainly the result of an unrecorded introduction from elsewhere in the world, in this case probably from Australasia/SE Asia. The evaluation of such 'endemic introductions' is problematic and they are currently not afforded high conservation status.

Endemic Species

Review of UK endemic invertebrates should be completed. Truly endemic species should be treated as priority species under BAP, their conservation needs assessed and projects initiated, if need be, to ensure their conservation.

Near endemics

Near endemic species are those with a restricted distribution where a high proportion, but not all of the world range and population of the species occurs in Britain. Again, the UK has a major responsibility for maintenance of their populations. Those identified so far are mainly Atlantic fringe and wet woodland species and examples are the maritime ground beetle *Aepus robinii* and the snail *Abida secale*. Better knowledge of the pan-European distribution is needed before our responsibilities for these species can be defined.

Endemic subspecific taxa

While we have few endemic species, Britain has a large number of distinct endemic forms and varieties. While some differences may result from a single different gene, others represent distinct British subspecies, where the whole British population is at considerable taxonomic distance from those in mainland Europe. Many species are different ecologically, such as having another food-plant, from conspecific forms in mainland Europe and there is sometimes a cline in ecological plasticity within the UK, with species often considerably specifically restricted to certain microhabitats, foodplants etc, towards the edge of their range. Within England, Dungeness and the Scilly Isles have a high proportion of highly restricted subspecies. To date, little emphasis has been placed on infra-specific taxa in prioritization of conservation effort, including the BAP & H&SD process, although such inherent variation is an important part of the concept of biodiversity.

Infra-specific Endemic Taxa

A policy is needed to clarify the priority given to the conservation of taxa showing intra-specific variation within the UK and between the UK and mainland Europe.

Invertebrates protected under domestic legislation

Wildlife & Countryside Act 1981

A total of 62 species of terrestrial, freshwater and saline lagoon invertebrates are protected under Schedule 5 of the 1981 Wildlife & Countryside Act (Appendix 3), of which 22 are protected only under some of the provisions of the Act, either against trade or the destruction or disturbance of their place of shelter. The Schedules of the Act are reexamined in quinquennial review and there has been an extensive consultation process involving an inter-agency panel on which the statutory conservation agencies have invertebrate representatives. The panel's function is to make suggestions of possible amendments to the Schedule, undertake consultation within and external to the agencies, consider the recommendations made by other bodies and make a recommendation of changes to DETR for inclusion on the Schedule. The procedure and rationale for the next QQR is currently under review by JNCC.

While useful to deter the collection of a few particularly vulnerable species that may be so targeted, protection under Schedule 5 does little to protect species of invertebrate from the main causes of their decline; habitat loss and degradation. Suggestions have been made in earlier QQRs for the addition of large numbers of invertebrates to the schedule, including all RDB species and all butterflies. Some European countries have given legal protection to large numbers of invertebrates, and this seems to have little positive effect on their conservation and inhibits serious study, including that for conservation purposes.

There are certain ambiguities in the existing legislation which currently prevent some species from receiving the benefits of the protection which the Act was intended to afford. For example, the immediate progeny of eggs derived from wild-caught females of protected species are not considered to be covered by the "protection with respect to sale" provisions and this represents a loophole in the spirit of the Act.

Legislation

There is need for further development of species conservation legislation to close loopholes which hinder the implementation of the spirit of the original Act.

Invertebrates on the UK Biodiversity Action Plan

The International Convention on Biodiversity was signed by the UK at the Earth Summit in Rio de Janeiro in 1992 and subsequently ratified by Parliament. The UK government's response, 'Biodiversity: The UK Action Plan', was published in 1994 and 'Biodiversity: The UK Steering Group Report' was published the following year (UK Steering Group, 1995).

This report lists 467 species of invertebrates in 'short', 'middle' and 'long' lists. The lists were reviewed in 1997 and amendments made. Species Action Plans or Priority Statements for 237 species are included in that and further reports (UK Biodiversity Group, 1999a&b 2000)(Appendix 4). The differentiation of the lists is now discontinued, all listed species now being referred to as 'Priority Species'. JNCC maintain a further list of 'Species of Conservation Concern' which includes all Red-listed species and those regarded as Nationally Scarce.

The inclusion of a large number of invertebrate species within the BAP lists is a welcome recognition of the importance and vulnerability of invertebrates.

Selection of species onto BAP Lists

In selecting species for the Biodiversity Action Plan, some difficulty was encountered in the selection of invertebrate species using the criteria formulated by the BURD group. Data deficiency precluded strict application of a number of the criteria, including international threat and 50% decline in range or population within the 25 years. Few recent records, when compared with a similar paucity over an earlier but longer time-frame, may have given the appearance of decline making some species appear to match the criteria. As a result, a number of species may now remain on the priority list that are arguably of lesser priority for conservation effort than others that are not included.

Adjustment of BAP species list

There is need for flexibility in the BAP-listing process and for a mechanism for adding or removing species from the BAP lists as better information accrues. It may be necessary to amend the BAP lists for a number of reasons:-

addition of species to the list:-

- populations of a species formerly thought to be extinct are rediscovered
- a formerly data deficient species is shown to be at risk through survey, data collation or review
- the fortunes of a species take a turn for the worse and it then matches the criteria
- a very rare species, which has nonetheless not undergone serious decline within the criteria period, is considered to be at risk from becoming extinct

removal of species from the lists:-

- further work collating data or surveying for the species indicates that it does not realistically qualify
- conservation measures taken may be so successful that the species can be considered to be out of danger, or the species may spontaneously recover and expand its range.
- all survey initiatives fail to find the species: it is assumed to have become extinct
- successive attempts to implement conservation measures all come to nothing and the species is deemed beyond recovery

Flexibility in the BAP-listing Process

Criteria for future additions and deletions to the BAP lists need to be improved to accommodate data deficient groups such as invertebrates, lower plants and fungi. Species on existing lists and in RDBs should be periodically re-examined against these criteria and action taken either to remove or add them.

Implementation of BAP

A system of Contact Points, Lead Partners and Champions has been derived in order to promote partnership in dealing with the conservation of these species. Contact Points and Lead Partners are listed in the Invertebrate Volume of the Tranche 2 Action Plans (UK Biodiversity Group, 1999). These are defined by DETR (ex unpublished DETR Lead Partner Guidance Notes, 1998).

"*Contact Points* are statutory bodies or Government Departments who act as the initial point of contact for anyone making a general enquiry about progress, or wishing to become involved with a plan's steering group. The Contact Point will also normally be a key player in the relevant plan's implementation. Where appropriate the Contact Point may provide support for the Lead Partner in, for example, securing appropriate representation on a steering group, assisting with approaches to potential sponsors, or providing quality assurance in a work programme. Contact Points may provide financial support for action plan implementation, however, there is no obligatory requirement for such support. Contact Points should also provide a means of alerting the UK Group in cases where progress with a plan is unsatisfactory and species status continues to deteriorate."

The role of the *Lead Partner* is "establishing and running steering groups of key players (where appropriate), agreeing geographical apportionment of UK targets to the country level, developing a coherent work programme across key players, identifying and seeking necessary resources for plan, implementation co-ordinating reporting on progress with plan, implementation maintaining support and ownership of the plan across key players."

Lead partners have been determined for most of the larger, more attractive species, for ones where populations only exist on the Lead Partner's land holdings, and for species where the objectives can reasonably be expected to be attained (Appendix 4). EN is Contact Point for 115 species and currently Lead Partner for 47 species of invertebrate.

There remain a small number of species for which lead partners have not been found and English Nature has funded a project with a full time project officer with Biodiversity Challenge to further the conservation for these species in England.

Champions are individuals, organizations or companies who facilitate the conservation of species by the provision of resources in the form of sponsorship, either in cash or kind. They need not necessarily have any particular expertise in conservation, nor any strong relationship with the species they sponsor. Invertebrates have the potential to attract such sponsorship either appealing to the aesthetic senses with popular species such as butterflies, or the 'quirky' or even 'tingle factor' with more obscure groups or ones with unusual or even gruesome lifestyles.

So far there have been relatively few examples of sponsorship of invertebrates by champions, perhaps the best example being the sponsorship of the People's Trust for Endangered Species stag beetle survey project by the outdoor clothes manufacturers TOG 24. Manufacturers of mechanical excavators JCB also championed a local BAP initiative on the conservation of digger wasps in Staffordshire.

Champions for invertebrate conservation.
More effort is need in the targeted promotion of opportunities for sponsorship of invertebrate project with possible champions.

Implementation of Species Action Plans

The Species Recovery programme is EN's main vehicle for the implementation of SAPs for BAP-listed species in England, in particular for the species on which it leads, although assistance is also given to projects for other Lead Partners. 'Pre-recovery' work, possibly leading to setting up of SRP projects for particular species, usually precedes the formal initiation of a SR project.

Management of the over 70 current Species Recovery programme invertebrate projects is currently takes more than 50% of the time of three EN invertebrate specialists and implementation of projects managed in-house for additional BAP-listed species has the potential to overwhelm staff resources, diverting effort from input to habitat conservation and other priority areas. There are two ways in which this work can be reduced and shared:-

- Many species may be dealt with as part of the implementation of the BAP key habitat in which they occur. Progress has already made on the matching of BAP-listed species with BAP key habitats (Simonson & Thomas, 1999) and a joint funded project between the SRP and the HAP project for Lowland Parkland and Wood-pasture has been set up to investigate monitoring methods and the use of habitat by saproxylic invertebrates in parklands.

- Species may be grouped taxonomically, geographically, by habitat type or by a mixture of each and dealt with by a single project and/or led by a single steering group. There are a number of possible natural groupings that may be used and pragmatism is needed in setting up individual projects to match available expertise. Large grouped projects have recently been funded by English Nature covering Bumblebees, other Aculeate Hymenoptera, moths, leaf beetles of the genus *Cryptocephalus*, saproxylic species and projects are being set up to covering most ground and phytophagous beetles and a variety of flies. Other combined species projects and steering groups cover butterflies, beetles and flies associated with exposed river sediments and snails of the genus *Vertigo*.

Grouped SAP Recovery Projects

Further SR projects grouping species on various criteria should be formulated and the benefits and shortfalls inherent in this approach identified.

Local and national projects to implement BAP

Most but by no means all projects to undertaking the actions to fulfill targets of individual invertebrate SAPs are being undertaken as National Projects, administered centrally. However many projects have also been initiated as part of Local Biodiversity Action Plans by local authorities, County Wildlife Trusts and other organizations, sometimes on the same species as those that are the subject of national projects. There are many local initiative implementing national HAP targets which impinge on the habitats of priority species of invertebrate. There remains a lack of communication between national and local projects, a concern that was the subject of a DETR conference in April 2000. Communications problems lie in both directions and is a wider problem rather than peculiar to invertebrate projects.

It is wholly appropriate that there is local action for national priority species, but highly desirable that there is communication between those working on species at National and Local level in order to share experiences, avoid duplication of effort and head off possible conflicting approaches.

Local/National SAP/HAP Integration

A mechanism is needed to facilitate communication between Local and National projects implementing individual SAPs and HAPs

Rare species

Red-listed invertebrates

British Red Data Books have been prepared for insects (Shirt, 1987) and non-insect invertebrates (Bratton, 1991). The former is now out of date and superseded by a series of species group reviews (eg Hyman & Parsons, 1992, 1994; Falk, 1991 a&b), although changes to RDB status proposed by these reviews are described as "provisional". 2565 species are now included on red lists for invertebrates. Criteria and categories used for red-listing nearly all invertebrate species pre-date those of the IUCN. The JNCC Species Status project aims eventually to update the Red Data Books and reviews.

Nationally Scarce (Notable) invertebrates

Species listed in the reviews that are likely to occur in 100 or less of the approximately 3500 10km squares of the UK National Grid are described as Nationally Scarce (formerly Nationally Notable). For some taxa, this category is subdivided into categories - A (15-30 10km squares) and B (31-100 10km squares). 2742 species are so listed in the UK, of which it is estimated that 98% occur in England, 22% exclusively so (Key, 1994).

Reviewing species status

The occurrence of assemblages of RDB and Nationally Scarce species on a site is extremely useful in evaluating a site's conservation value for invertebrates. Assessment of the status of species therefore must be as accurate as possible and the assessment procedure flexible enough to accommodate advances in our knowledge and real changes in the status of species. It is vital therefore that conservation statuses are subject to periodic review.

Knowledge of the distribution and habits of some species has progressed considerably since the publication of the Red Data Books and reviews. Their production has stimulated recording of the species included in them and encouraged publication of records of those species and their submission to the ISR. A small number of suggested changes to species status have now been published (eg Fowles et al, 2000) although none have yet been formally adopted.

Some species have also considerably changed their range, status or abundance since the production of the RDBs or reviews and the status to which they are assigned may now be inaccurate. Examples are the jewel beetle *Agrilus pannonicus* (RDB3) and the bee-wolf *Philanthus triangulum* (RDB1), both thermophilic species which have undergone explosive extensions in range since the publication of the reviews, possibly in response to climatic change. Neither now warrant RDB status. In contrast some species have become much rarer in the same period, eg the pearl-bordered fritillary butterfly *Boloria euphrosyne* (NB), which has continued to decline drastically in England.

Reviewing Invertebrate Species' Status

> ***In addition to periodic review of the status of species across whole groups, a 'fast-track' process to review the status of selected species is necessary in order to take into account rapid changes in species' range or abundance or our state of knowledge.***

Certain potentially important groups of invertebrates have not been reviewed at all in this way (sawflies, woodlice, myriapods, ichneumons, earthworms and other members of the soil fauna) while a number of groups have been reanalysed or analysed for the first time and the products of the analysis have yet to become available.

Species Groups Status Reviews

There is need for review of remaining species groups where appropriate data is available.

Conservation of Red-listed and Nationally Scarce invertebrates

The guidelines for selection of biological SSSIs (Nature Conservancy Council, 1989) indicate that RDB and Nationally Scarce species ideally should be conserved as part of overall rich assemblages of invertebrate species. In most cases this is the most practicable and appropriate way to ensure their conservation. The very large number of Nationally Scarce species precludes initiating similarly large numbers of national projects aimed at their conservation. EN's Species Recovery programme does, however, allow for around 10% of its budget to be allocated to projects for species other than those on BAP and there are SR projects on a small number of RDB invertebrates not on BAP, for example the ground beetle *Badister meridionalis* and the shield bug *Geotomus punctulatus*. Local action is also especially appropriate for the conservation of RDB and Nationally Scarce species and such species are targeted in local Red Data Books, Agenda 21 lists and local BAPs.

Invertebrates with strong sssociation with vulnerable habitats

The fidelity of many invertebrate species and assemblages to a particular habitat, microhabitat or combination of them can be a very good indication of their ecological vulnerability, habitat management needs and potential as indicators for habitat quality monitoring. However, in the absence of easily accessible data relating species to their habitats, emphasis is currently placed on species' rarity rather than their habitat association when evaluating faunas. This approach has recently been criticised in the literature (Eyre, 1998).

Analysis of species lists by habitat association is often requested by data users and currently this involves manual analysis of the lists by invertebrate specialists.

An analysis of BAP-listed species by BAP key and broad habitats has been prepared (Simonson & Thomas, 1999) but this covers only BAP species and habitats. A very useful analysis was undertaken on RDB & Nationally Scarce species as part of the Habitat Fragmentation Project (Kirby, 1994) and an excellent start on addressing this issue more widely was made in the ISR Habitat Association project. This was to be developed as part of the 'Recorder' biological recording package and analysis of some groups of species with habitats was completed. Unfortunately this project was ended prematurely in the early 1990s.

Analysis & Evaluation of Invertebrate/Habitat Association

Future development of the National Biodiversity Network & Recorder should have the capacity to include or undertake species/habitat association analysis.

Local Priority Species of invertebrates

Many nationally widespread species are either patchily distributed, or show strong trends in abundance along geographical axes. Such species, while abundant in some parts of the country, are decidedly rare in others and may necessitate conservation action to maintain local biodiversity and the typical character of the fauna. An example is the rose chafer *Cetonia aurata* which, while common in some areas of southern England, is scarce and declining in the north and midlands.

Identification of locally important species is necessarily the responsibility of locally based organizations, including Local Records Centres, County Wildlife Trusts and local natural history societies. Some analysis of local importance has also been undertaken by EN in reviewing the Natural Area Profiles (see below). Criteria for the determination of local priorities might include: occurrence in five or fewer sites or ten kilometre squares within an area of search, which could be approximately equivalent in area to a Watsonian vice-county, or government region (Ball, 1986), a Natural Area or aggregation of Natural Areas. However, criteria are best determined locally, and local action is appropriate for the conservation of these species. Such species are targeted in local Red Data Books, Agenda 21 lists and local BAPs.

Significant assemblages of invertebrate species

Identification of the composition and distribution of significant assemblages of species has the potential to reduce the dependence solely of rarity in assessing conservation priorities for invertebrates. Although only a little work has been undertaken in this direction so far, starts have been made on the identification of assemblages of species associated with dead wood in ancient trees (Harding & Rose, 1986, Fowles et al, 1999) and exposed river sediment (Eyre & Lott, 2000). Such work is expensive in time and resources and ideally should be carried out in partnership with other organizations with interests in particular habitats.

Invertebrate Assemblages

The use of assemblages in priority setting should be increased. Reviews of the assemblages of species characteristic of various habitat types should be undertaken, coupled with new survey designed with this as an objective.

Priority Habitats for Invertebrates in England

Identification of key invertebrate habitats and microhabitats and the appropriate management of good quality sites to favour the invertebrate interest is usually the most effective way of achieving the conservation of the majority of invertebrates.

There are a huge number of invertebrates associated with each major habitat type. Some habitats support especially large numbers of species of conservation concern including heathland, various riparian habitats, dunes, maritime soft cliffs and calcareous grassland and habitats with a long continuity of traditional management such as parklands and wood-pasture with ancient trees and well maintained coppice. Perhaps the largest number of species are associated with nutrient-rich wetlands and with woodland/ scrub/ grassland mosaics

A few habitats are naturally quite poor in the numbers of species they support, for example some upland biotopes, but some of these support a high proportion of highly stenotypic rare species, for example lowland raised mire. Even in these species-poor habitats, the number of invertebrate species present in a good example of the habitat will easily be in hundreds.

Habitat management for invertebrates usually involves tuning of existing site management operations to a greater or lesser extent to accommodate the needs of invertebrates. This involves identifying, protecting, enhancing or creating features which are of particular importance to invertebrates, some of which may not be perceived as important for conservation of the plant community or species in other groups. Examples are small areas of bare ground or poached ground in many habitats, small seasonal hydrological features, accumulations of plant litter, decay features on trees, nectar sources, often of weed species and, in particular, small and medium-scale mosaic of various features that are used by

invertebrates at different stages in their life cycles. These may simply not be noticed by a site manager or may even be regarded as a negative feature in need of remedial management, such as scrub which may be invaluable for the invertebrate fauna.

Sometimes the past management of a site, often with conservation objectives, has actually caused the decline of species of invertebrates or maintained them as precariously low populations. In some instances it may thus be necessary to modify significantly the way a site is managed in order to conserve an invertebrate species or assemblage. For example, in a damp grassland managed mowing, it may be necessary change the management to cattle grazing in order to conserve a population of marsh fritillaries *Eurodryas aurinia*.

Communication of invertebrate features to habitat managers

Communication, training and making available guidance material in the recognition of features of importance for invertebrates and their appropriate management is an ongoing requirement.

Habitat Action Plans under BAP

Conservation of all forms of biodiversity will increasingly be achieved through the implementation of Habitat Action Plans for key habitats identified within the Biodiversity Action Plan. It is important therefore that the needs of invertebrates are accommodated at the start of the process of implementation of HAPs, rather than as a retrospective add-on.

Representation of invertebrates in HAPs

It is vital that there is representation from invertebrate ecologists to the national steering groups and with local implementation of HAPs to inform objectives and targets set for habitat conservation.

A number of critical invertebrate habitats are, however, not included among the BAP key habitats. These include some types of river margins (especially those with exposed sediments), some flushed and seepage systems, vernal pools and winterbournes, and various pioneer communities, including those typical of 'brown-field' sites such as sand quarries, sites with ancient trees (other than parkland and wood-pasture) in particular orchards and riverside pollarded willows, and partly coniferised ancient woodland with well-managed ride systems.

Priority Invertebrate Habitats not represented in BAP Key Habitats

Critical invertebrate habitats not currently with in BAP should be considered for addition to the lists of BAP key habitats and Habitat Action Plans prepared

Integration of habitat and species conservation for invertebrates

The conservation of most species is far better addressed by concentrating on conservation of their habitat and progress has been made in identifying links between habitat and species conservation for BAP listed habitats and species (Simonson & Thomas, 1999).

Implementation of HAPs without due regard to invertebrates, or of SAPs for species requiring modification of the way large areas of a habitat is managed, may have the potential, in some instances, to harm large assemblages of species of invertebrates of conservation concern. However, only in rare instances is there genuine conflict between the needs of an important invertebrate fauna and that of other aspects of the fauna or flora of a site or habitat. One example might be in the requirement of wetland birds for reedswamp in standing water,

whereas the invertebrate fauna of the same site may require either bare mud at the base of the reed, or an accumulation of moist, but not submerged, reed litter.

In nearly all instances of apparent conflict it is possible to reconcile the differences, providing that the requirements of the 'competing' groups of organisms are made known at the outset of planning management.

Many other scarce or vulnerable invertebrates other than those listed on BAP occur in BAP key habitats. It is important that general principles to accommodate the needs of a wider spectrum of invertebrates than those listed on BAP are incorporated into HAP objectives and work programmes. Such principles are presented in Kirby (1991). The provision of invertebrate conservation training for members of national and local BAP/HAP steering groups could help considerably in achieving the desirable level of integration between HAPs and SAPs.

Practical Integration of HAP/SAP Work

The needs of invertebrates, especially of BAP-listed species ascribed to BAP key habitats should be thoroughly integrated into implementation of HAPs from the outset. Some invertebrate input is necessary on all BAP key habitat working/steering groups implementing HAPs.

Training in invertebrate conservation should be targeted for members of National HAPs and Local BAPs.

Avoiding conflict between SAPs

A watching brief should be kept across the range of SAPs, including non-invertebrate SAPs that may have a potentially big impact on the way large areas of habitat are managed in order to avoid conflict before it arises. This is best addressed through communication of SAP steering groups through the relevant HAPs at either local or national level as appropriate.

In addition to species that can be associated with a BAP key or broad habitat, there are also numerous BAP-listed species of invertebrates that do not occur in any prioritised habitat. These species require individual consideration.

Balance of work under SAPs and HAPs

With the advent of BAP, the resources available for work on single species of invertebrate has reached an unprecedented level and the proportion of effort and resources spent on such work has never been greater. In 1999/2000 over £300,000 was committed from EN towards the conservation of invertebrates and this will be exceeded in 2000/01. The balance of work between the primarily species-based and habitat-based approaches to the conservation of invertebrates is currently swinging in favour of the former. This may become imbalanced as further SAPs are implemented and recovery programmes set up. However, HAPs have the potential to have far more general influence on the conservation of species of invertebrate of conservation concern than individual SAPs.

Balance of work under SAPs and HAPs

There is need to ensure a balance of work between habitats and species, best achieved by integration of work on conservation of individual species with that on their habitats.

Priorities for invertebrates in particular habitats

Early pioneer successional stages

Early stages in the development of heathland, dune & dry grassland, with sparse vegetation and bare ground are very important for thermophilic species for basking, for tunnelling and ground-nesting species, for plant-feeding species associated with ruderal plants and for ground-active predators. Groups particularly well represented are the solitary wasps and bees, plant-feeding beetles, bugs, robberflies, and moths. Such microhabitat is easily neglected and active management may be necessary which may be resource-intensive, can sometimes encourage 'weed' species and can produce results that may be considered unsightly either by conservation managers or visitors to the site. Conservation and amenity initiatives aimed to eliminate poaching by domestic stock in grassland and to restore areas of eroded heathland and acid grassland to a monoculture of heather may directly threaten this fauna.

Bare Ground Features in Heaths, Dunes and Grassland

The need for bare and sparse substrate should be taken into account in the management planning for these habitats, particularly in the implementation of HAPs for them.

Urban and post-industrial 'derelict wastelands,' for example demolition sites, mine tailings, slag and ash heaps, sand pits, quarries and clay and gravel pits frequently have their vegetation succession arrested by low soil nutrient content, toxicity, adverse pH and/or regular disturbance and erosion from continued extraction or recreational use. They often have irregular topography including pits and banks which may be important invertebrate nesting sites. For these same reasons, such sites are often considered to be of low value, unsightly and sometimes hazardous. They may, however, be exceptionally important for pioneer invertebrate communities, with very rich faunas and large numbers of rare species (Gibson, 1998; Key, 2000) often associated with plant communities characterised by high 'cover' of bare ground and dominance by nectar bearing ruderal foodplants.

Despite being composed of scarce species, the fauna of such sites is probably relatively robust and is likely to be composed of species with comparatively good colonisation abilities. However, these species need refugia of frequently disturbed areas from which colonization can occur. The robust nature of this fauna makes them potentially of high value for education, especially as they are frequently in or near centres of high population, including inner city areas where access to wildlife sites is otherwise difficult.

Sites of this nature are often targeted for development for industry, landfill and housing, including by the 1998 policy statement "Planning for the Communities of the Future" which specifically seeks to redirect housing development to urban 'brown-field' sites.

Such sites are also often targeted for restoration as greenspace for wildlife, recreation or agriculture, often at great expense. Such restoration is often misinformed, usually involving landscaping, levelling topography, spreading topsoil and planting grasses, herbs and trees, all of which are usually very damaging to the intrinsic wildlife interest.

Such sites are very poorly represented in the SSSI series other than on some Geological Sites and there has been reluctance to include them in the biological series. Certain Natural Areas may, however, be particularly important for such sites.

Conservation of Invertebrates in 'brown-field' Sites

Guidance on the value, retention and conservation of such sites for nature conservation should be incorporated into the PPG9 guidelines.

Guidance on the after-use of mineral workings and spoil that is sympathetic to the needs of invertebrates should be prepared and distributed pro-actively to the mineral industry and to planners.

There should be coordination in the selection of geological conservation sites and invertebrate habitat and its management in such environments.

Key 'brown-field' sites should be identified and included in the SSSI series and/or identified as locally important with local BAPs and Structure Plans. There is need for a strategic overview of such sites and their conservation.

Intermediate seral habitats - in particular scrub

Well-structured scrub is a vital, dynamic component of the habitat of a very high number of BAP-listed and RDB and other species of conservation concern in many habitats, in particular for heathland, grassland, dunes, some wetlands and woodland edge. Examples include various fritillary butterflies, the barberry carpet moth *Paraleupe berberata*, the hazel pot beetle *Cryptocephalus coryli* and 4 other BAP-listed species of this genus. Many scarce species require scrub associated with shorter vegetation to complete their life-cycles.

Scrub is, however, considerably undervalued and frequently mis-managed and is often considered unsightly, either by conservation managers or site visitors. It is often considered as a problem to be eradicated rather than a asset to be sympathetically managed. Clearance, and aftermath browsing can eliminate valuable scrub or alter it structurally so it becomes far less valuable for dependent species. There are instances where its management, control or eradication has led to the local extinction of scarce species of invertebrates. As a seral habitat, management is necessary to maintain valuable scrub, without allowing it to spread at the expense of grass or heathland etc and it is important that a dynamic balance is maintained between the habitats.

Under BAP, increased resources are being put into conservation of heathland, certain grassland types, bogs and dunes. Consequently, increased scrub management is likely and, while it is welcome that a better balance between, for example, heathland and scrub may be restored at many sites, it is vitally important that scrub is maintained as a valued and integral part of these habitats.

In 1999/2000 English Nature undertook a review of the overall wildlife conservation value of scrub habitats which, at the time of writing, was yet to report.

Scrub Management

The importance of scrub and the vulnerability of invertebrates to overenthusiastic scrub control needs to be communicated to HAP steering groups and guidance literature is needed on the value and management of scrub in grasslands, heaths wetlands and dunes, integrating its importance for invertebrates with that for other organisms.

Ancient trees and decaying timber

The ancient forest fauna of invertebrates associated with large old trees, decaying timber and, in particular, a long continuity of such conditions is the most threatened invertebrate fauna in Europe (Speight, 1989). Two associated H&SD listed species, the Violet Click Beetle *Limoniscus violaceus* (W&CA Schedule 5, Berne Convention annex 2 & BAP) and the Stag Beetle *Lucanus cervus* (W&CA Schedule 5 Section 9a, Berne Convention annex 2 & BAP) occur in Britain and a further 15 species associated with this habitat are listed on the UK BAP.

Parks and wood-pasture, the habitat which is most, although not exclusively important for this fauna, is a BAP Key Habitat. Other significant habitats are old orchards (specific habitat of the BAP-listed Noble Chafer *Gnorimus nobilis*) and pollarded riverside trees, mainly willows. Neither of these habitats are identified as key habitats in BAP. A Countryside Stewardship scheme directed towards orchards initially concentrated mainly on the maintenance of fruit tree varieties and grassland rather than necessarily conserving the very old trees that provide important habitat. The environmental organization Common Ground has recently adopted old orchards as a key habitat (Common Ground, 2000).

Research in eastern Europe suggests that pollarded mature street trees in towns may be of significance for this fauna but their value in Britain is completely unknown.

Between 1995 and 2000, English Nature undertook a Veteran Trees Initiative, which did much to publicise the value of ancient trees for all forms of wildlife. It produced various items of guidance literature, including a veteran tree management manual, safety guidance and survey methodology and led on to the foundation of the HAP Steering Group for Lowland Parkland and Wood-pasture.

Veteran Tree other than in Parks/wood-pasture

Old orchards, areas with high densities of riverside willow pollards and ancient street trees should be targeted for strategic survey and conservation.

Recognition of the value of ancient trees and dead wood has improved tremendously in the past decade. At a number of key sites, conflict has been replaced by active cooperation and pro-active conservation measures are now being undertaken where formerly conservation and land management interests were at loggerheads. Some areas of conflict still remain but overall the trend is in a very hopeful direction. Nevertheless there remain areas of concern regarding the conservation of veteran trees and dead wood and mismanagement and intentional destruction still occur, often through misunderstanding of safety issues in areas that are managed for public access and also in the wider countryside.

Of critical importance is the future continuity of the decaying wood habitat as populations of veteran trees die naturally. In many instances there has been little regeneration on significant sites and there may be huge gaps in the age structure of tree populations. These are not always apparent at sites without an analysis of the age structure of the trees over a broad area. A tree survey process that records age structure and condition has been developed as part of EN's Veteran Trees Initiative.

Veteran Tree Population Structures

A method to model the age structure of tree populations through time is needed to assist planning of tree replacement strategies.

Multidisciplinary research (arboricultural, mycological & entomological) is necessary into keeping veteran trees alive as long as possible, together with researching processes which may prematurely age trees and initiate appropriate decay conditions for invertebrates.

Priorities for synecological research should be formulated and implemented aimed at determining practical management options of trees and woodland.

Our knowledge of the conservation ecology of saproxylic species is often almost entirely restricted to an understanding of how to find the adults. Knowledge of how trees, fungi and invertebrates interact and how saproxylic invertebrates relate to nectar sources and abiotic environmental variables would appear to be crucial in determining colonization, oviposition behaviour etc and. Currently we have almost no knowledge of what processes we can manipulate through habitat management in order to conserve this fauna. English Nature has recently commissioned a three year research project with CABI Bioscience International reviewing and investigating these inter-relationships and a PhD studentship at Birmingham University of investigating barriers to colonization by saproxylic species within parkland and wood-pasture.

Wetland and waterside habitats

One of our most diverse invertebrate faunas is that associated with wetlands and water margins. A significant number of these faunas have become at risk in recent years as a result of a series of very dry years in the mid 1990s, coupled with increased abstraction of water from groundwater and rivers and land drainage adjacent to important sites. Assemblages of species associated with spring-heads, seepages & flushed systems, blow-wells, vernal pools and winterbournes, spring-fed and groundwater-fed fens and the relict faunas of post-glacial geomorphological features such as pingos, are particularly at risk. Vulnerable groups include communities of water beetles & ground beetles, flies including soldier flies, craneflies, snail-killing flies, various spiders and a diversity of aquatic groups. Cave, subterranean, interstitial and soil faunas may also be at risk but little is known about them. Some of these groups may respond to changes in hydrology far more quickly than does the vegetation and have the potential to be useful tools for site quality monitoring.

Some of these habitats are BAP-listed key habitats, for which HAPs have been prepared, but others are usually only found as small features occurring variously in other habitats and not currently included in the BAP process. Some other faunas are also threatened, probably most notably saproxylic species associated with very old trees, some of which are dying as a result of falling water tables. The problem is particularly acute in East Anglia, south-central and south eastern England and in many areas the situation is deteriorating.

Water Conservation Issues

The needs of aquatic and hygrophilic invertebrates should be taken into account in formulating policy on water conservation and land drainage and in routine assessment of the effects of water abstraction on wildlife, including small wet features on non-wetland sites.

Attractive species such as dragonflies and soldierflies should be used in publicising this acute problem.

Water abstraction should be opposed or, where possible, reversed when significant sites and species are at risk.

Research is needed into the survival strategies in relation to drought and recolonisation abilities of hygrophilic species most at risk, although this is secondary to achieving successful control over water loss from sites.

Conversely, a related problem in a small number of instances, may sometimes be an excess of water at certain or all times of year resulting from changes in water regime on sites brought about by conservation management with other objectives in mind. Flooding or deepening of standing water in reedbeds and conversion of wet grassland to permanent winter or summer flooding may particularly impact on invertebrates.

Water level management for nature conservation.

Dialogue should be maintained with invertebrate biologists when significant changes, including increases, in water table are planned for nature conservation purposes.

Flushed systems and seepages

Areas with base-rich flushing and with surface or subsurface seepage or trickling of water support particularly rich highly specialised faunas in particular of soldierflies, including the BAP-listed species *Odontomyia hydroleon*, craneflies, ground and rove beetles. They are often associated with springlines and, although included in the Fenland HAP, may be relatively very small features in larger sites considered to be more important for other habitats, including grasslands, woodlands and various upland and coastal habitats. Only rarely are they identified as a conservation feature in their own right and there have been instances where ecologically important systems have been drained to provide dry footage for access or dammed to provide permanent standing water, to the great detriment of the fauna. Our knowledge of the extent, protection and conservation management of these systems is very sketchy and EN initiated a pilot review in 1999 by compiling an inventory of such base rich sites in northern England.

Seepages and flushes

There is need of full strategic review and survey of the extent of flush and seepage systems their faunas and their conservation status.

Ditch systems

Managed ditch systems are exceptionally important for the conservation of a broad spectrum of aquatic invertebrates across a range of species groups, most notably of water beetles, and guidelines for the selection of biological SSSIs specifically give criteria for the selection of such sites based on their waterbeetle faunas. Such systems are especially important in grazing marsh systems, including ones with a limited saline influence which have a particularly characteristic fauna, including the BAP listed species *Hydrochara caraboides* and *Laccophilus ponticus*. These species are highly dependent on the vegetation clearance management regime and, although existing regimes may generally be favourable to the invertebrate fauna, the later stages of the hydroseral succession are often missed as the ditches may be cleaned on too short a time-frame to benefit the fauna associated with the later vegetation choked conditions.

Ditch Systems

There is a need to inform the fine tuning of the clearance cycle of some ditch systems in grazing marshes in order to accommodate the fauna of the later hydroseral stages.

Rivers

Exposed river sediment, in particular of shingle and sand in the upper and middle reaches of rivers, and eroding clifflets along river banks, support very diverse faunas of, in particular, ground and rove beetles, spiders, bugs, bees, wasps and flies that are very specific to that habitat. Impoundment and regulation of river flow, in particular changes in the periodicity of flood events, threatens riparian faunas considerably more than lack of summer flow caused by drought. Lack of winter scour can lead to stabilization of riparian vegetation and loss of exposed river sediments, which may also become permanently covered by regulated flow released from reservoirs in summer. Communities of invertebrates are also threatened by shading or blanketing by alien invasives, notably Himalayan balsam, *Impatiens glandulifera* and Japanese knotweed *Fallopia japonica*. Stretches of river supporting good assemblages appear to be rare, but our knowledge of the extent and distribution of the habitat and its fauna is patchy. Eight species of beetle from this fauna are listed under BAP, sharing a common SAP and a further three BAP-listed flies are associated with this habitat.

The Environment Agency, Countryside Council for Wales, English Nature, Birmingham University of and Scottish Natural Heritage have all recently been involved in various complementary reviews and surveys of riparian margins with exposed river sediment, including sites within Northern and South-western England.

Invertebrates of exposed river sediments

There is need to combine existing effort in review and survey of the fauna of exposed riparian sediments to give a comprehensive overview, and the best sites for this fauna should be considered for protection within the SSSI series.

Coastal habitats

Certain coastal habitats support distinctive assemblages of maritime invertebrates with a high proportion of scarce species. Ungrazed saltmarsh, vegetated shingle, freshwater seepages on cliffs, unstable boulder clay and other soft cliffs and the strandline in many habitats are particularly rich in species highly specialised to these habitats, while sand dunes support many scarce species that often occur otherwise only on heathland and/or dry, often calcareous grassland. Some communities of coastal invertebrates are at risk from various activities undertaken on the coast, in particular coastal defence including the stabilization of cliffs, either by construction of physical defences or through reduction of water seepage to the cliff face, and the landward truncation of saltmarsh succession by sea banks.

Saltmarsh invertebrate communities are most diverse in ungrazed systems and may suffer extinctions if grazing is introduced, sometimes for nature conservation purposes, into sites that have never been grazed.

Localised problems for species may also arise from in the clearance of strandline debris for amenity and agricultural purposes.

Coastal Invertebrate Assemblages

A strategic review is needed of the fauna of some coastal habitats, notably of boulder clay and soft-rock cliffs.

Consideration of the needs of invertebrates is necessary in coastal zone management and the planning of managed retreat.

The uplands

The invertebrate assemblages of England's uplands are relatively very poorly documented, but significant boreal faunas are known to occur on summits in Lakeland and the northern Pennines and other predominantly northern species occur as far south as Exmoor and Dartmoor. The distribution, status and ecology of most upland species is poorly understood, but many species seem to be restricted to small features of uplands, rather than occurring on large expanses of blanket mire. Particularly important features are summit boulder fields and outcrops, some types of screes, small seepages, flushes and water bodies and diverse herb rich areas, in particular those with abundant nectar sources.

Some of these faunas are known to have declined considerably in recent decades, but the impacts and issues affecting upland species of invertebrate are, on the whole, poorly understood. Possible factors are:

- changes in vegetation architecture and plant species composition and loss of key plant species resulting from overgrazing by sheep
- loss of upland woodland through lack of regeneration
- summit erosion caused by hill walkers and mountain bikers
- acidification and eutrophication, particularly for those species associated with seepages, streams and oligotrophic waters
- changes in water regimes resulting from regulated flow of upland rivers, flood alleviation and reservoir construction
- changes in hydrological regimes from drainage and moor-gripping
- global warming leading to changes in altitudinal zonation
- afforestation and bracken invasion
- the use of synthetic pyrethroids in sheep dip and its disposal on land

Invertebrates of upland habitats

A strategic examination of the true status and distribution of upland and montane invertebrates is necessary, preferably in association with the other country agencies where upland species can be expected to be more widespread.

Habitat mosaics

Mosaics of habitats, at scales from landscape to microhabitat, is very important for invertebrates which frequently use different juxtaposed habitats or microhabitats in successive life-stages. Mosaics are undervalued, sometimes regarded as scruffy and unsightly and sites are rarely managed specifically to maintain them. Good mosaics may be difficult to achieve at the right scale and yet they are vitally important for invertebrate conservation. Some elements of the mosaic, (notably scrub) may be regarded as a negative features and destroyed, reduced rather than managed appropriately.

Mosaic

The value of mosaics at all spatial scales should be promoted, in particular to HAP steering groups, both within evaluation and management of sites, and in the management of the wider countryside through ELMS.

Invertebrates Conservation, the Wider Countryside and Agricultural Policy

Invertebrate Biodiversity Outside 'Sites'

A proportion of invertebrate species of conservation concern, including BAP-listed species, do not fall neatly either into BAP key, or broad habitats (Simonson & Thomas, 1999) and so it is possible for them to escape attention through using only species or habitat based approaches. They are associated either with habitats not considered as high priority under the BAP, or with scarce, but widely dispersed micro-habitats across a range of habitats throughout the countryside. Some species, for example the high brown and marsh fritillary butterflies *Argynnis adippe* and *Eurodryas aurinia* have also been shown to exist in dispersed meta-populations requiring large areas in which to colonise and recolonise.

Other examples are the various species of rare and declining bumble-bees typical of a diverse countryside of pastures, hedgerows, arable margins etc, and the various dung and carrion feeding species not associated with any particular habitat. A small number of BAP-listed invertebrates, such as the flixweed flea beetle *Psylliodes sophiae*, are almost entirely restricted to arable farmland, usually being dependent on the arable weed flora and two species of saproxylic invertebrate *Gastrallus immarginatus* and *Ampedus rufipennis*, are at least as prevalent in hedgerow trees as they are in old parks and wood-pastures.

The wider countryside of arable and pastoral farmland, hedges and verges, woods and plantations, gravel pits and quarries etc are home to a vast number of species and individual invertebrates that comprise a significant element of the general biodiversity of the countryside and are critical in the food web of vertebrate predators, including most farmland birds. Studies in the East Anglian fen counties have revealed that field drains in what is usually considered by conservationists as very uninspiring countryside, contain populations of species of invertebrate considered to be scarce, although these rarely form part of recognisable assemblages typical of semi-natural habitat.

Arable and pastoral habitats in certain Natural Areas of the country appear to be 'hot spots' for species of invertebrate generally considered to be scarce, perhaps the most apparent of which are the Norfolk/ Suffolk Breckland for xerophilic, sabulicolous species often associated with arable weeds, the East Anglian fenlands for wetland species, the south-western Culm grasslands for species of damp pasture, the Cotswold fringes for the faunas of mature hedgerow trees and the Hampshire/ Sussex border area for hedgerow and verge faunas. No doubt other 'hot spots' remain undiscovered.

Such species, however, seem to exist in low populations and the features upon which they depend are subject to similar, but increased pressures as their counterparts on semi-natural habitats on 'sites'. For example, exacerbated problems of future continuity of hedgerow and riverside veteran tree populations exist as in the parks and wood-pasture recognised to be of importance for the fauna dependent on old trees.

The invertebrate faunas of the wider countryside habitats and the issues confronting them are very poorly documented indeed and there is need for baseline information both to characterise faunas and to inform studies of future change.

Invertebrate faunas of the wider countryside

There is need for some pilot studies to characterise various farmland invertebrate faunas and to initiate surveillance to enable observation of changes in populations and diversity.

Enhancement of the wider countryside for invertebrates

These wider countryside features have considerable potential for restoration and enhancement. Pioneering work in this direction has been undertaken by the Game Conservancy in their development of unsprayed headlands and beetle banks which have been shown considerably to increase the invertebrate productivity and diversity of ordinary arable farmland. However, the only realistic way that such features can be promoted is via Agri-Environment and Ecological Land Management Schemes, such as MAFF's Countryside Stewardship and the Forestry Commission's Woodland Grant Scheme, rather than through protection of individual sites. Coastal policies concerning saltmarsh restoration and managed retreat also offer great potential benefits and the transport infrastructure manages huge swathes of land that have the potential to form extremely important dispersal corridors and habitats in their own right. Afteruse policy on mineral extraction sites and post-industrial and urban derelict ('brown-field') sites currently often mitigate against important established or developing invertebrate faunas and have potential for improvement (see 'brown-field' sites, above).

Resources available to such schemes are set to increase considerably and there is now an opportunity to influence their design and suggest additional modules within the schemes that would favour the invertebrates of particular agricultural microhabitats:

- encouragement of ruderal and arable weed faunas by encouraging summer fallows on areas with light sandy or calcareous soils
- provision of unploughed buffers along hedgerows with older trees to prevent root damage and premature death
- planting of additional hedgerow and waterside trees to become tomorrow's veteran trees
- encouragement of managed hedgerow or scrub external margins to woodland to soften woodland edges and provide foodplants and nectar sources
- creation and management of grassland and scrub internal edges within woodland
- low-intensity pasture schemes that favour the maintenance of structural mosaic of turf structure
- targeted grazing management to restore pasture to areas containing seepage, flush and springline features
- schemes for the control or eradication of invasive alien plant species
- managed coastal retreat to increase the area of ungrazed saltmarsh
- managed coastal retreat of boulder clay and other soft-rock cliffs to maintain natural slippage and coastal seepage systems
- scrub management as separate from scrub eradication schemes on most habitats
- establishment of semi-natural grassland, heathland or scrub margins to motorway and other road verges
- after-use policy of mineral workings and post-industrial sites adjusted to take advantage of their low fertility pioneer vegetation communities and inherent varied topography to benefit invertebrates
- consideration of nectar source provision in all new and existing AE and ELM schemes

Agricultural schemes designed for other purposes, such as land setaside to reduce agricultural overproduction, have potential to assist in the enhancement of invertebrate populations and diversity in the wider countryside. However, current setaside schemes do not realise their potential in this direction. In particular the mandatory summer herbicide application on setaside prevents the development of significant faunas associated with ruderal and nectar plants by destroying the developing habitat at a critical stage in its development.

Enhancing Invertebrate Habitat in the Wider Countryside

Invertebrate conservation biologists should be proactive in influencing the planning and review of new and existing AE schemes, ELMS and other incentive schemes to ensure that invertebrates benefit.

Priority Sites for Invertebrates

As with other groups of wildlife, the conservation of invertebrate species and communities relies on the safeguard and management of the sites on which they occur. Selection of sites as SSSIs and nature reserves needs to take into account the presence of important species and assemblages and to ensure their representation on well-managed conservation sites. Data are therefore needed on the occurrence of species and assemblages on existing and potential conservation sites and those data analysed to ensure that there is adequate representation.

Representation of invertebrate habitats

Although some habitats for invertebrates are well covered by the SSSI series, there are gaps in the coverage. Certain invertebrate habitats of little value for other taxa are under-represented or the knowledge base is too patchy to determine the true situation. These include some habitats that are already listed in BAP and others that should be considered as future BAP key habitats; riparian margins, especially exposed river sediments, seasonally flooded water bodies, some types of coastal cliffs with landslips, parks/pasture woodland and arrested pioneer communities. A strategic overview of some invertebrates habitats is necessary before we can even begin to determine whether the SSSI series adequately represents them.

Under-represented Invertebrate Habitat in SSSI Series

Strategic reviews and, in some cases, targeted survey of under-represented habitats is needed and the most important sites should be considered for SSSI notification.

Representation of invertebrate species

Invertebrate species on SSSIs

The ISR has extensive but incomplete data on the SSSI series and it is not possible to determine if all Red Data Book and Nationally Scarce invertebrates are adequately represented on SSSIs. Careful interpretation of available data is needed prior to suggesting notification of sites purely for the representation of scarce species not known to occur on other SSSIs. Guidelines for the selection of Biological SSSIs do, however, recommend that RDB & Nationally Scarce species should be represented in the series.

SSSI Equilibrium Project

Between 1997 and 2000 English Nature undertook a project to in review the SSSI series, including the identification of gaps. Analysis of the Invertebrate Site Register has identified a series of non-SSSI sites worthy of some further consideration in consultation with Local Teams and a number of these have now already been notified or are in the pipeline.

Guidelines for the selection of SSSIs for invertebrates

The Guidelines for the Selection of Biological SSSIs are prescriptive for sites with outstanding assemblages of butterflies, dragonflies and some habitats for water beetles. For the remainder of invertebrates, they state that strong populations of RDB & Nationally Scarce species should be represented in the SSSI series, preferably as components of rich assemblages. It is however, also important that invertebrate species and assemblages are adequately covered by the guidelines for selection of SSSIs to represent individual habitats.

SAPs for a number of BAP-listed species suggest that SSSI status be sought for some or all of the sites on which they occur. Currently there are no guidelines regarding representation of BAP-listed species on SSSIs.

Guidelines for the Selection of SSSIs for Invertebrate

There is a need for either the production of invertebrate supplements to the Guidelines, or incorporation of the needs of invertebrates in general habitat criteria if a wider revision is to be carried out.

Site Objective Statements & Site Management Statements for SSSIs

The Country Agencies are currently setting Site Objective Statements, formulating Site Management Statements and determining criteria the assessment of 'Favourable Conservation Status' for all SSSIs, concentrating on those features for which the site was initially notified. The specialised needs of invertebrates are easily overlooked in setting such objectives for vegetation communities, especially if the invertebrate interest is not specified as one of the reasons why a site was notified, even though it has subsequently been found to be important for invertebrates. The significance of invertebrate faunas on many sites has been recognised relatively lately and the citations of a number of very important sites do not include reference to the invertebrate interest, particularly those that were notified early in the period of renotification immediately following the 1981 W&CA. This is a problem shared with other, less well known species groups, in particular the lower plants and fungi.

Site Objective Statements and Site Management Statements

An holistic approach to the setting of SOS and SMS and assessing FCS is needed for species assemblages on SSSIs. The general management needs of invertebrates typical of a habitat should be taken into account in the setting these objectives for the habitats in which they occur, including on sites where the invertebrate interest is not a primary reason for notification

Invertebrate species on National Nature Reserves

Original criteria for the selection of NNRs were given in the Nature Conservation Review (Ratcliffe, 1977) and sites for declaration as NNRs are now approved by the Chief Scientist of the Country Agency. The NCR gave little attention to invertebrate habitat and the A-grading of sites in the ISR was initiated to identify potential NNRs to cover important invertebrate habitat and these were reviewed in the SSSI Equilibrium Project, all now being SSSIs.

The NNR Review project (Massey, 1997 a&b) undertook a partial review of representation of key invertebrate groups on NNRs. However, no attempt was made to identify new potential NNRs for invertebrates.

Representation of key invertebrate habitat on National Nature Reserves

The representation of key invertebrate habitats within the NNR series should be reviewed and appropriate cases for NNR listing put forward as appropriate.

Natural Areas

In the mid 1990s English Nature and Countryside Agency (then Countryside Commission) formulated the concept of Natural Areas/ Countryside Character Areas - subdivision of England into areas based on common ecological and landscape features and English Nature is now committed to the use of Natural Areas for the setting of the conservation agenda and is producing profiles and objectives for each Natural Area. BAP targets are also to be delivered through the NA targets. It is important that this target-setting does not omit or undervalue invertebrates and also that the needs of a broader spectrum of invertebrates rather than just the species on BAP are included in the analysis.

Inclusion of invertebrates in this process has been achieved by interrogation of the ISR database. Input to the Natural Area process has been difficult and slow, largely because of the vast number of species and the diversity and complexity of the habitats they inhabit. While it is a simple process to produce a list of scarce species that have been recorded within each Natural Area, the lists produced are so large as to be overwhelming (eg the Thames Basin NA is home to over 1,000 RDB/Scarce species).

An alternative approach has been to develop lists of important *characteristic* species for individual biota in each Natural Area, together with generic objectives for their habitats.(Drake et al, 1998).

However, other data are available at BRC, in LRCs and local natural history societies. The development of the NBN (see below) will improve accessibility to these data and greatly facilitate future analysis of invertebrate information by NA.

Natural Areas

The characterization and targets for invertebrates in Natural Areas should be reviewed when more data is available via the National Biodiversity Network and more easily analysed using Geographic Information Systems.

Data & Information

Up-to-date data on the distribution and occurrence of invertebrate species is essential in the identification of priority species, site evaluation, and management planning. New data on the occurrence of scarce species is constantly needed to identify species' trends in status and distribution and to enable important context-setting and maintain national overviews.

For invertebrates, baseline information is, in most instances, a collation of information from surveys and observations obtained from amateur invertebrate biologists who are often experts in their field, but have nevertheless collected the information for other purposes.

In some instances, for example the butterflies, larger moths, dragonflies, grasshoppers, most ground and water beetles, this information is so extensive as to provide an excellent baseline against which the faunas of newly surveyed sites can be compared and national and local trends identified. For other taxa and assemblages, while it is possible to undertake *ad hoc*

comparisons, the gaps in the dataset, in space and time, are sufficient to necessitate caution when interpreting information, selecting sites and making firm statements about their value. This has limited the use made of invertebrate information in, for example, site defence at Public Inquiry, only to the very cream of top sites, and very extensive additional work has been necessary in those instances to gather additional data on the disputed site and others with which they must be compared in order to justify the claims that are made about their quality and conservation value.

Information about the distribution of the British invertebrate fauna lies with the various invertebrate recording schemes coordinated by the Biological Records Centre, as well as with various independent groups such as Butterfly Conservation, the British Arachnological Society the Hoverfly Recording Scheme etc. Other information on invertebrates is held by County Trusts, Local Natural History Societies and in the notebooks and collections of individual professional and amateur invertebrate biologists, and is often not readily available for analysis. Only a proportion of invertebrate datasets are computerised, the remainder in paper form held by scheme organizers. Data in the computerised BRC schemes are not integrated and access to data is not currently "on-line" and therefore it is not possible to interact with the data to identify optimum search strategies etc.

Incompleteness and patchiness of our knowledge-base on invertebrates are impediments to the prioritization of work on species, habitats and issues, but the size of the invertebrate fauna (30,000+ species) makes the needed information base very large.

The Invertebrate Site Register (ISR)

The Invertebrate Site Register was set up in the late 1970s to collate records of the occurrence of scarcer species, in particular on conservation sites. Data were actively trawled from all available sources during the compilation of reviews of individual counties and national reviews of species. In 1996, the ISR records on paper were archived at the Biological Records Centre following the Chairman's Review of JNCC. Copies of the computerised database were taken at that time by each country agency and by JNCC and the data is now maintained at country level.

The data in the ISR is widely consulted by EN Local Team staff in the preparation of Site Management and Objective Statements, environmental impact assessments and Natural Area profiling and objective setting. It is also widely consulted externally by Local Authorities, VCOs and ecological consultants for similar purposes, as well as for setting priorities for local BAPs. Servicing requests and input of incoming data takes about 70% of the time of one scientific support post in EN. No charge is made for ISR consultation and a Charter Mark Standard is maintained on enquiries, all being answered well within 10 working days of the initial request.

It is important that the data quality is of the highest standard. This is particularly important when it is open to challenge, such as in public inquiries. The data in routine site reports and summary data provided both internally in English Nature and externally to local authorities and consultants cannot, however, be routinely be checked for accuracy because of time constraints. Each report therefore carries the JNCC disclaimer of responsibility for any inaccuracies undetected at the time of production and the sources of the data are identified so that the recipient can check against the original data.

There has been regular entry of data as it has been forwarded by Local Team staff for interpretation and by a number of regular contributors, but data has not been actively trawled from primary sources since the production of county reviews. Data from the largest species group reviews on beetles, ants, bees and wasps and flies and moths has not all been systematically entered. An exception has been the trawling and input of all information of BAP-listed species from all available sources.

Data Entry to the Invertebrate Site Register

Data entry to the ISR should be maintained at least at current levels.

The National Biodiversity Network

The practical remedy for the current limitation to access to important invertebrate data is via the development of the National Biodiversity Network and its query via geographic information systems. EN invertebrate specialists have had considerable input to the development of the NBN, as representatives on the Recorder Technical Group and the NBN National User Group.

Development of the National Biodiversity Network

Invertebrate specialists should continue to be be involved in the NBN planning process in order to influence its development to best suit invertebrate conservation.

The English ISR may eventually become integrated with the NBN. However, the ISR is a summary, secondary data compilation and much information on commoner species is omitted on data entry. It is hoped that eventually all invertebrate data entry, maintenance and quality control will become a function of Local Records Centres and national recording schemes, interconnected via the NBN and it is important that the original data on which the ISR is based, rather than its current summary form, is that which becomes available over the NBN. This will be achieved by progressively downloading geographical units of the ISR to LRCs together with its original source material, where there will then be local 'ownership' of the data. English Nature will provide access for LRCs to all its holdings of invertebrate data and in turn key into the network to access data and maintain appropriate overviews.

Special attention will need to be paid to maintaining the quality of invertebrate data within such a dispersed system. Experience has shown that invertebrate data-entry by non-specialists may be unreliable, mainly a result of taxonomic instability of some groups and frequent species name changes. It is therefore likely that there will remain some need for specialist interpretation of invertebrate data output.

Dispersal of Invertebrate Data Holdings to LRCs.

The long-term aim should be that LRCs maintain local ownership of most invertebrate data, but interconnected with the national recording schemes and society data sources. ISR data, including copies of its original source material, should be parcelled to LRCs and recording schemes as they develop the capability to maintain it and are connected to the NBN.

Invertebrate literature

Much important information on invertebrates pertinent to assessing their ecology, status, distribution and conservation has been published. Maintenance of an up-to-date knowledge of

all that is published on invertebrate ecology and conservation is very time-consuming and increased reliance is made of various literature-abstracting services.

The NCC invested considerable resources into developing "Entscape", a computerised bibliography on the British invertebrate fauna, (Penny & Key, 1994) now held as part of EN's Library's information system and searchable in conjunction with "Wildscape". This is a useful tool for identifying information located within the literature.

The project updating this bibliography was, however, discontinued in 1989 through lack of resources and searches therefore do not extract information later than this. Searches of the Zoological Record (on CD-ROM back to 1976) are able to some extent compensate for this, but not to the depth that is possible within ENTSCAPE.

Invertebrate Literature Abstraction

ENTSCAPE should become much more widely available within and external to the conservation agencies, preferably on the Internet.

Invertebrate Survey and Monitoring

Invertebrate survey

Selection of SSSIs for the representation of invertebrates, and their subsequent safeguard usually depends up-to-date information, set in the national and local context. This frequently necessitates the commissioning of surveys of single sites and comparative survey. The UK BAP identifies survey as a major need in a high proportion of HAPs and SAPs, ranging from determination of the extent and quality of a particular habitat, to estimation of the numbers and description of populations of BAP-listed species. Reporting on the State of the Environment assumes a baseline knowledge of the extent and quality of a resource (habitat, species assemblage or individual species) is available to monitor changes. This can only be acquired by repeated surveillance of the whole or a representative subset of the resource.

The NCC undertook a number of strategic surveys of the invertebrate fauna of particular habitats in particular regions in the 1980s. In the 1990s, little centrally organised invertebrate survey was undertaken, other than for single species under Species Recovery. Smaller surveys have frequently been directed by Local Teams towards assessing the fauna of individual sites, but sometimes in isolation from comparative information.

Prioritising and resourcing strategic survey

There is a clear need for various programmes of strategic survey, identified elsewhere in this framework, delimiting and assessing the quality of particular assemblages of invertebrates across specific habitats both throughout the UK and within specific geographical regions or Natural Areas. Priorities are for survey information on assemblages of invertebrates associated with habitats which are considered to be under-represented within conservation sites with the objective of conserving key representative sites. Resources for strategic survey need to be collated from a number of partners with similar objectives in understanding a particular assemblage associated with a habitat type.

Prioritising and resourcing Strategic Survey

There is a need to identify priorities for survey of key invertebrate habitats and assemblages in England. Intensive survey should be undertaken, where possible, in partnership in order to pool resources.

Survey methodology

EN invertebrate specialists are constantly asked to advise on the planning and methodology for survey for invertebrates by colleagues and external bodies and individuals. Guidance on methodology for survey and analysis techniques for invertebrate conservation is not widely available and yet is essential in establishing best practice and getting best value for money. Encouraging and facilitating others to undertake survey and to pool data increases our knowledge of species' range and status and the contextual base against which to examine all invertebrate data. It also develops and increases the expertise available to undertake survey. Measures that can facilitate others to undertake invertebrate survey and disseminate the results are potentially a valuable and cost-effective way of increasing the knowledge base. A start has been made in the provision of this guidance (Drake in prep).

Invertebrate Survey Handbook

EN should complete an invertebrate survey handbook which should then be published and actively marketed.

Surveillance & monitoring invertebrates

In order to assess the conservation status of most habitats, it is necessary to measure the performance through time of at least some of their component species, including invertebrates. It is also desirable to monitor individual rare species in order identify trends in abundance to trigger action in the event of serious decline.

Invertebrates have considerable potential as indicators of various qualities of habitats in ecological monitoring and reporting on the state of the environment. A high degree of specialization, annual life cycles and high intrinsic rate of increase mean that some are able to respond rapidly, positively or negatively, to environmental change and the existence of species with either very low powers of mobility or good colonization abilities means that, considered together, they can be sensitive ecological indicators of a variety of environmental variables.

One group, the butterflies, has been regularly monitored for many years through a nationally coordinated scheme, the Butterfly Monitoring Scheme, which enables trends in species abundance at individual sites to be assessed against national trends across a network of sites across the country. Similar long-term trends in the populations of moths are monitored in a network of light traps throughout the country coordinated by the Rothamstead Experimental Station.

Challenges in monitoring invertebrates

However, most invertebrates present particular challenges in monitoring because of:-

- huge species diversity - there may be 100s or 1000s of species, including many species of conservation concern, within a habitat on a site.
- the large number of priority species that occur in England.
- their small size and secretive nature - some species seldom leave their specialist niches, some of which don't lend themselves to easy sampling.
- the lack of any non-destructive sampling methods for some vulnerable microhabitats.
- the inherent variability of their populations - very large daily, seasonal, annual and spatial fluctuations may obscure and conceal long-term trends in status.
- their response to the vagaries of the weather and season may prevent monitoring in some conditions and times of year.

- the tendency of most trapping techniques to collect large quantities of non-target organisms as well as those being monitored, necessitating very time-intensive primary sorting of samples.
- the specialist nature of the techniques in sampling, identifying and quantifying invertebrate species populations, coupled with the low availability of expertise in these areas.

Taken together, these challenges mean that realistic monitoring able to achieve significant information on trends is likely to be both expensive and highly labour-intensive and the potential of some species and species groups as indicators of environmental quality may not be realised within the near future. The populations of a good proportion of priority species, including those listed under BAP and HSD, may of necessity remain unmonitored in the immediate future, save for occasional surveillance of their presence or absence.

However, the UK has an obligation under the H&SD to set up a monitoring strategy for each of the listed species and most SAPs suggest that species be monitored. Neither HSD nor BAP currently delimit what level of monitoring is necessary in order to fulfill the obligations and commitments and Lead Partners and steering groups are currently unclear as to what constitutes acceptable levels of monitoring. In the absence of generic guidance, Lead Partners should be encouraged to determine the monitoring needs of their own projects. For many species, this may be as simple as periodic confirmation of the continuing presence of a species, coupled with monitoring the continuing suitability of its habitat. Monitoring of invertebrates poses considerable difficulties and realistic monitoring protocols need to be devised for BAP-listed species.

Monitoring of HSD & BAP-listed Species

A review is necessary of the realistic possibilities for monitoring of HSD & BAP-listed species.

Research is needed on monitoring of key species, possibly as one or more combined projects on invertebrate monitoring rather than piecemeal for each species. Such research should also investigate the practicability and desirability of alternatives to monitoring the populations of the species themselves.

Appropriate protocols for monitoring are needed by Lead Partners and/or the steering group of BAP projects. Programmes for monitoring those priority species considered practicable should be set up within implementation of individual SAPs & SRPs.

In 1999, in a project to address monitoring needs laid out in both SAPs for saproxylic species and the HAP for Lowland Parkland and Wood-pasture English Nature English Nature has initiated a PhD studentship with the Birmingham University to develop non-invasive monitoring techniques for saproxylic species and to use these methods to investigate barriers to dispersal by these species.

Monitoring features of importance for invertebrates

With the difficulties identified above, alternative strategies need to be sought in order fulfil our obligations and commitments and to ensure the conservation of priority species. An alternative is to monitor the quantity/quality of habitat features identified as necessary for priority invertebrate species, providing a validated relationship can be shown between the

availability of the microhabitat and the performance of the particular species (JNCC, 1998, English Nature, 1999a). This will necessitate autecological research on priority species and will necessarily be a long term process as work on them is initiated and comes to fruition.

In this way, aspects of the quality of particular habitats of a broader spectrum of invertebrates may be identified and monitored to assess their continuing suitability to support scarce and typical species. Examples are the development and use of methods for quantifying trends in the availability and quality of dead wood available for saproxylic species, and estimates of the 'cover' of appropriate bare ground in various habitats to provide nesting, basking and hunting territories.

Habitat Feature Monitoring

A pilot project is needed to investigate the routine monitoring of invertebrates' (micro)habitats and validate this against the performance of individual species as part of habitat monitoring for implementation of the BAP HAPs and site quality monitoring of some SACs and SSSIs.

Monitoring of invertebrates as SSSI features

One particularly important aspect of monitoring of invertebrates is in the assessment Favourable Conservation Status of SACs and SSSIs. For SACs, guidelines have already been produced covering each of the species on the H&SD Annexes (English Nature 1999b). These have concentrated largely on assessing the features of particular importance to the particular species, rather than for the populations of the invertebrates themselves.

However, for SSSIs where species-rich groups (invertebrates, lower plants etc) are specifically mentioned on SSSI citations, it is impractical to produce FCS guidelines for individual species as was done for the H&SD listed species, perhaps other than perhaps a tiny handful of high-profile ones with very highly demanding needs that may conflict with other objectives on sites. For the invertebrates, with 237 BAP-listed species and over 2000 Red Data Book and Nationally Scarce species which might be included on citations - these cannot realistically be dealt with individually, either by the specialists writing them or the Local Team staff who would need to integrate them for an individual site.

Therefore what are needed are generic guidelines for the assessment of FCS for features of importance for whole groups of species characteristic of each habitat type important for each species group (probably roughly equivalent to the BAP broad habitat categories). Ideally these guidelines would be thoroughly integrated with the guidelines on the assessment of FCS for vegetation communities already produced by habitat specialists as part of the overall assessment of FCS for that habitat type, but these are already available and in use (English Nature 1999b). Separate guidelines to supplement these are therefore under preparation.

Invertebrate identification literature to assist survey and monitoring

A number of target groups to assess the conservation status of some habitats have already been identified (Drake in prep), but the potential for some groups of invertebrates to be used in this way is hampered by the lack of adequate identification literature. An illustration of this is the upsurge in recording of the hoverflies (Syrphidae) and their now routine use in site evaluation which resulted from the publication of a user-friendly identification guide (Stubbs, 1983). Species at risk are almost certainly being overlooked through lack of recording resulting from the lack of good identification literature.

Examples of groups with inadequate or out-of-print identification guides are bugs, most beetles, solitary bees, various parasitoid wasp groups and centipedes.

A number of identification guides for some of these groups have been near completion for a number of years, prepared by professional and amateur specialists and their final publication hampered by lack of resources or lack of encouragement.

Many identification works have recently been produced in Europe, most notably in Spain, Germany, France, Italy and Scandinavia, sometimes covering the whole European fauna including most or all British species. Some of these are in English and translation and republishing others under licence would produce very good guides to the British fauna.

Identification Literature

Organizations that are able to produce good identification literature (eg Field Studies Council, Royal Entomological Society, Ray Society, Natural History Museum and the specialist societies) need encouragement and facilitation of the publication of identification literature useful for conservation purposes.

Licensed translation of literature in other languages should be considered.

Sources of grant aid and/or sponsorship to facilitate the above should be investigated.

Major Issues in Invertebrate Conservation

Ecological processes and human activities inevitably impact on invertebrate populations, either on the invertebrates themselves, or in ways different from their impact on other organisms. This may necessitate action specifically targeted towards solving the problems they pose for invertebrates while integrating those action with ones targeted to achieve other conservation goals.

Information on which to base assessment and mitigation these impacts is often inadequate. There is need both to review existing knowledge in some of these areas and to undertake research to determine the importance of their effects and develop mitigation methods if necessary. Research may concentrate on the autecology of representative species that may elucidate ecological principles, or on a synecological approach to groups of species sharing a similar habitat but with differing ecologies.

Research into Invertebrate Conservation Issues

We need to seek partnership with academia and other research institutes. Influence should also be sought with the funding policies of the research councils to support applied conservation research on invertebrates.

Fragmentation of sites and the colonization abilities of invertebrates

All invertebrates must be able to disperse during some phase of their life-cycle and they often follow linear shelter features to cross open areas. Hedges, road verges, streams etc may have a vital function enabling invertebrates to disperse and outbreed. Although some invertebrates are very efficient dispersers, these tend to be common and widespread species of little conservation concern. Anecdotal evidence points to the poor ability of some species to colonise new areas of suitable habitat. These are often restricted to special sites with a long

continuity of management conditions and such species have little prospect of being able to move between sites or into the wider countryside.

Fragmentation and isolation of habitat are therefore likely to be a major factor reducing the survival of populations by preventing dispersal and colonisation. Although there is circumstantial evidence of the effects of fragmentation and isolation, there have been few detailed studies of its effect and we have little knowledge of the processes involved, or methodology for mitigating their effects.

Groups of invertebrates thought to be especially sedentary and thus at risk are:

- flightless species
- saproxylic species associated with ancient trees
- wetland and woodland molluscs
- post-glacial relict faunas
- some semi-colonial bees and wasps
- some phytophagous species including some butterflies that tend to form small, discrete populations.

English Nature English Nature is currently funding a PhD studentship with the Birmingham University with the objective of investigating barriers to dispersal by saproxylic species.

The theory has been put forward that the tendency or ability to disperse may have become selected against in a fragmented landscape, and that some populations may now be genetically predisposed against mobility. Isolated populations are also thought more likely to lose genetic variability and become less adaptable and vulnerable both to habitat change and inbreeding.

Habitat Fragmentation and Species' Mobility

Research is needed effort into the dispersal abilities of selected groups of organisms, concentrating on factors triggering and limiting colonisation events that may be open to manipulation by conservation managers.

Research should be targeted on the effects of barriers to dispersal such as roads bisecting sites, progressing to landscape-scale problems.

Further research should be undertaken into genetic variability and viability of populations and the benefits and dangers of assisting gene flow between populations.

Climate change

The various models of climate change may have differing impacts on the populations of invertebrates as diverse as total extinction of species, changes in dispersal behaviour and geographical range, and natural and man-assisted colonization of Britain by species with different climatic requirements from elsewhere in Europe and the rest of the world. Depending on what direction climate change takes, faunas at particular risk may be our upland boreo-montane fauna, our East Anglian and Southern English wetland faunas or our Lusitanian and temperate Atlantic fringe faunas. Faunas which may benefit include southern thermophilic species, especially those associated with heathland, dry grassland and open woodland/scrub, or possibly again our upland boreo-montane fauna.

Certain species of invertebrate are potentially very sensitive to climate shift and may prove to be very valuable trend indicators. There is already evidence for expansion of range of some highly thermophilic species such as the bee-wolf *Philanthus triangulum* and oak jewel beetle *Agrilus pannonicus* and the phenology of some species has been shown to be shifting towards earlier emergence of adults in the spring.

Climate Change

We need to identify what can realistically be done to mitigate effects of climate change on invertebrates. Research into changes in land management might help maintain populations of vulnerable species and it may be necessary to investigate provision of corridors to facilitate species to move to areas that become more suitable via ELMS.

Alien & invasive species particularly affecting invertebrates

A number of alien invasive species regularly threaten the habitats of scarce native invertebrates. For example, rhododendron *Rhododendron ponticum* endangers at least three BAP-listed species; the ladybird spider *Eresus sandaliatus*, the Lundy cabbage flea beetle *Psylliodes luridipennis* and the violet click beetle *Limoniscus violaceus.* Himalayan balsam *Impatiens glandulifera* are a threat to whole communities of riparian and wet woodland invertebrates including BAP-listed species associated with exposed river sediments, while New Zealand pygmyweed *Crassula helmsii* and floating fern *Azolla carolinensis* threaten aquatic communities in scarce and vulnerable habitats.

New Zealand & Australian flatworms *Artiposthia spp,* have decimated northern populations of earthworms, about which remarkably little is known of their conservation status and which are also likely to change pasture productivity and vegetation dynamics.

Chemical or physical control of all of these alien species is slow, expensive and remarkably ineffective. All of them offer significant threats to other wildlife and economic interests.

Some of these species, including four species of alien invertebrate, are listed under Schedule 9 of the 1981 W&CA, (Appendix 3) but little, if any, use of that part of the Act has ever been applied other than for crayfish species.

In 2000 English Nature initiated a project looking at the impact of alien species on wildlife.

Any or all of these alien species may be vulnerable to biological control using invertebrate or other organisms native to their countries of origin. However, no serious attempt has been made to investigate biological control of any of them and, moreover, there is little culture of the use of biological control against aliens for conservation purposes in Britain, although such methods are widely used in other countries. However, such methods are not without risk of further ecological harm and any proposed programmes of biological control will need to be subject to rigorous screening.

Problems with Invasive Alien Species

Communication with institutes familiar with evaluation of biocontrol agents is needed to assess likely success against alien species that pose conservation problems to invertebrates and risks attached to their use. Policy is needed on the control of alien species and on the use of biocontrol agents.

Predators & diseases introduced as biocontrol agents

There is a constant trickle of proposals for the use of alien biocontrol agents against crop and livestock pests. These vary from well-researched, ultra-low risk proposals from responsible companies and research institutes to hare-brained schemes with wide-spectrum predators or diseases which could easily naturalise and have unpredictable effects on native species. DETR consult widely over these proposals, including Country Agency specialists and JNCC.

Research into non-native and novel forms of bacterial and viral diseases has been targeted at pest species of invertebrates in Britain This is an area of considerable concern. Escape of such diseases into the wild or hybridization or other form of gene transfer to other wild invertebrate diseases has considerable implications for populations of native invertebrates. In the event such a disease leading to the decline of scarce species, it is unlikely that the cause of their decline could either be discovered or anything done to remedy it. Considerable resources might be put into research on ecology and habitat management of a species that is in fact declining because of a new disease.

Release of Non-native Biocontrol Agents, including Microbes

It is important that the DETR consultation procedure continues in order to minimise the risk to our native fauna and flora.

Genetically modified organisms

Three forms of genetically modified organisms have particular implications for the conservation of invertebrates.

- bacterial or viral diseases genetically modified for virulence, targeted towards invertebrate pest species.
- crop plants genetically modified to produce compounds toxic to plant-feeding invertebrates as a form of pest control
- crop plants genetically modified for tolerance to herbicides to enable eradication of weeds among the crop

There has already been one instance of a controversial release of a viral disease targeted at invertebrate an pest species: a disease with low specificity, genetically modified for virulence by the incorporation of a gene to produce a toxin derived from scorpions, into an area adjacent to an SSSI of known importance for scarce invertebrates closely related to the target pest species. The arguments for caution are similar to those outlined above for non-native disease species, with the added caveat that novel diseases are likely to be even more unpredictable in their behaviour.

The genes for the production of the toxic agent derived from the commonly used insect bacterial pathogen *Bacillus thuringiensis var israelensis* (Bti) have been incorporated into a number of crop plants, including potatoes, corn and oilseed rape. Again, escape of these genes into wild populations of related species of plants might confer competitive advantage to individuals possessing them with implications for the populations of their associated entomofauna. As an example of a fauna at risk, Lundy Cabbage *Coincya wrightii* is not distantly related to oilseed rape and supports one confirmed endemic plant-eating insect and possibly two others. Transference of Bti toxin genes to this plant could have considerable implications for this fauna. Dustings of pollen of Bti engineered corn has also been shown in the laboratory to be toxic to lepidopterous larvae on unrelated weed species.

The implications of crop plants modified to be resistant to herbicides are more indirect but nonetheless significant to the invertebrate fauna of farmland in the potential completely to eradicate weed foodplants and important structural elements in their habitat such as cover-producing leaf rosettes. There are obvious potential knock-on effects for other insectivorous organisms, notably birds, mammals and other invertebrates.

Genetically Modified Organisms

It is important that invertebrate conservation specialists be consulted over any proposals and policies for on the release of GMO diseases targeted at any species of invertebrate and that invertebrate biologists play a full role in the assessment of GMO trials of entomotoxic and herbicide resistant crops.

Veterinary products toxic to invertebrates

Concern has repeatedly been expressed over the use of veterinary products, especially but not exclusively the avermectins, including ivermectin, against parasites of livestock. (eg Cox, 1999). This leads to the production of toxic faeces which may threaten dung-dependent organisms and possibly aquatic organisms where dung enters the water. The subject is controversial and there is no consensus of opinion on the threat posed. As a result of this concern, the National Trust has recently discontinued the use of certain such chemicals on its land holdings.

Nevertheless, there are at least two BAP-listed dung-dependent insects, the Beaulieu dung beetle *Aphodius niger* and hornet robber fly *Asilus crabroniformis,* and two aquatic crustaceans, the tadpole shrimp *Triops cancriformis* and fairy shrimp *Chirocephalus diaphanus,* (both listed on Schedule 5), as well as a large number of other coprophilous and aquatic organisms which may be at some risk from these chemicals. Horseshoe bats and the chough have been identified as being potentially indirectly at risk from these chemicals through the loss of dung-feeding invertebrate prey.

A disproportionate number of these vulnerable species occur in the New Forest SSSI/SAC, where there have recently been proposals to introduce/ increase the use of such products.

Grazing agreements on SSSIs and nature reserves with external graziers on conservation land may inadvertently or unknowingly bring toxic substances into sites. There is also pressure to ensure that stock is treated against parasites for animal welfare reasons.

Veterinary Products Excreted in Dung

There is a need for multidisciplinary research into the long and short-term effects of these chemicals on all aspects of biodiversity a differing spatial scales. More knowledge is needed on the pattern of use of these chemicals and ways to assess and, if necessary, minimise risks to biodiversity developed.

In the interim period, the use of these chemicals in the New Forest should be minimised.

Light pollution

Many insects are night-flying and are attracted to point sources of light, including many moths, the stag beetle *Lucanus cervus*, lesser silver water beetle *Hydrochara caraboides* and others, some of which are listed on BAP or are in other priority categories. While flying around light, they are subject to high levels of predation by bats and cats and their normal

nocturnal activities, including feeding and breeding, are disturbed. Developments adjacent to conservation sites may involve the inclusion of new lighting and invertebrate specialists have been asked to advise on its likely impact. Certain light spectra (eg sodium lighting) seem to be less attractive than others (eg mercury lighting) to insects. There is, however, virtually no information on the actual effects of light pollution on the populations of night- flying insects.

Effects of Light Pollution on Priority Species

There is need for research on the impact of various types of outdoor lighting on night-flying invertebrate populations in order more realistically to assess the impact of development proposals. Its implications should be disseminated to conservation bodies and planning departments.

Ex situ invertebrate conservation

There has been an increasing tendency towards the use of captive rearing in invertebrate conservation, either to maintain insurance populations of species, to bulk up populations for re-release to an original site or for establishment at different sites, or as an act of desperation to try and prevent a species from going extinct at least by maintaining it in captivity. There has been a varying level of success with these strategies, ranging from some degree of success with, for example, the field cricket *Gryllus campestris* to complete loss of the breeding colony as with the Essex emerald moth *Thetida smaragdaria.*

Concerns have been expressed over the possible effects of parasites and diseases, acclimatization and desensitization to disturbance on the suitability of captive reared stock as the basis of re-establishments. For example, there have been problems with diseases/parasites established in a captive population of the wart-biter *Decticus verrucivorus*, preventing their subsequent use as establishment stock. There may also have been inbreeding and/or genetic selection towards the conditions of captivity and loss of variability in the fitness of captive bred stock for establishment of wild populations. For example, a long-standing captive population of large copper *Lycaena dispar* has been shown to have almost no genetic variability and has proved incapable of persisting in the wild. It is also thought that inbreeding finally led to the extinction of the last captive population of Essex emrald moth *Thetida smaragdaria.*

The Terrestrial Invertebrate Taxon Advisory Group (TITAG) of the Federation of Zoological Gardens is a key partner in a number of projects under BAP and the Species Recovery Programme. They have considerable expertise in the maintenance of captive populations of invertebrates and have important links with zoos throughout the UK and overseas.

The Role of Captive Breeding & Rearing

The role of captive populations in conservation establishments needs to be examined and guideline procedures drawn up. Research areas need to be defined and research undertaken in areas of concern.

Translocations and (re-)establishments

Translocations of individual species, areas of habitat and materials that form invertebrate microhabitat are increasingly being undertaken, both as pro-active conservation measures to enhance populations of threatened species and to "rescue" populations and habitats destined to be destroyed by development pressure. Some species of invertebrate have populations which are so fragmented that natural dispersal is now unlikely to be sufficient to counter the impacts

leading to their extinction. Artificial establishments may therefore be a necessary process to encourage establishment of more and viable populations.

Caution is necessary, however as there are a number of problems associated with translocations and establishments to assist in nature conservation:-

- stock of unknown or unsuitable genetic origin may be used which may enter the genotype of an indigenous population remaining at the translocation site or nearby.
- many 'unofficial' undocumented releases have and continue to be made to sites which may or may not be ecologically suitable.
- undocumented attempts at establishment may mask a downwards trend in a species status, especially if a colony is continually reinforced by introduction of additional stock.
- it tends only to be the larger, showier species which are usually translocated in 'rescue' exercises. Many smaller, potentially scarcer species that co-exist with these may be equally threatened but are not similarly moved.
- success in 'rescue' translocations of the showier species may be used as precedents in order to argue for the translocation of other populations to allow destruction of sites, leading to complacency by planners and ecologists and an overall loss in biodiversity.

It is important both to understand the degree to which translocations and establishments are already being undertaken for the purposes of invertebrate conservation and the degree of success which is being achieved. There have been a number of attempts to maintain registers of such translocations and establishments (eg Oates & Warren, 1990), none of which appear to have been maintained and information on the success of individual schemes collated to give an overview of the usefulness or otherwise of this procedure in conservation.

The JNCC have prepared a draft policy on species translocations (McLean, 1997) which addresses some of these issues.

Understanding the results of establishments

The successes and failures of establishments should be monitored in order to assess the usefulness of this procedure in conserving populations of invertebrates.

Collecting

There is a long history of insect collecting in Britain. As a result, museums in Britain have the largest collections of natural science heritage of any country in the world. Many of the standard reference works were written by authors who began their interest as collectors and the maintenance of a reference collection remains essential for the proper study of most invertebrates. There is no evidence to suggest that collectors have ever reduced a thriving population to the point of extinction, although collectors have probably hastened the extinction of declining populations and may possibly be a threat to recovery, re-establishment and restoration programmes. The remaining populations of some of the more 'desirable' species can no longer sustain the level of collecting that once occurred. Controls, such as 1981 W&CA, may have deterred some, but it is known that some illegal collecting of vulnerable species still occurs.

Protection under Schedule 5 of the 1981 W&CA is largely aimed to deter collectors and dealers from reducing fragile populations of target species. It also offers limited protection against destruction of habitat.

However, protection also has the negative effects of:

- encouraging 'last-minute' collecting of species known to be about to receive protection.
- discouraging study of invertebrates by amateur specialists through licensing bureaucracy and worries about prosecution.

During the discussions on the previous two Quinquennial Reviews the argument was put forward by some consultees that *all* invertebrate collecting should be licensable, and that blanket bans be applied to collecting some groups of invertebrates - notably butterflies. This situation already prevails in some member states of the EU and serves only to stifle research, Invertebrate conservation scientists do not regard such action as desirable and it would impede the study and recording of invertebrates in Britain, while not protecting the invertebrates from factors that really threaten them.

Some conservation organizations have shown a resistance to allowing invertebrate biologists to remove any specimens from reserves, even for conservation research purposes, or restrict trapping or sampling methods such as suction samplers or water traps. These restrictions are usually unjustified and impede important study of invertebrates, including conservation research. Young naturalists, potentially the conservation entomologists of the future, are often discouraged from making a collection, often on misinformed conservation or ethical grounds.

Collecting

Illegal collecting of protected species should be discouraged, and prosecutions pursued when appropriate.

There is need for informed debate about responsible collecting of invertebrates. Understanding of the need for collecting specimens should be promoted, and young naturalists should not be discouraged from serious study which may involve making a collection.

Trade in invertebrates

Trade in British species involves largely the more popular groups, mainly butterflies, larger moths and a few large beetles for collections, educational or decorative purposes. Specimens are sold either as livestock or as pinned or papered specimens. There are a number of annual trade fairs and a number of mail-order dealers as well as a society dedicated towards livestock rearing. Collecting for trade usually involves either the removal of gravid females for the collection of eggs and rearing in captivity and consequent sale of living larvae or dead adults or the removal, usually of freshly emerged adults, from the wild for sale as specimens. Subsequent generations of livestock derived from wild-caught females, including their immediate progeny, are not considered to be covered by the 'protection with respect to sale' provisions under Schedule 5 of the 1981 W&CA and this represents a loophole in the provisions of the act.

Trade in exotic species involves large, colourful or spectacular specimens from live millipedes through spiders and scorpions to dead goliath and rhinoceros beetles and a host of tropical butterflies and moths. Certain of these species are covered by CITES legislation, such as the

apollo and birdwing butterflies, and invertebrate specialists are sometimes asked to assist HM C&E officers in species identification. At least some illegal trade in protected species is known to occur and there have been prosecutions, involving EN invertebrate specialists as expert witnesses. Dealers are currently unclear about what is and is not illegal trading and there is a lack of adequate guidance on this.

Trade in truly captive-bred stock is, in itself, not a threat to conservation although the release of such stock into the wild may cause genetic complications or temporarily unbalance parasite or predator/prey equilibria.

Monitoring of trade in protected species is an essential measure of the impact of trading on wild populations. Summary statistics on the level of licensed trade are needed as currently there is no knowledge of the level of trade.

Trade in Protected Species

There is a need for an overview of the level of licensed trade in protected species to monitor the effectiveness of the legislation in achieving appropriate control.

Guidelines to enable dealers to remain within the law are also needed.

Licensing Advice

Invertebrate specialists are regularly consulted by DETR, JNCC and EN about the issuing of licenses for trade, scientific research and release of animals into the wild, relating mainly to species listed under Schedule 5 of the W&CA. There also is a demand from the police and HM Customs & Excise for an expert advisory and witness service. Investigations centre on illegal collecting and trade in protected species. Police Wildlife liaison officers have little knowledge of invertebrate issues and are frequently unable to identify protected species.

Advice on Protected Species

Invertebrate specialists should continue to advise on licensing issues on Schedule 5 species and provide advice and expert witness to the law enforcement agencies.

There is need for training of PWLOs, HMC&E officers &DETR inspectors on protected species, and for guidance on the recognition of possibly protected species of invertebrates.

Communicating invertebrates and their conservation

For invertebrate conservation to progress, there needs to be continual communication between those working in the subject area, with the wider conservation world and also with the general public. Although there has been considerable progress in recent years, some invertebrate issues remain relatively very poorly understood and they are often an undervalued area within conservation. Invertebrates are still sometimes either ignored or are a belated afterthought of many nature conservation projects. The conservation of invertebrates is a vast subject and no small group of specialists is able to deal with all its aspects.

International communication

All EU member states are required to undertake conservation measures and monitoring of species listed on the H&SD and considerable work is being undertaken on invertebrate

conservation elsewhere in Europe and further afield. Currently there is remarkably little communication over what work member states are doing, either about ongoing work and expertise, or of published material. Such contact as has already occurred has proved extremely useful in enabling selection of some internationally scarce species for BAP and identifying the requirements of some H&SD and BAP-listed species. Not only do we in England have much that we may learn from work being undertaken in mainland Europe, but also the work done here has the potential to influence conservation in Europe.

Meetings such as the European Congress of Entomology are useful to initiate and maintain contacts but resources are too scarce for frequent meetings with invertebrate conservation workers elsewhere in the world. However, e-mail and the Internet obviously have the potential to enable regular contact in this area. In 1991 a European Society of Entomology was set up and attempted to initiate a European conservation group, based on an e-mail bulletin board. This initiative foundered, however, probably through lack of adequate coordination.

1999 the basis for an international groups concerned with the conservation of saproxylic invertebrates was started at a conference in Östergötland, Sweden and a collaborative follow-up meeting is planned in England in 2001.

International Communication

Greater communication is needed over HSD & BAP listed species with other European workers in invertebrate conservation by the establishment of a pan-European electronic bulletin board on invertebrate conservation, with links to work being undertaken elsewhere.

UK invertebrate specialists should be encouraged to attend and contribute to occasional international conferences relevant to invertebrate conservation in order to make and maintain contacts.

Communication within the UK

Communication with the UK entomological community

Most invertebrate recording and much ecological knowledge is generated by amateur entomologists who are frequently the recognised national experts. They are the main people who can be expected to undertake research, survey and conservation work, including on BAP-listed species. Contracted-out survey and conservation work has enabled a number of amateur entomologists to become semi or fully professional and now undertake much of the work on EN's invertebrate Species Recovery projects.

EN also capitalises on the enthusiasm of amateur recorders to carry out entomological survey of areas suggested by Local Teams staff who, together with central support team specialists, have organised residential recording meetings which provide very extensive invertebrate recording, sometimes equivalent to strategic survey. However, contact between statutory agency specialists and the entomological community has become reduced in recent years, with less frequent attendance at entomological conferences and field/exhibition meetings etc. Such work is time-intensive, but it is important to maintain contact with other workers in the field.

Communication with the Invertebrate Biological Community

Country Agency specialists should maintain their contact with the wider amateur and professional entomological community attending occasional conferences and amateur recording and exhibition events.

Formal and informal societies clubs and recording groups exist for the study of invertebrates from a number of groups. These undertake various levels of conservation activity and they meet twice annually under the aegis of the Joint Committee for the Conservation of British Invertebrates, on which each of the statutory agencies has an observer.

This organization has recently put forward a proposal for the formation of an invertebrate conservation trust (with 'Buglife' as a working title) to undertake a larger coordinating role, particularly in assisting the implementation of BAP for invertebrates. This has generated considerable debate over the value of forming a separate organization against encouraging greater consideration of invertebrate conservation issues by existing organizations.

Coordination of Invertebrate Conservation Activity

There is continual need for coordination of invertebrate conservation work between specialist study societies, the statutory agencies and the VCOs at national and local level.

In 1999 English Nature scoped a coordinator post to facilitate communication between the invertebrate societies and recording schemes and with the conservation agencies and organizations. A memorandum of intent between English Nature and the Natural History Museum has been set up, covering both invertebrates and lower plants, and an invertebrate coordination post will be recruited, based at the Natural History Museum, in 2000.

Communication within English Nature and between the Country Agencies

The Inter-agency Invertebrate Forum (IAIWG) is a very small forum composed of the invertebrate specialists from each country agency meeting annually to discuss areas of mutual concern and to influence the strategic direction of specialists' work programmes.

EN Local Team staff are being called upon to undertake invertebrate conservation projects on BAP-listed species. LTs have variously delegated responsibility for such work to Species Officers, Natural Area Officers, County Officers and Site Managers. Although a small number have considerable invertebrate conservation skills, most are uncertain as to how to proceed with projects and properly call upon the invertebrate specialists for advice.

Networking Invertebrate Work in English Nature

There is a need for an internal invertebrate communication network composed of invertebrate specialists, Local Team officers with invertebrate conservation skills, and Local Team staff responsible for invertebrate conservation projects. This, together with the IAIWG should influence the strategic direction of invertebrate conservation in EN.

Communication with academic and other research institutions and museums

Certain universities, other educational establishments and research institutes have the potential to become centres of excellence in invertebrate conservation research. Leeds University has taken on the Lead Partner role for a suit of invertebrate species under BAP and instigated a PhD studentship to progress the species' research needs, and Birmingham Unversity is developing its expertise in invertebrate conservation genetics and saproxylic invertebrates. Teaching input on invertebrate conservation by agency invertebrate specialists to masters courses on biodiversity and conservation has also been undertaken, influencing course content and informing and enthusing the next generation of conservation ecologists about invertebrate issues.

A limitation on further involvement by other similar institutions in conservation is often the relatively very high cost of such research resulting from the high overhead costs charged by some of these organisations in comparison with that undertaken by private individuals and consultants. The very large number of priority species of invertebrates and relatively small resources available for this area of work precludes initiation of many more similar cooperative ventures. Research councils have not traditionally prioritised pragmatic research on practical conservation problems very highly and the likelihood of funding for ivertebrate conservvation fellowships and studentships seems to be low. However, the high quality of work of such organizations makes cooperative work with them and the research councils a high priority.

Working with Universities and Research Institutions

There is need further to develop ways of working with institutions with good expertise in invertebrate ecology and with the research councils.

Communication with the wider conservation community and the provision of training

The need for communication between HAP and SAP projects, and between national and local projects aimed to deliver BAP targets has been discussed above.

The need to develop and maintain invertebrate expertise is constant as conservation staff work their way through the system, new staff are recruited and additional organizations start to address their conservation responsibilities, particularly under BAP. EN staff, local authority ecologists, conservation/site management staff from VCOs, country park rangers, ecological consultants etc are in the position of having to make decisions over the future of sites which will impinge considerably on the populations of invertebrates, often with inadequate knowledge of invertebrate issues.

The provision of invertebrate conservation training for members of national and local BAP/HAP steering groups could help considerably in achieving the desirable level of integration between HAPs and SAPs.

Between 1984 and 1993, an 'Invertebrate Roadshow' was taken around the country by the Terrestrial Invertebrate Zoology Branch staff of the NCC and subsequently by EN Species Branch and JNCC specialists to a total of 78 events over 9 years, usually hosted by a County Wildlife Trust or local authority. This was enormously influential in alerting over 2500 conservation management staff, countryside rangers, planners etc to the theory and practicality of management for the needs of invertebrates and led directly to the publication of the basic work on the conservation of invertebrates, the JNCC/RSPB/NP book *Habitat Management for Invertebrates - A Practical Handbook* (Kirby, 1992), which provides practical guidance for site managers. This has been out of print since 1995, although a reprint is planned for 2000.

Whilst no internal training course on Invertebrate Conservation has been available in EN since 1991, its invertebrate specialist staff have undertaken half-day training seminars for Local Teams on request.

Since the Roadshow, agency specialists have contributed widely to training events and courses organised externally, particularly by the National Park study centres and the RSPB, on which there has often been a number of English Nature staff participating both as trainers and trainees. RSPB, with EN specialist staff assistance are progressing a series of training events for their own staff, while the need for the wider provision of training has recently been identified as a priority by the JCCBI and CABI Bioscience International.

Experience has shown that training courses benefit if groups of trainees are from mixed backgrounds, leading to better information exchange and understanding of problems and solutions.

Invertebrate Conservation Training

There is continual need proactively to encourage training in the identification and management of habitat features of importance for invertebrates of conservation for land management staff of all organizations concerned with conservation land management.

In particular, training in invertebrate conservation should be targeted for members of National HAPs and Local BAPs

Events should ideally be run in partnership between organizations to encourage cross-fertilization of ideas.

Species Conservation Handbook

There is valuable information in the notes within the invertebrate sections of the Species Conservation Handbook (English Nature, 1994) and considerable potential to increase the influence of this work. There are also other areas of invertebrate conservation which could usefully be covered by additional information notes. The Species Conservation Handbook will be eventually be distributed via EN's Intranet and external Web site. This will considerably add to the potential audience that the information will reach.

Species Conservation Handbook

EN should promote via the Internet the information in the Species Conservation Handbook, which should continue to be added to and updated as necessary.

Dissemination of the results of research & survey projects on invertebrates

EN has commissioned a considerable number of surveys and research projects investigating all aspects of invertebrate conservation, including recording the occurrence of assemblages of species at conservation sites, impact assessments, single species surveys and detailed studies of conservation ecology. This has produced a wealth of data, a significant proportion of which has been disseminated only for the specific purpose for which it was collected.

These studies would be of potential use to a wider audience, ranging from local records centres to other ecologists working in this field. Standard research and survey contracts from English Nature now stipulate that all data generated by the projects should be provided in a form compatible with the NBN and EN is committed to inclusion of its data holdings within the NBN.

Dissemination of Research Results

Unpublished significant reports and datasets on invertebrates currently held EN centrally and locally should be identified disseminated as appropriate via 'English Nature Research Reports' and/or made available to the NBN.

Due consideration, however, needs to be paid to the confidential nature of some of the information.

Invertebrate conservation and the World Wide Web

Of the huge amount of invertebrate information currently available across the Internet, most of the information on invertebrate conservation concerns North American species and projects. However, there is an increasing amount of information on the European and UK fauna including the recording schemes and specialist societies and there are various web bulletin boards concerning aspects of the UK invertebrate scene upon which various conservation related issues are regularly raised. The Web pages of a numerous NGO conservation organizations occasionally include information on invertebrate conservation projects in which they are involved.

There remains, however, considerable potential for the use of the Web to publicise invertebrates and their conservation issues amongst conservationists and the wider web-aware population. The web is increasingly the medium by which younger people access information of interest. It is therefore not only desirable, but vitally important that information on all aspects of invertebrate conservation be made available via the Web and its access monitored.

The World Wide Web

Promotion and dissemination of invertebrate conservation issues should increasingly utilise the WWW in order to gain greater currency, particularly among younger people.

Communicating invertebrates with the wider world - publicity

Invertebrates are little understood by members of the wider public and yet invertebrate conservation issues have the potential to capture very positive media attention by using their accessibility and bizarre life cycles. Recent media publicity regarding, for example, the ladybird spider, rare bumble-bee project, field cricket, Lundy cabbage flea beetle and violet click beetle Species Recovery projects has enabled EN to get its message over regarding heathland, agriculture, alien species and veteran tree conservation issues very effectively to audiences that would be otherwise difficult to reach.

Input to the 'Countryside Hour' & 'Langley Country' series (both on BBC2 TV), together coming to over an hour of air time on invertebrates, and to the Natural History Programme (BBC Radio 4) has influenced the messages that these programmes put over to include more on invertebrate conservation issues.

There is considerable potential to expand the coverage of invertebrate conservation issues in the media and the subject lends itself to production of a self-contained TV programme or series. Positive feedback from the media has already been received on such a concept.

EN specialists have also acted as a contact point, putting the media in touch with other invertebrate projects. Together, these have given English Nature very positive exposure and stimulated further interest among the media and the general public in this aspect of the conservation of biodiversity.

Publicity

Publicity is a continuing area of work which should be maintained. We should continue to identify and target positive publicity opportunities to promote invertebrate conservation & EN's role in the work and to pursue the possibility of dedicated TV coverage of this subject area.

Photographs of invertebrates
While invertebrate conservation issues have intrinsic appeal in promoting conservation issues, the specialist nature of invertebrate macrophotography means that few conservation workers have access to appropriate images for publication, exhibition or lecturing.

EN invertebrate specialists have an extensive collection of transparencies of invertebrates and contacts who have similar libraries. EN currently operate a loan service for photos of invertebrates and their conservation and loans average around 450 images per year, about 40% to EN, the remainder to a very wide variety of users, in particular to the published media. We are frequently asked for suggestions for the most appropriate species to use to illustrate a particular issue and can therefore influence the conservation message that goes out.

In 1996 English Nature produced, in partnership with the Amateur Entomologists' Society, the first of two invertebrate conservation transparency packs, which was distributed to all EN conservation teams and marketed externally by the AES. This was very favourably received, selling out within a month of issue and was reissued by the AES in 1999. It had the result of reducing internal demand in EN for pictures for lecturing by over 50%. An additional pack covering additional habitats is to be produced in 2000 in collaboration with the AES and Farming and Wildlife Advisory Group.

The ARKIVE project, initiated by the BBC and the Wildscreen project at Bristol aims to make images of species of conservation concern available across the Internet and it is planned that the NBN will connect into this image source. EN has already provided some invertebrate images for this and anticipates provision of more.

Invertebrate Images

EN should continue to offer the photographic loan and information service directly and via the ARKIVE project and collaborate on the production of further slide packs.

The future for invertebrates - making things happen

In this document we have suggested a host of developments for the furtherance of invertebrate conservation in England. There are far more suggested developments of existing and new areas of work than ourselves at English Nature or any other single organization could hope to address. English Nature will continue to play a major part in progressing invertebrate conservation in England, but our intension is both to promote existing and new ideas that may be taken on by other organizations and individuals and to stimulate communication and cooperation on this subject between all organizations involved in wildlife conservation and land management in England.

A range of other organizations in England include invertebrate conservation in their core work, notably Forest Enterprise, the Environment Agency, the Royal Society for the Protection of Birds and the Wildlife Trusts, all of whom have dedicated considerable staff and financial resources to invertebrates as do a number of the national and provincial museums. Butterfly Conservation, of course, has been dedicated to the conservation of one group of invertebrates since its inception and now has a wider remit to include the whole of the Lepidoptera. There is also the possibility of the inception of a new 'Buglife' Trust dedicated to the conservation of all invertebrates in the UK.

The need for yet further activity, however, inevitably raises the question of future resources available for invertebrate conservation. Whilst levels of funding are higher now than they have ever been (English Nature has made available more than £500,000 directly available for invertebrate conservation in 2000/2001, the highest amount ever to date, largely a result of the focus placed on invertebrates in the BAP) there are whole areas where new work is proposed and where there are currently no dedicated resources.

So far, perhaps with a few exceptions, individual projects on the conservation of invertebrate species under SRP and other projects have proved remarkably cheap. This is largely because much of the work has been undertaken by amateur specialists, working as full or part-time consultants, often at low rates and without the overheads that are inherent to university and research institute projects. However, it is often only those projects that are still in the early, pre-recovery phase, when work is concentrating purely on survey and relatively superficial ecological observation, that can be undertaken as small projects. Later research stages of at least some may necessitate research methods and expertise only found in research institutes and universities and these are likely to be much more expensive. Moreover, this framework has identified the need for a number of wider, systematic strategic survey projects and major research projects aimed to elucidate underlying principles.

There is need, therefore to increase yet further the resources available for the conservation of invertebrates in England. Research Council funding is needed for university conservation research projects on invertebrates, with perhaps some shift of emphasis to accommodate pragmatic conservation research as well as research into general ecological principles. Relatively little commercial sponsorship (species 'champions') has so far been directed towards invertebrates and there is considerable potential in using the publicity opportunities afforded by invertebrates to attract sponsors. There is, however, a need to spend resources to attract more. Leverage funding has the potential to bring in more resources and attract new organizations to become involved in invertebrate conservation.

Activity in invertebrate conservation is now at a higher level than it has ever been. Of course it needs to be yet higher, but the subject now has its own momentum and we have left behind its years as a Cinderella area within nature conservation.

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References

BALL, S.G. 1986. Terrestrial and freshwater invertebrates with RDB, notable or habitat indicator status. *Invertebrate Site Register Reports.* **66**. Nature Conservancy Council. Peterborough.

BRATTON, J.H. (ed), 1991. *British Red Data Books: 3. Invertebrates other than insects.* Joint Nature Conservation Committee. Peterborough.

COMMON GROUND, 2000. *Orchards and Wildlife. Proceedings of a Common Ground/English nature Conference. Much Marcle & Ledbury. 22-23 Sept 1999.* Common Ground. London.

COX, J. 1999. The nature conservation importance of dung. *British Wildlife.* **11**. 28-36.

DRAKE, C.M. in prep. *Invertebrate Survey for Site Evaluation.*

DRAKE, C.M., CLEMENTS, D., EYRE, M., GIBBS, D. & KIRBY, P. 1998. Invertebrates and their Habitats in Natural Areas. 2 Vols. *English Nature Research Reports.* **298.**

ENGLISH NATURE, 1994. *Species Conservation Handbook.* English Nature. Peterborough.

ENGLISH NATURE, 1999a. The implementation of common standards for monitoring and conservation objectives. *Monitoring and Reporting Paper.* English Nature. Peterborough.

ENGLISH NATURE, 1999b. National specialist guidance for conservation objectives. I. Annex 1 Habitats & Earth Heritage Features. *Monitoring and Reporting Paper.* English Nature. Peterborough.

EYRE, M. 1998. Invertebrates and the environment: time for a reassessment. *Antenna.* **22.** 63-70.

EYRE, M. & LOTT, D.A. 2000. Records of rare and notable beetle species from riverine sediments in Scotland and northern England. *The Coleopterist.* **9**. 25-38.

FALK, S.J. 1991a. *A review of the scarce and threatened bees, wasps and ants of Great Britain.* Research and Survey Series: 35. NCC. Peterborough.

FALK, S.J. 1991b. *A review of the scarce and threatened flies of Great Britain.* Part I - Research and Survey Series: 39. NCC. Peterborough.

FOWLES, A.P., ALEXANDER, K.N.A. & KEY, R.S. 1999. The Saproxylic Quality Index: evaluating wooded habitats for the conservation of dead-wood Coleoptera. *The Coleopterist.* **8**. 121-141.

GIBSON, C.W.D. 1998. Brown field: red data. The values artificial habitats have for uncommon invertebrates. *English Nature Research Reports.* **273**

HAMMOND, P.M. 1996. *A taxonomic review of possibly endemic non-marine invertebrates.* Natural History Museum. London.

HAMMOND, P.M. 2000. U.K. tachyine beetles (Coleoptera: Carabidae) with special reference to the status of *Tachys edmondsi* Moore. Natural History Museum report to English Nature.

HARDING, P.T. & ROSE, F. 1986. *Pasture-woodlands in lowland Britain: a review of their importance for wildlife conservation.* Institute of Terrestrial Ecology. Huntingdon.

HENSHAW, D.J. & WHITE, I.M. 1997. *Taxonomic review of possibly endemic British Diptera.* Unpublished report from the Natural History Museum to English Nature.

HYMAN, P. & PARSONS, M. 1992. *A review of the scarce and threatened Coleoptera of Great Britain Part 1.* UK Nature Conservation: 3. JNCC. Peterborough.

HYMAN, P. & PARSONS, M. 1994. *A review of the scarce and threatened Coleoptera of Great Britain Part 2.* UK Nature Conservation: 12. JNCC. Peterborough.

JNCC, 1998. A statement on common standards monitoring. JNCC Peterborough.

KEY, R.S. 1994. Invertebrates in England - Introduction. Section Invertebrates 1.1. in English Nature (1994). *Species Conservation Handbook.* EN. Peterborough.

KEY, R.S. 2000. Bare ground and the conservation of invertebrates. *British Wildlife.* **11**. 183-191.

KIRBY, P. 1991. *Habitat Management for Invertebrates: A Practical Handbook.* Royal Society for the Protection of Birds.

KIRBY, P. 1994 Habitat Fragmentation. Species at Risk. Invertebrate Group Identification. *English Nature Research Reports.* **89**. Peterborough.

McLEAN, I.F.G. 1997 *Translocations and biodiversity: a draft policy.* JNCC Discussion document. Unpublished.

MASSEY, M. 1997a. Assessment of NCR/GCR sites against NNR Review priority features. *National Nature Reserves Information Paper.* **2**. English Nature. Peterborough.

MASSEY, M. 1997b. Representation of key species in National Nature Reserves. *National Nature Reserves Information Paper.* **3**. English Nature. Peterborough.

NATURE CONSERVANCY COUNCIL, 1989. Guidelines for Selection of Biological SSSIs.

OATES, M.R. & WARREN, M.S. *A Review of Butterfly Introductions in Britain.* Worldwide Fund for Nature. Godalming.

PENNY, S. & KEY, R.S. 1994. "ENTSCAPE" - Computerized Invertebrate Bibliography. Section Invertebrates 8.3. in English Nature (1994). Species Conservation Handbook. EN. Peterborough.

PIPER, R. & COMPTON, S.G. 2000. Molecular tools to examine putative UK endemic beetles. Unpublished Leeds University Report to English Nature.

RATCLIFFE, D.A. 1977. *A Nature Conservation Review.* 2 Vols. Cambridge University Press.

SADLER, J.P. & PETTS, G.E. 1999 in press. Invertebrates of Exposed River Sediments. *Environment Agency Research and Development Technical Report*

SHEPPARD, D.A. 1994. Species of invertebrate thought to be extinct in Britain. Invertebrates 1.4. in English Nature (1994). *Species Conservation Handbook.* EN. Peterborough.

SHIRT, D.B. (ed), 1987. *British Red Data Books: 2. Insects.* Nature Conservancy Council, Peterborough.

SIMONSON, W. & THOMAS, R. 1999. UK Biodiversity - making the link. English Nature. Peterborough.

SPEIGHT, M.C.D. 1989. Saproxylic invertebrates and their conservation. *Nature and Environment Series.* **42**. Council of Europe. Strasbourg.

STUBBS, A.E. 1983. British Hoverflies. British Entomological & Natural History Society. London.

SWAAY, C.A.M. & WARREN, M.J., 1998. Red Data Book of European Butterflies (Rhopaclocera). Dutch Butterfly Conservation/ Butterfly Conservation.

UK STEERING GROUP, 1995. *Biodiversity: The UK Steering Group Report.* 2 volumes. HMSO. London.

UK BIODIVERSITY GROUP, 1999. *Tranche 2 Action Plans. Volume IV Invertebrates.* English Nature. Peterborough.

UK BIODIVERSITY GROUP, 1999. *Tranche 2 Action Plans. Volume VI Terrestrial and freshwater species and habitats.* English Nature. Peterborough.

Appendix 1. The British non-marine invertebrate fauna

Some explanatory notes

This list is not comprehensive. There are literally hundreds of families of invertebrates, many with only a few, or even a single, species in Britain.

Column 1 - Group. Depending on the size of the `group', this may mean Phylum, Order, Class, Subclass or Family, or some non-scientific term such as `macro-moths'. The `groups' used are ones that invertebrate biologists use for convenience, rather than having any taxonomic consistency.

Column 2 - Number of British Species. In varying degrees of exactness. For the largest groups, only to the nearest 1000 species. For some, such as the Mites or nematode worms there appears to be no source of figures, so the estimate is hearsay only - these are indicated by an order of magnitude guess, indicated thus: N, N0, N00, N,000. Where known, the number of established aliens is added in brackets.

Column 3 - Number of Schedule 5 species. This is given in brackets if the representatives are saline lagoon species. An sterisk denotes species protected with respect only to parts of the Act - ie, with respect to sale or advertisement for sale, or with respect to taking or harming.

Column 4 - Number of RDB (Red Data Book) Species. Lagoon species are bracketed. A dash means that the group was not even considered when RDBs were prepared. A `0' means that they were considered but no species were sufficiently scarce to warrant inclusion.

Column 5 - Review y/n. `y' indicates that NCC or JNCC have produced a Review of the species' status, distribution, management needs etc within that group. A `p' indicates that only part of the group has been reviewed. A bracketed (y) means that a review is in press.

Column 6 - BAP. Number of species included in the UK Biodiversity Action Plan.

	GB Spp	Sch 5	RDB	Review	BAP
PORIFERA					
Sponges	5	-	-	n	0
COELENTERATA					
Hydroids etc	7(+1)	(2)	(2)	n	(2)
PLATYHELMINTHES					
Flatworms Freshwater	13	-	-	n	0
Terrestrial	3(+5)	-	-	n	0
NEMERTEA					
Ribbon worms	2	-	1	n	1
NEMATODA					
Threadworms	N,000	-	-	n	0
NEMATOMORPHA					
Horsehair Worms	4	-	-	n	0
ROTIFERA					
Wheel Animalcules	200+	-	-	n	0
MOLLUSCA					
Gasteropoda					
Snails & slugs	162	2	30	y	8
Bivalvia					
Mussels etc	28	1*	3	y	3
ANNELIDA					
Oligochaeta					
Earthworms	26	-	-	n	0
Other species	140+	-	-	n	0
Polychaeta					
Bristle-worms	?	2	1	n	(1)
Hirudinea					
Leeches	16	1	2	n	1
CRUSTACEA					
Anostraca Notostraca					
Fairy/Tadpole shrimps	2	2	2	-	1
Cladocera					
Water fleas	90	-	-	n	0
Ostracoda	85	-	-	n	0
Copepoda	N00	-	-	n	0
Bathynellacea					
Cave Shrimps	2	-	-	n	0
Mysidacea					
Opossum shrimps	2	-	1	n	0
Isopoda					
Woodlice/hoglice	50	-	2	n	0
Amphipoda					
F/water shrimps	15	-	4	n	(1)
Decapoda					
Crabs & crayfish	1(+6)	1*	-	n	1
MYRIAPODA					
Chilopoda					
Centipedes	40	-	3	n	0
Diplopoda					
Millipedes	52	-	2	n	0
Symphyla	N0	-	-	n	0
Pauropoda	N0	-	-	n	0
INSECTA					
total	20,000+	18+22*	1753	p	220
Collembola					
Springtails	300+	-	-	n	0
Protura	12	-	-	n	0
Thysanura					
Bristletails	9	-	-	n	0
Diplura	12	-	-	n	0
Ephemeroptera					
Mayflies	46	-	4	y	1

	GB Spp	Sch 5	RDB	Review	BAP
Odonata					
Dragon/damselflies	41	1	9	n	1
Plecoptera					
Stoneflies	34	-	2	y	1
Orthoptera					
Grasshoppers/crickets	30	3	6	y	4
Dictyoptera					
Cockroaches	8	-	-	y	0
Dermaptera					
Earwigs	7	-	-	n	0
Heteroptera					
True Bugs	540+	-	79	y	2
Homoptera					
Hoppers/Cicada/Aphids	1150+	1	1+23	p	2
Psocoptera					
Booklice	87	-	-	n	0
Thysanoptera					
Thrips	160+	-	-	n	0
Coleoptera					
Beetles	4000+	2	546	y	87
Carabidae					
Terrestrial Beetles	3900+	0	50	y	75
Water-beetles	260+	0	64	(y)*	12
Strepsiptera					
Stylops	15	-	-	n	0
Neuroptera					
Lacewings etc	60	-	0	y	0
Mecoptera					
Scorpion flies	4	-	0	y	0
Trichoptera					
Caddisflies	199	-	33	y	0
Lepidoptera					
Butterflies/Moths	2500				65
Micro-moths	1500+	-	-	p	1
Macro moths	900+	6	113	y	53
Butterflies	56	3+22	9	n	11

	GB Spp	Sch 5	RDB	Review	BAP
Diptera					
Flies	6000+	0	827	(part)	21
Hymenoptera					
Wasps etc - total	6000+	0	164	p	32
Symphyta					
Sawflies	400+	0	-	n	0
Parasitica					
Ichneumons etc	5000+	0	-	n	0
Aculeates					
Ants/wasps/bees	580	0	164	y	32
Ants	41	0	11	y	8
Solitary Wasps	230+	0	50	y	7
Social Wasps	10	0	1	y	0
Solitary Bees	230	0	63	y	12
Bumblebees	25	0	1	y	5
ARACHNIDA					
Scorpionidea					
Scorpions	(1)	-	-	n	0
Pseudoscorpionida					
False Scorpions	21	-	2	n	0
Araneida					
Spiders	620+	2	86	y	6
Acarina					
Mites & Ticks	2,000+	-	-	n	0
Phalangida					
Harvestmen	22	-	0	n	0
TARDIGRADA					
Bear Animalcules	74	-	-	n	0
BRYOZOA					
Moss Animals	14	(1)	1	n	1

Appendix 2. Species occurring in England listed on E.U. Habitats & Species Directive and Berne Conventions

	EC Directive Annex(es)	Bern Conv App	W&C Act Schedule
INVERTEBRATES			
Natural range includes GB			
Austropotamobius pallipes	IIa, Va	III	5 (taking & sale)
Lucanus cervus	IIa	III	5 (taking & sale)
Limoniscus violaceus	IIa		5
Eurodryas aurinia	IIa	II	5
Coenagrion mercuriale	IIIa	II	5
Margaritifera margaritifera	IIa, Va	III	5
Vertigo angustior	IIa		
V. genesii		IIa	
V. geyeri		IIa	
V. moulinsiana	IIa		
Hirudo medicinalis	Va	III, II	5
Extinct			
Oxygastra cuitsii	II, IVa	II	
Graphoderus bilineatus	IIa, IVa	II	
Cerambyx cerdo	IIa, IVa	II	
Extinct but re-established			
Lycaena dispar	II, IVa	II	5
Maculinea arion	IVa	II	5
Vagrant			
Parnassius apollo	IVa	II	
Danaus plexippus	(Bonn Convention Appendix II)		
Proserpinus proserpina	IVa	II	
Established aliens			
Helix pomatia (probably ancient introduction)	Va	III	
Astacus astacus	Va	III	9
Callimorpha quadripunctata	*IIa		

Appendix 3. Species occurring in England listed on Schedules 5 & 9 of 1981 Wildlife & Countryside Act

Schedule 5 - Protected Species

Scientific name	English name	Sections of Act	Year scheduled cited where complete protection is not afforded
Butterflies			
Apatura iris	Purple emperor	Sale only S.9(5)	1989
Argynnis adippe	High brown fritillary		1992 (previously sale only)
Aricia artaxerxes	Northern brown argus	Sale only S.9(5)	1989
Boloria euphrosyne	Pearl-bordered fritillary	Sale only S.9(5)	1989
Carterocephalus palaemon	Checkered skipper	Sale only S.9(5)	1989
Coenonympha tullia	Large heath	Sale only S.9(5)	1989
Cupido minimus	Small blue	Sale only S.9(5)	1989
Eurodryas aurinia	Marsh fritillary		1998 (previously sale only)
Erebia epiphron	Mountain ringlet	Sale only S.9(5)	1989
Hamearis lucina	Duke of Burgundy fritillary	Sale only S.9(5)	1989
Hesperia comma	Silver-spotted skipper	Sale only S.9(5)	1989
Leptidea sinapis	Wood white	Sale only S.9(5)	1989
Lycaena dispar	Large copper		1998 (previously sale only)
Lysandra bellargus	Adonis blue	Sale only S.9(5)	1989
Lysandra coridon	Chalkhill blue	Sale only S.9(5)	1989
Maculinea arion	Large blue		1981
Mellicta athalia	Heath fritillary		1981
Melitaea cinxia	Glanville fritillary	Sale only S.9(5)	1989
Nymphalis polychloros	Large tortoiseshell	Sale only S.9(5)	1989
Papilio machaon	Swallowtail		1981
Plebejus argus	Silver-studded blue	Sale only S.9(5)	1989
Strynwnidia pruni	Black hairstreak	Sale only S.9(5)	1989
Strymonidia w-album	White-letter hairstreak	Sale only S.9(5)	1989
Thecla betulae	Brown hairstreak	Sale only S.9(5)	1989
Thymelicus acteon	Lulworth skipper	Sale only S.9(5)	1989
Moths			
Acosmetia caliginosa	Reddish buff		1981
Bembecia chrysidiformis	Fiery Clearwing Moth		1998
Hadena irregularis	Viper's bugloss		1988-1998
Gortyna borelii	Fisher's Estuarine Moth		1998
Pareulype berberata	Barberry carpet		1981
Siona lineata	Black-veined		1981
Thalera fimbrialis	Sussex emerald		1992
Thetidia smaragdaria	Essex emerald		1981
Zygaena viciae	New Forest burnet		1981
Beetles			
Chrysolina cerealis	Rainbow leaf beetle		1981
Curimopsis nigrita	Mire pill beetle	Damage/destruction of place of shelter/protection S.9(4)(a) only	1992
Graphoderus zonatus	Water beetle		1992
Hydrochara caraboides	Lesser silver water beetle		1992
Hypebaeus flavipes	Moccas Beetle		1992
Limoniscus violaceus	Violet click beetle		1988
Lucanus cervus	Stag Beetle	Sale only S.9(5)	1998
Paracymus aeneus	Water beetle		1992
Bugs (Hemiptera)			
Cicadetta montana	New Forest cicada		1988
Crickets			
Decticus verrucivorus	Wart-biter		1981
Gryllotalpa gryllotalpa	Mole cricket		1981
Gryllus campestris	Field cricket		1981
Dragonflies			
Aeshna isosceles	Norfolk aeshna		1981
Coenagrion mercuriale	Southern Damselfly		1998
Spiders			
Dolomedes plantarius	Fen raft spider		1981

Eresus sandaliatus	Ladybird spider		1981
Crustaceans			
Austropotamobius pallipes	Atlantic stream (white-clawed) crayfish	Taking S.9(1) (part); sale S.9(5)	1988
Chirocephalus diaphanus	Fairy shrimp		1988
Gammarus insensibilis	Lagoon sand shrimp		1988
Triops cancriformis	Apus		1988
Sea-mats			
Victorella pavida	Trembling sea-mat		1988
Molluscs			
Caecum armoricum	De Folin's lagoon snail		1992
Catinella arenaria	Sandbowl snail		1981
Margaritifera margaritifera	Pearl mussel	Killing & injuring S.9(1) (part)	1991
Myxas glutinosa	Glutinous snail		1981
Paludinella littorina	Lagoon snail		1992
Tenellia adspersa	Lagoon sea slug		1992
Worms (Annelida)			
Alkmaria romijni	Tentacled lagoon-worm		1992
Armandia cirrhosa	Lagoon sandworm		1988
Hirudo medicinalis	Medicinal leech		1988
Sea anemones and allies			
Edwardsia ivelli	Ivell's sea anemone		1988
Nematostella vectensis	Starlet sea anemone		1988

Schedule 9 - Release into the Wild Prohibited

Artiposthia triangulata	New Zealand Flatworm
(Australoplana sanguinea	Australian Flatworm)*
Astacus astacus	Noble Crayfish
Astacus leptodactylus	Turkish Crayfish
(Eriocheir sinensis	Chinese Mitten Crab)*
Pacifastacus leniusculus	Signal Crayfish

* proposed 1998

Appendix 4. Terrestrial & freshwater invertebrates listed on the UK Biodiversity Action Plan

Species with individual or grouped Action Plans (ones not occuring in England *italicised*)

	Contact Point	Lead Partner	EN SRP Project	
Bryozoa	**Moss Animals**			
Lophopus crystallinus	a moss animal	EA	tbd	
Mollusca	**Slugs, sanils & bivalves**			
Anisus vorticulus	a ramshorn snail	EA	EA	✔
Catinella arenaria	sandbowl snail	EN	EN	✔
Margaritifera margaritifera	freshwater pearl mussel	SNH	SNH/EA	✔
Myxas glutinosa	glutinous snail	EA	EA	✔
Pisidium tenuilineatum	an orb mussel	EA	EA	✔
Pseudanodonta complanata	depressed river mussel	EA	EA	✔
Segmentina nitida	shining ramshorn snail	EA	EA	✔
Vertigo moulinsiana	Des Moulin's whorl snail	EN	EN	✔
Vertigo angustior	a whorl snail	CCW	CCW	✔
Vertigo genesii	a whorl snail	SNH	SNH	✔
Vertigo geyeri	Geyer's whorl snail	CCW	CCW	✔
Annelida	**Segmented Worms**			
Hirudo medicinalis	medicinal leech	SNH	RSPB	✔
Insecta	**Insects**			
Plecoptera	**Stoneflies**			
Brachyptera putata	a stonefly	SNH	TBD	
Odonoata	**Dragonflies**			
Coenagrion mercuriale	southern damselfly	EA	WT	
Orthoptera	**Grasshoppers & Crickets**			
Decticus verrucivorus	wart-biter cricket	EN	CABI	✔
Gryllotalpa gryllotalpa	mole cricket	EN	NHM/EN	✔
Gryllus campestris	field cricket	EN	NHM/EN	✔
Stethophyma grossum	large marsh grasshopper	EN	CABI	✔
Hemiptera	**Bugs**			
Cicadetta montana	New Forest cicada	EN	FE(NF)	✔
Coleoptera	**Beetles**			
Bidessus unistriatus	a water beetle	EN	BBC	
Agabus brunneus	a water beetle	EA	BBC	✔
Amara famelica	a ground beetle	EN	tbd	
Anisodactylus poeciloides	a ground beetle	EA	tbd	
Anostirus castaneus	a click beetle	EN	tbd	
Aphodius niger	Beaulieu dung beetle	EN	EN	✔
Bembidion argenteolum	a ground beetle	EHS	EHS	
Byctiscus populi	poplar leaf roller	EN	Leeds Univ	
Carabus intricatus	blue ground beetle	EN	EN	✔
Cathormiocerus britannicus	Lizard weevil	EN	EN	✔
Cicindela germanica	cliff tiger beetle	EN	EN	✔
Cicindela hybrida	northern dune tiger beetle	EN	EN	✔
Cicindela sylvatica	heath tiger beetle	EN	EN	✔
Cryptocephalus coryli	hazel leaf beetle	EN	Leeds Univ	✔
Cryptocephalus exiguus	Pashford leaf beetle	EN	WT	✔
Cryptocephalus nitidulus	a leaf beetle	EN	Leeds Univ	✔
Cryptocephalus primarius	a leaf beetle	EN	Leeds Univ	✔
Cryptocephalus sexpunctatus	a leaf beetle	EN	Leeds Univ	✔
Curimopsis nigrita	mire pill beetle	EN	WT	
Donacia aquatica	a reed beetle	EN	SNH	
Donacia bicolora	a reed beetle	EN	BBC	
Ernoporus tiliae	bast bark beetle	EN	FE	
Gastrallus immarginatus	a wood boring beetle	EN	CABI	✔
Gnorimus nobilis	noble chafer	EN	PTES	✔
Graphoderus zonatus	spangled water beetle	EN	EN	✔
Harpalus froelichi	a ground beetle	EN	WT	
Helophorus laticollis	a scavenger water beetle	EN	FE(NF)	
Hydrochara caraboides	lesser silver water beetle	EN	BBC	✔

Hydroporus rufifrons	a water beetle	EN	BBC	
Laccophilus poecilus	a water beetle	EN	BBC	✔
Limoniscus violaceus	violet click beetle	EN	EN	✔
Lucanus cervus	stag beetle	EN	PTES	✔
Malachius aeneus	scarlet malachite beetle	EN	EN	✔
Melanapion minimum	a small weevil	EN	Leeds Univ	
Melanotus punctolineatus	a click beetle	EN	tbd	
Oberea oculata	a longhorn beetle	EN	NT	
Pachytychius haematocephalus	gilkicker weevil	EN	tbd	
Panagaeus cruxmajor	crucifix ground beetle	CCW	CCW/EN	✔
Paracymus aeneus	Bembridge beetle	EN	BBC	✔
Procas granulicollis	creeping corydalis weevil	CCW	CCW	
Psylliodes sophiae	flixweed flea beetle	EN	WT	
Pterostichus aterrimus	*a ground beetle*	EHS	EHS	
Pterostichus kugelanni	Kugelann's ground beetle	EN	FE(NF)	
Rhynchaenus testaceus	a weevil	EN	tbd	
Stenus palposus	a rove beetle	EHS	EHS	
Synaptus filiformis	a click beetle	EA	tbd	
Tachys edmondsi	Edmond's ground beetle	EN	EN	
joint action plan for:		CCW	EA	
Perileptus areolatus	a ground beetle			
Bembidion testaceum	a ground beetle			
Lionychus quadrillum	a ground beetle			
Bidessus minutissimus	a water beetle			
Hydrochus nitidicollis	a scavenger water beetle			
Thinobius newberyi	a rove beetle			
Meotica anglica	a rove beetle			
Lepidoptera	**Butterflies & Moths**			
Butterflies				
Hesperia comma	silver-spotted skipper	EN	BC	✔
Carterocephalus palaemon	chequered skipper	SNH	BC	
Lycaena dispar	large copper	EN	BC/EN	✔
Maculinea arion	large blue	EN	BC/EN	✔
Plebejus argus	silver-studded blue	EN	BC	✔
Lysandra bellargus	Adonis blue	EN	BC	
Boloria euphrosyne	pearl bordered fritillary	SNH	BC	✔
Argynnis adippe	high brown fritillary	EN	BC	✔
Eurodryas aurinia	marsh fritillary	CCW	BC	✔
Mellicta athalia	heath fritillary	EN	BC	✔
Moths				
Acosmetia caliginosa	reddish buff	EN	BC	✔
Aspitates gilvaria gilvaria	straw belle	EN	BC	✔
Athetis pallustris	marsh moth	EN	BC	✔
Bembecia chrysidiformis	fiery clearwing	EN	EN/BC	✔
Catocala promissa	light crimson underwing	EN	BC	✔
Catocala sponsa	dark crimson underwing	EN	BC	✔
Coleophora tricolor	a micro-moth	EN	BC	✔
Coscinia cribraria bivittata	speckled footman	EN	BC	✔
Cosmia diffinis	white-spotted pinion	EN	BC	✔
Cucullia lychnitis	striped lychnis	EN	BC	
Cyclophora pendularia	dingy mocha	EN	BC	✔
Dicycla oo	heart moth	EN	BC	✔
Epione paralellaria	dark bordered beauty	SNH	BC/RSPB	
Eustroma reticulata	netted carpet	EN	BC/NT	✔
Heliophobus reticulata	bordered gothic	EN	BC	✔
Hemaris tityus	narrow-bordered bee hawk	CCW	BC	✔
Hydrelia sylvata	waved carpet	EN	BC	
Hypena rostralis	buttoned snout	EN	BC	
Idaea dilutaria	silky wave	CCW	BC	✔
Idaea ochrata cantiata	bright wave	EN	BC	
Jodia croceago	orange upperwing	EN	BC	
Lycia zonaria britannica	belted beauty	CCW	BC	
Mythimna turca	double line	CCW	BC	
Noctua orbona	lunar yellow underwing	EN	BC	
Oria musculosa	Brighton wainscot	EN	BC	
Pareulype berberata	barberry carpet	EN	BC	✔
Pechipogon strigilata	common fan-foot	EN	BC	✔
Polia bombycina	pale shining brown	EN	BC	✔
Rheumaptera hastata	argent and sable	EN	BC	
Semiothisa carbonaria	netted mountain moth	SNH	BC	
Siona lineata	black-veined moth	EN	BC	✔
Trichopteryx polycommata	barred tooth-striped	EN	BC	
Tyta luctuosa	four-spotted	EN	BC	✔
Xestia rhomboidea	square-spotted clay	EN	BC	

Xylena exsoleta	sword-grass	SNH	BC	
Zygaena loti scotica	slender Scotch burnet	SNH	BC	
Zygaena viciae argyllensis	*New Forest burnet*	SNH	SNH	
Diptera		**Flies**		
Asilus crabroniformis	hornet robber fly	CCW	CCW	✔
Blera fallax	a hoverfly	SNH	RSPB	
Bombylius discolor	a bee fly	EN	EN	✔
Bombylius minor	a bee fly	EN	BENHS	✔
Callicera spinolae	a hoverfly	EN	EN	✔
Chorisima (Psilocephala) rustica	a stiletto fly	EA	EA	
Chrysotoxum octomaculatum	a hoverfly	EN	EN	✔
Doros conopseus (profuges)	a hoverfly	EN	EN	✔
Dorycera graminum	a fly	EN	EN	✔
Eristalis cryptarum	a hoverfly	EN	EN/DNP	✔
Hammerschmidtia ferruginea	a hoverfly	SNH	RSPB	
Lipsothrix ecucullata	a cranefly	EN	SNH	
Lipsothrix nervosa	a cranefly	EN	CCW	
Lipsothrix nigristigma	a cranefly	EN	EN	✔
Odontomyia hydroleon	a soldierfly	CCW	CCW	
Spiriverpa (Thereva) lunulata	a stiletto fly	CCW	EA	
Thyridanthrax fenestratus	a bee fly	EN	BENHS	✔
Hymenoptera	**Ants, Wasps & Bees**			
Ants				
Anergates atratulus	dark guest ant	EN	EN/ACG	
Formica aquilonia	Scottish wood ant	SNH	FC	
Formica rufibarbis	an ant	EN	EN/ACG	✔
Formica exsecta	narrow-headed ant	SNH	SNH/WT	✔
Formica nigricans/pratensis	meadow ant	EN	EN	✔
Formica candida	bog ant	CCW	WT	✔
Wasps				
Cerceris quadricincta	a solitary wasp	EN	EN/ACG	✔
Chrysis fulgida	a rubytail wasp	EN	EN/ACG	
Cerceris quinquefasciata	5-banded Digger Wasp	EN	EN/ACG	✔
Homonotus sanguinolentus	a spider-hunting wasp	EN	EN/ACG	✔
Pseudepipona herrichii	Purbeck mason wasp	EN	EN/ACG	✔
Bees				
Andrena ferox	a solitary bee wasp	EN	EN/ACG	✔
Andrena gravida	banded mining bee	EN	EN/ACG	
Andrena lathyri	a solitary bee wasp	EN	EN/ACG	
Bombus sylvarum	shrill carder bee	EN	WWF	✔
Bombus distinguendus	great yellow bumble bee	SNH	RSPB/BWG	✔
Bombus humilis	brown-banded carder bee	EN	EN/BWG	✔
Bombus ruderatus	large garden bumble bee	EN	EN/BWG	✔
Bombus subterraneus	short haired bumble bee	EN	EN/BWG	✔
Colletes floralis	northern colletes	SNH	RSPB/BWG	
Nomada armata	a nomad or mason bee	EN	EN/ACG	
Nomada errans	a nomad or mason bee	EN	EN/ACG	✔
Osmia inermis	*a solitary bee*	SNH	SNH/ACG	
Osmia parietina	wall mason bee	EN	EN/ACG	✔
Osmia uncinata	a solitary bee	SNH	RSPB	
Osmia xanthomelana	a solitary bee	CCW	CCW/ACG	✔
Crustacea		**Crustaceans**		
Triops cancriformis	tadpole shrimp	EN	FE(NF)	
Austropotamobius pallipes	freshwater crayfish	EA	EA	
Araneae		**Spiders**		
Clubiona rosserae	a foliage spider	EN	EN	
Dolomedes plantarius	fen raft spider	EN	EN	✔
Eresus sandaliatus	ladybird spider	EN	EN	✔

Species with Priority Statements

Nemertea	**Ribbon Worms**
Prostoma jenningsi	Jennings' ribbon worm
Insecta	**Insects**
Ephemeroptera	**Mayflies**
Heptagenia longicauda	a mayfly
Hemiptera	**Bugs**
Aphrodes duffieldi	a leafhopper
Hydrometra gracilenta	lesser water measurer
Orthotylus rubidus	a plantbug or grassbug

Coleoptera	**Beetles**
Amara strenua	a ground beetle
Anisodactylus nemorivagus	a ground beetle
Badister collaris (anomalus)	a ground beetle
Badister peltatus	a ground beetle
Bembidion humerale	a ground beetle
Bembidion nigropiceum	a ground beetle
Ceutorhynchus insularis	*a weevil*
Chrysolina cerealis	*rainbow leaf beetle*
Cicindela maritima	dune tiger beetle

Cryptocephalus decemmaculatus	leaf beetle	✔
Dromius quadrisignatus	a ground beetle	
Dromius sigma	a ground beetle	
Dyschirius angustatus	a ground beetle	
Harpalus cordatus	a ground beetle	
Harpalus dimidiatus	a ground beetle	
Harpalus obscurus	a ground beetle	
Harpalus parallelus	a ground beetle	
Harpalus punctatulus	a ground beetle	
Hydroporus cantabricus	a water beetle	
Ochthebius poweri	a small water beetle	
Protapion ryei	*a seed weevil*	
Psylliodes luridipennis	Lundy cabbage flea beetle	✔
Tachys micros	a ground beetle	
Single priority statement for:		
Gnorimus variabilis	a chafer	✔
Lacon quercus	a click beetle	✔
Ampedus nigerrimus	a cardinal click beetle	✔
Ampedus ruficeps	a cardinal click beetle	✔
Ampedus rufipennis	a cardinal click beetle	✔
Megapenthes lugens	a click beetle	✔
Elater ferrugineus	a click beetle	✔
Eucnemis capucina	a false click beetle	✔
Hypebaeus flavipes	Moccas Beetle	✔
Dryophthorus corticalis	a weevil	✔
Lepidoptera	**Butteflies & Moths**	
Butterflies		
Aricia artaxerxes	northern brown argus	
Moths		
Calophasia lunula	toadflax brocade	
Hadena albimacula	white spot	✔
Hydraecia osseola	marsh mallow moth	✔
Lygephila craccae	scarce blackneck	
Minoa murinata	drab looper	
Moma alpium	scarce merveille du jour	
Paracolax tristalis	clay fan-foot	✔
Paradiarsia sobrina	*cousin German*	
Phyllodesma ilicifolia	small lappet	
Polymixis xanthomista	black-banded	✔
Schrankia taenialis	white lined snout	
Scotopteryx bipunctaria	chalk carpet	
Thetidia smaragdaria	Essex emerald	
Trisateles emortualis	olive crescent	
Xestia alpicola alpina	northern dart	
Xestia ashworthii	*Ashworth's rustic*	
Diptera	**Flies**	
Lipsothrix errans	a cranefly	
Myolepta potens	a hoverfly	
Rhabdomastix hilaris	a cranefly	
Tipula serrulifera	a cranefly	
Hymenoptrea	**Ants, wasps & bees**	
Ants		
Formica lugubris	northern wood ant	
Formica rufa	southern wood ant	
Wasps		
Chrysura hirsuta	*a rubytail wasp*	
Evagetes pectinipes	a spider-hunting wasp	
Bees		
Lasioglossum angusticeps	a solitary bee	
Nomada ferruginata (xanthosticta)	a nomad or mason bee	
Araneae	**Spiders**	
Clubiona subsultans	a foliage spider	
Euophrys browningi	a jumping spider	
Uloborus walckenaerius	a cribellate orb web spider	

Species on original BAP long list but not transfered to Priority Species

Mollusca	**snails, slugs and bivalves**
Ashfordia granulata	a snail
Clausilia dubia	a snail
Ena montana	a snail
Gyraulis acronicus	a ramshorn snail
Helicodonta obvoluta	a snail
Helix pomatia	a snail
Lauria sempronii	a snail
Leiostyla anglica	a snail
Limax tenellus	a slug
Lymnaea glabra	a freshwater snail
Monacha cartusiana	a snail
Oxyloma sarsi	a snail
Paludinella littorina	a lagoon snail
Pisidium conventus	a pea-mussel
Pisidium pseudosphaerium	a pea-mussel
Pseudamnicola confusa	a brackish water snail
Sphaerium solidum	a freshwater bivalve
Succinea oblonga	a mud snail
Truncatellina callicratis	a snail
Truncatellina cylindrica	a snail
Valvata macrostoma	a freshwater snail
Vertigo lilljeborgi	a snail
Vertigo modesta	a snail
Diplopoda	**Millepedes**
Chordeuma proximum	a millepede
Chordeuma sylvestre	a millepede
Melogona scutellare	a millepede
Metaiulus pratensis	a millepede
Nanogona polydesmoides	a millepede
Polydesmus coriaceus	a millepede
Trachysphaera lobabta	a millepede
Insecta	**Insects**
Odonata	**Dragonflies**
Aeshna isoceles	Norfolk hawker
Coenagrion hastulatum	northern blue damselfly
Lestes dryas	scarce emerald damselfly
Leucorrhina dubia	white faced darter
Libellua fulva	scarce chaser dragonfly
Oxygaster curtisii	orange spotted emerald dragonfly
Orthoptera	**Grasshoppers & Crickets**
Chorthippus vagans	heath grasshopper
Gomphocerripus rufus	rufous grasshopper
Pseudomogoplistes squamiger	scaly cricket
Plecoptera	**Stoneflies**
Isogenus nubecula	a stonefly
Coleoptera	**Beetles**
Aegialia rufa	a dung beetle
Aepus marinus	a ground beetle
Agabus striolatus	a water beetle
Amara alpina	*a ground beetle*
Ampedus cardinalis	cardinal click beetle
Bagous arduus	a weevil
Bledius furcatus	a rove beetle
Ceutorhynchus verrrucatus	a weevil
Chrysolina crassicornis	a leaf beetle
Ernoporus caucasicus	a bark beetle
Hydrophilus piceus	great silver water beetle
Lebia cyanocephala	a ground beetle ✔
Negastrius pulchellus	a click beetle
Lepidoptera	**Butterflies & Moths**
Butterflies	
Apatura iris	purple emperor
Argynnis paphia	silver-washed fritillary
Boloria selene	small perarl-bordered fritillary
Coenonympha tullia	large heath
Cupido minimus	small blue
Erebia epiphron	small mountain ringlet
Hemearis lucina	Duke of Burgundy
Leptidea sinapis	wood white
Lysandra coridon	chlkhill blue
Melitaea cinxia	Glanville fritillary
Papilio machaon britannicus	swallowtail
Strymonidia pruni	black hairstreak
Thecla betulae	brown hairstreak
Thymelicus actaeon	Lulworth skipper

Moths

Adscita globulariae	scarce forester
Adscita statices	forester
Agrochola haematidea	southern chestnut
Agrotera nemoralis	a micro-moth
Agrotis cinerea	light feathered rustic
Anarta cordigera	small dark yellow underwing
Anarta melanopa	broad-bordered white underwing
Apamea zeta marmorata	the exile
Aplasta ononaria	rest harrow
Apoda limacodes	festoon
Archana algae	rush wainscot
Archanara neurica	white-mantles wainscot
Brachionycha nubeculosa	Rannoch sprawler
Chesias rufata	broom-tip
Clostera anachoreta	scarce chocolate-tip
Coenocalpe lapidata	slender striped rufous
Cossus cossus	goat moth
Cucullia asteris	starwort
Deltote bankiana	silver-barred
Dyscia fagaria	grey scalloped bar
Eilema pygmaeola pallifrons	pigmy footman
Eilema pygmaeola pygmaeola	pigmy footman
Eilema sericea	northern footman
Eilema sororcula	orange footman
Endromis versicolora	Kentish Glory
Epischnia banksiella	a micro-moth
Eriogaster lanestris	small eggar
Eriopygodes embecilla	the Silurian
Eugraphe subrosea	rosy marsh morth
Eupithecia egenaria	pauper pug
Eupithecia extensaria occidua	scarce pug
Gortyna borelii lunata	Fisher's estuarine
Hadena caesia mananii	the grey
Hadena irregularis	viper's bugloss
Heliothis maritima warneckeri	shoulder-striped clover
Heliothis viriplaca	marbled clover
Hemaris fuciformis	broad bordered bee hawk
Herminia tarsicrinalis	shaded fan-foot
Heterogenea asella	triangle
Hypena obsitalis	Bloxworth snout
Idaea contiguaria	Weaver's wave
Idaea degenaria	Portland ribbon wave
Idaea serpentata	ochraceous wave
Leucochlaena oditis	beautiful gothic
Lithostege griseata	grey carpet
Luperina nickerlii gueneei	sandhill rustic
Luperina nickerlii leechi	sandhill rustic
Malacosoma castrensis	ground lackey
Meganola strigula	small black arches
Mythimnia favicolor	Matthew's waiscot
Orgyia recens	scarce vapourer
Pelosia muscerda	dotted footman
Pelosia obtusa	small dotted footman
Perizoma sagittata	marsh carpet
Photedes brevilinea	Fenn's waiscot
Photedes captiuncula	least minor
Photedes extrema	concolorous
Phragmataecia castaneae	reed leopard
Pima boisduvaliella	a micro-moth
Sabra harpagula	scarce hook-tip
Schrankia intermedialis	autumnal snout
Sciota hostilis	a micro-moth
Scopula nigropunctata	sub-angled waves
Scopula rubiginata	tawny wave
Spilosoma urticae	water ermine
Synanthedon scoliaeformis	Welsh clearwing
Syncopacna vinella	a micro-moth
Thalera fimbrialis	Sussex emerald
Zygaena exulans subochracea	Scotch burnet
Zygaena purpuralis caledonensis	transparent burnet
Diptera	**Flies**
Atrichops crassipes	an aquatic snipe fly
Atylotus plebeius	a horsefly
Atylotus rusticus	a horsefly
Bombylius canescens	a beefly
Chrysopilus laetus	a snipefly
Chrysops sepulchralis	a horsefly
Ctenophora flaveolata	a cranefly
Dasyhelea lithotelmatica	a midge
Didea alneti	a hoverfly
Epitriptus (Machimus) cowini	a robberfly
Erioptera bivittata	a cranefly
Eumerus ornata	a hoverfly
Geranomyia bezzia	a cranefly
Gonomyia bradleyi	a cranefly
Laphria flava	a robberfly
Lejops vittata	a hoverfly
Limonia goritiensis	a cranefly
Metasyrphus lapponicus	a hoverfly
Microdon devius	a hoverfly
Molophius pusillus	a cranefly
Nephrotoma quadristriata	a cranefly
Odontomyia angulata	a soldier fly
Odontomyia argentata	a soldier fly
Odontomyia ornata	a soldier fly
Oxycera analis	a soldier fly
Oxycera leonina	a soldier fly
Oxycera terminata	a soldier fly
Oxycera varipes	a soldier fly
Pamponerus germanicus	a robber fly
Pandivirilia melaleuca	a stiletto fly
Parasyrphus nigritarsis	a hoverfly
Pherbellia knutsoni	a snail-killing fly
Pocota personata	a hoverfly
Poecilobothrus ducalis	a dance fly
Solva (Xylomyia) maculata	a fly
Spilogona alpicola	a muscid fly
Stratiomys chamaeleon	a soldier fly
Trichocera maculipennis	a winter gnat
Urophora quadrifasciata	a picture-winged fly
Hymenoptera	**Ants, wasps & bees**
Wasps	
Chrysis pseudobrevitarsis	a ruby-tailed wasp
Crossocerus vagabundus	a digger wasp
Miscophus ater	a digger wsp
Odyneurus simillimus	a mason wsp
Pemphredon enslini	a digger wasp
Bees	
Andrena floricola	a solitary bee
Andrena lepida	a solitary bee
Anthophora retusa	a solitary bee
Colletes cunicularius	a solitary bee
Lasioglossum angusticeps	a solitary bee
Lasioglossum sexnotatum	a solitary bee
Nomada sexfasciata	a solitary bee
Psithyrus rupestris	a cuckoo bee
Crustacea	**Crustaceans**
Armadillidium pictum	a pill woodlouse
Chirocephalus diaphanus	fairy shrimp
Corophium lacustre	a brackish-water crustacean
Crangonyx subterraneus	a freshwater crustacean
Metatrichoniscoides celticus	a woodlouse
Mysis relicta	a freshwater opossum shrimp
Niphargus glenniei	a freshwater crustacean
Niphargus fontanus	a freshwater crustacean
Proasellus cavaticus	a freshwater cave woodlouse
Pseudoscorpionida	**False scorpions**
Dendrochernes cyrneus	a false scorpion
Neobisium carpenteri	a false scorpion
Neobisium maritimum	a false scorpion
Araneae	**Spiders**
Agroecia lusatica	a spider
Alopecosa fabrilis	a wolf spider
Altella lucida	a spider
Apostenus fuscus	a spider
Arctosa (Tricca) alpigena	a wolf spider
Aulonia albimana	a wolf spider
Baryphyma gowerense	a money spider
Callilepis nocturna	a spider
Carorita limnaea	a money spider

Centromerus albidus	a money spider
Dipoena coracina	a spider
Dipoena melanogaster	a spider
Dipoena torva	a spider
Enoplognatha tecta	a spider
Episinus maculipes	a spider
Ero aphana	a spider
Gibbaranea bituberculata	a spider
Hahnia candida	a spider
Hahnia microphthalma	a spider
Haplodrassus soerenseni	a spider
Hyptiotes paradoxus	a spider
Lepthyphantes antroniensis	a money spider
Lepthyphantes midas	a money spider
Maro lepidus	a money spider
Mastigusa (Tuberta) arietina	a spider
Mastigusa) Tuberta macropthalma	a spider
Oxyopes heterophthalmus	a spider
Pardosa paludicola	a wolf spider
Pelecopsis elongata	a money spider
Pellenes tripunctatus	a jumping spider
Pistius truncatus	a crab spider
Porrhomma rosenhaueri	a money spider
Robertus insignis	a spider
Robertus scoticus	a spider
Tegenaria picta	a spider
Theridion pinastri	a spider
Tuberta maerens	a spider
Xysticus luctator	a crab spider

Appendix 5. Abbreviations used in the text

ACG	Aculeate Conservation Group
AES	Amateur Entomologists' Society
AREV	Advanced Revelation (computer database application)
BBC	Balfour-Browne Club
BAP	Biodiversity Action Plan
BC	Butterfly Conservation
BENHS	British Entomological & Natural History Society
BIS	Biodiversity Information System (JNCC)
BRC	Biological Records Centre
BURD	UK Database for Ranking Biodiversity
BWG	Bombus Working Group
CA	Countryside Agency (formerly Countryside Commission)
CABI	CABI Bioscience International
CITES	Convention on the International Trade in Endangered Species
CCW	Countryside Council for Wales
CP	Contact Point
CS	Countryside Stewardship
DETR	Department of Environment Transport & the Regions
DNP	Dartmoor National Park
EA	Environment Agency
ELMS	Environmental Land Management Scheme
EHS	Environment & Heritage Service (Northern Ireland)
EN	English Nature
FE(NF)	Forest Enterprise (New Forest Group)
FC	Forestry Commission
FCS	Favourable Conservation Status
FRCA	Farming & Rural Conservation Agency
GMO	Genetically Modified Organism
H&SD	European Union Habitat & Species Directive
HAP	Habitat Action Plan
IAIWG	Inter-agency Invertebrate Working Group
ISR	Invertebrate Site Register
IST	Information Services Team (EN)
ITE	Institute of Terrestrial Ecology
JCCBI	Joint Committee for the Conservation of British Invertebrates
JNCC	Joint Nature Conservation Committee
LP	Lead Partner
LRC	Local Records Centre
LT	Local Team (EN)
MAFF	Ministry of Agriculture, Fisheries & Food
MRF	Machine Readable Form
NA	Natural Area - or - Nationally Scarce category A
NB	Nationally Scarce category B
NBN	National Biodiversity Network
NERC	Natural Environment Research Council
NHM	Natural History Museum
NGO	Non-governmental Organization
NP	National Park
NT	National Trust
OLD	Operations Likely to Damage (an SSSI)
PDO	Potentially Damaging Operation (formerly OLD)
PTES	People's Trust for Endangered Species
QQR	Quinquennial Review of the 1981W&CA Schedules
RDB	Red Data Book
RDB1	Endangered
RDB2	Vulnerable
RDB3	Rare
RDBI	Indeterminate
RDBK	Insufficiently Known
RES	Royal Entomological Society
SAC	Special Area for Conservation
SAP	Species Action Plan
SMS	Site Management Statement
SOS	Site Objective Statement
SNH	Scottish Natural Heritage
SRP	Species Recovery programme
SR	Species Recovery
UKBG	United Kingdom Biodiversity Group
W&CA	1981 Wildlife & Countryside Act
WGS	Woodland Grant Scheme
WT	Wildlife Trusts

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