Guidelines for the Selection of Biological SSSIs

Part 2: Detailed Guidelines for Habitats and Species Groups

Chapter 20 Terrestrial and Freshwater Invertebrates

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Cover note

This chapter updates and replaces the Invertebrate, Butterfly and Dragonfly Chapters (17a 17b and 17c, 18 and 19) in the Guidelines for the Selection of Biological SSSIs (Nature Conservancy Council 1989). It was prepared by Jon Curson, Jon Webb and David Heaver (Natural England), Michael Howe (Natural Resources Wales), and Athayde Tonhasca (Scottish Natural Heritage), and provides detailed guidance for use in selecting invertebrate sites throughout Great Britain to recommend for notification as SSSIs. It should be used in conjunction with Part 1 of the revised SSSI Selection Guidelines published in 2013 (Bainbridge *et al.* 2013), which details the overarching rationale, operational approach and criteria for selection of SSSIs. The main changes from the previous Invertebrate chapters are:

- the amalgamation of the Invertebrate, Butterfly & Dragonfly sub-chapters into a single Invertebrate chapter – with so much more known about various other invertebrate groups now (contra section 3.3 in the 1989 guidelines), there is no justification in continuing to treat butterflies and dragonflies as special groups;
- section 1 'Introduction': amalgamation of 'British Red Data Books' into the 'Britain's Invertebrate Fauna' sub-section;
- section 1 'Introduction': replacement of 'Invertebrate Site Register' with 'Sources of invertebrate data';
- section 1 'Introduction': addition of the following sections: - 'Assemblages of specialised habitats' and 'Habitat heterogeneity/ mosaics'. These are to reflect current thinking on assemblages and knowledge of various invertebrate groups;
- section 3 'Site selection requirements': addition of 'Representation of international site features' requirement to ensure SSSIs include all coincident international site features, regardless of importance at SSSI level. Also, addition of: 'Species of least concern'. This is to reflect the new IUCN-based status reviews and current thinking on assemblages and knowledge of various invertebrate groups;
- section 3 'Site selection requirements': replacement of 'Representation of rare and scarce species' with the following sub-sections: 'Representation of Nationally threatened species',' Representation of Nationally Rare/Scarce species', 'Species of country conservation priority', 'Species endemic to Great Britain', '(Re)-introductions of threatened species', and 'Species with disjunct ranges and on the edge of their range';
- new section added – Section 4 'Setting SSSI boundaries', designed to cover meta-populations and resources (mosaics and habitat patches); and
- the 'Species assemblage' sub-section has been extensively re-written to reflect our current knowledge of invertebrate assemblages and the move to notifying habitat-based assemblages of invertebrates.

The revised chapter has been subjected to appropriate levels of evidence quality assurance. It is compliant with the JNCC Evidence Quality Assurance Policy 2014, and has been subjected to external peer review by Adrian Fowles, recently retired from Natural Resources Wales.

1 Introduction

With more than 1 million described species worldwide, invertebrates constitute 95% of all animal species and dominate virtually every ecosystem in terms of species richness, biomass and ecological function. As herbivores, predators, parasites, decomposers and prey to vertebrates and other invertebrates, they play a critical role in the functioning of healthy ecosystems. Without them, there would be no soil formation and aeration, a collapse in nutrient recycling, and significantly reduced pest control, pollination and seed dispersal. Despite their importance they have, in the past, often been largely overlooked during the development of conservation planning and biodiversity management strategies. To a certain extent this may still be true although there is now a lot more awareness of the importance of invertebrates to functioning ecosystems than there was a few decades ago.

Developing innovative approaches to studying the taxonomy and ecology of invertebrates, and strategies for monitoring, managing, and conserving them, represents a major challenge. In addition, efforts to conserve invertebrates are severely hampered by a lack of public understanding of the values of invertebrate biodiversity, except for their role in pollination.

It should be noted that the 1989 guidelines contained specific chapters on butterflies and dragonflies. This was because at that time these two groups of insects were relatively well-known and studied, and were also mostly easy to identify in the field (and therefore relatively easy to evaluate as a notified feature of a SSSI). These revised guidelines have abolished separate chapters on butterflies and dragonflies, amalgamating all invertebrates into a single revised invertebrate volume. This is because we now know a lot more about some other groups of insects and there is no scientific basis on which to treat these two insect groups as special cases. Butterfly and dragonfly species will continue to be notified (as will those in other taxonomic groups) as specific interest features where they meet the revised criteria, but dragonfly assemblages will not be notified as interest features in future. It should also be noted that these guidelines, as did the 1989 guidelines, consider terrestrial and freshwater invertebrates, and not marine species.

1.1 Historical perspective

Invertebrates pose distinctive challenges to those working in biological conservation, as there are thousands of species with specialised requirements, and we generally have a limited knowledge of their distribution, status and habitat needs. However, many groups have been extensively studied and there are good datasets for a range of invertebrates such as snails, spiders, butterflies and larger moths, dragonflies, hoverflies, bees, wasps and ants, plus some families of beetles. In many cases, these data are sufficient to detect changes in distribution and status which have occurred in response to habitat loss, improvement and fragmentation, and to climate change.

The increasing availability of good field guides and other identification materials has helped to boost levels of invertebrate recording. However, while many groups are sufficiently distinctive to allow accurate identification of live individuals in the field, many other groups contain large numbers of small, similar species which can be identified only by using a microscope and often only after dissection. This means that the collecting, killing and preserving of specimens are essential for surveying, sampling and studying the great majority of invertebrates. This has alienated some recorders, which has hindered the development of invertebrate conservation.

The steady growth in our knowledge of the British invertebrate fauna, with the publication of new, well-illustrated keys, and the development of over 70 national recording schemes co-ordinated by the Biological Records Centre, has enabled the recording of many groups on a systematic national basis. The publication of distribution atlases, which often include information on the biology and habitat preferences of the species recorded, is one output

from these recording schemes which contributes greatly to our knowledge of the status of individual species.

1.2 Characteristics of invertebrates

Most invertebrates have annual or bi-annual life cycles and, unlike plants, which can have dormant seed or resistant vegetative rootstocks, most also cannot survive adverse conditions or prolonged periods when their habitat is unsuitable. This makes them vulnerable to extinction in isolated habitat patches, including protected sites, if the continuity of their life history requirements is broken even for a short period. In addition, many invertebrates, particularly insects, have complex life histories in which the early stages typically have different needs from the more mobile, reproductive adult stage. Examples include beetles, flies and butterflies which feed on nectar or pollen as adults but have phytophagous (plant-feeding) or saproxylic (feeding on dead or decaying wood or the fungi involved in wood decay) larvae, and dragonflies which are terrestrial as adults and aquatic as larvae.

Most invertebrates are small (less than 10 cm in length), and their body temperature - and hence their activity - is greatly influenced by their micro-climate. Consequently, vegetation structure, as well as floral composition, has a profound effect upon the distribution and numbers of many species. Bare ground or short vegetation enables many insects to bask in sunshine, raise body temperature and become more active. Conversely, longer vegetation and shaded conditions are cooler and provide more humid conditions favoured by species susceptible to desiccation.

Complex life histories and the need for a diverse vegetation structure promote a reliance on habitat mosaics and habitat heterogeneity for many species. Early-successional habitats (bare or sparsely-vegetated substrates) and ecotones (the boundaries where habitats merge, or transitions through habitats - e.g. open water → reedbed → wetland carr) are particularly important to many invertebrates. The importance of such patchy and transitional habitats is often overlooked when selecting sites for more mainstream site conservation purposes which tend to focus on individual habitat examples.

Many invertebrates are highly mobile and can colonise newly available habitats rapidly. Others are sedentary and typically move only short distances, occupying the same sites in highly localised populations year after year. This can apply even to those species which can fly quite strongly, such as the heath fritillary and silver-studded blue, which tend to exist as closed populations with little inter-change between neighbouring sites. Such limited dispersal greatly restricts the ability of these species to re-colonise suitable sites after local extinctions, and habitat continuity is critical to the safeguarding of their populations. Sites with ancient natural and semi-natural habitats and features (e.g. veteran trees) often support populations of such poor dispersers.

Another characteristic of many invertebrates is their degree of specialisation. Some can occupy narrow niches and exploit micro-habitats within, for example, plant seeds or sap runs on mature trees; and others exist as the internal parasitoids of the eggs or later stages of other invertebrates. This enables many species to coexist within a habitat, but it can also mean that the rarest species, which tend to display the greatest specialisation, are vulnerable to local extinction if their precise habitat requirements and life cycle needs disappear. In a situation where habitats are declining and becoming increasingly fragmented, the combination of specialisation and limited powers of dispersal can lead to a reduction in the range and status of many species.

Many species of invertebrates are thought to exist as meta-populations, with spatially-separated populations interacting with one another as a consequence of intermittent dispersal events. As populations, particularly small ones, go extinct, vacant sites are re-colonised by individuals from neighbouring populations experiencing a population boom,

such that the overall meta-population remains stable. As occupied landscapes become increasingly fragmented and suitable habitat patches diminish, extinction rates increase and the meta-population itself can be lost. For species operating at a meta-population level, such as the marsh fritillary *Euphydryas aurinia*, it is often critical to protect all suitable and potentially suitable habitat within a landscape to ensure continued occupancy. The need to designate compound SSSIs is described in Part 1 of the SSSI Guidelines (Bainbridge *et al.* 2013; Section 4.9, p.12). Compound sites may become increasingly important for invertebrates and other taxonomic groups, given the development of the concept of ecological networks which are intended to increase the resilience of isolated sites to pressures such as climate change and fragmentation. In future, a compound SSSI might include all the key sites of a particular semi-natural habitat in a local area, as well as buffer land, linking land and restoration areas which will help to ensure ecological coherence.

Future climate change is likely to have a profound influence on the status and distribution of invertebrate species. Many species appear to have responded to the small-scale temperature rises experienced in recent years, with populations of butterflies such as the brown argus *Aricia agestis*, small skipper *Thymelicus sylvestris* and speckled wood *Pararge aegeria* expanding northwards. Similar expansions have been witnessed in some heteropteran bugs (for example the grass bug *Lygus pratensis)* and solitary bees such as *Andrena flavipes* and *Colletes hederae*. Of more conservation concern are species requiring cooler climates, including the mountain ringlet *Erebia epiphron,* as these are likely to experience significant declines. There are also examples of species that have recently colonised the UK, including the tree bumblebee *Bombus hypnorum,* which colonised in 2001 and has been rapidly expanding its range since then. Although our fauna is always in a state of flux, there is evidence to suggest that such changes have accelerated recently.

1.3 Britain's invertebrate fauna

More than 32,000 insect species have been recorded in Britain, and there are estimated to be many more species within other terrestrial and freshwater invertebrate groups such as the spiders, snails, woodlice, millipedes, centipedes and crustaceans. Additional British species are being discovered every year, mainly in those groups with large numbers of similar species whose identification remains the province of relatively few taxonomic specialists. As our knowledge of the status and distribution of these less well known invertebrate groups improves, the significance of additional habitat features or particular combinations of ecological conditions will continue to be revealed

In addition to these 'macro-invertebrates', there are also large numbers of 'micro-invertebrates' such as mites (about 2,000 species) and nematodes (about 500 species described so far - though the real number is likely to be considerably higher than this), where the current state of knowledge on the ecology, status and distribution of the individual species does not permit any rational conservation strategy to be attempted, apart from the general policy of attempting to conserve the full range of major habitat types within the SSSI series.

1.4 Sources of Invertebrate data

Invertebrate data are collated from a wide variety of sources including in-house databases, Local Biological Records Centres, the National Biodiversity Network, National Recording Schemes, volunteer recorders and the published literature. The country agencies are in the process of producing updated status reviews for as many invertebrate groups as possible, using the standardised IUCN criteria on threat (IUCN 2016). Many have already been published (see reference list; Section 6) and the aim is to produce such reviews for all the main invertebrate groups in Great Britain. These reviews will provide standardised and up to date information on the threatened species within these groups.

1.5 Assemblages of specialised habitats

Some macro- and micro-habitats are of particular importance to invertebrates and may support assemblages of species that can be rare, threatened and specialised. Some, such as exposed riverine sediments, are recognised within the existing habitat guidelines as being important to species but many are not - examples include temporary pools, upper saltmarsh, the high tide litter line, south-facing bare ground, sandy exposures, and unstable/ eroding coastal soft cliffs. As our knowledge of invertebrate ecology increases, so does the potential for the list of important habitats and such a list should never be considered complete. Section 3.10 discusses assemblages in more detail.

1.6 Habitat heterogeneity/ mosaics

Many invertebrates require habitat heterogeneity or a mosaic of habitats. These operate at both the large scale, where habitats such as grassland, scrub and woodland are proximal, and small scale, where a variety of structural and topographical conditions is critical. This is a consequence of many species living in situations which may be classed as transitional between habitat types (ecotones) or because they have a need for different habitat types or conditions at different stages of their life history. Most of the SSSI series has been chosen to represent examples of the major habitat types, with sites supporting habitat mosaics (where the individual component habitats do not qualify for SSSI selection in their own right) having largely been omitted or overlooked. The increasing fragmentation and isolation of many semi-natural habitats poses particular problems for invertebrates which require such habitat mosaics as there is less chance of the various components being available within their dispersal distance. It also diminishes the chances of local movement or colonisation by those invertebrates associated with a single habitat type within the mosaic.

2 National and International importance

Whilst the current and proposed volumes of the European IUCN status reviews do allow comparison with parts of the UK fauna, it remains the case that comprehensive assessments are often hard to achieve; this is due to the lack of consistent recording and data for some parts of the continent. Although Britain's invertebrate fauna is depauperate in terms of the total number of species in most of the major groups when compared to that of mainland Europe, it is generally better documented. There are 58 invertebrate species afforded special protection nationally on Schedule 5 of the Wildlife & Countryside Act 1981 (as amended), plus more than 300 species on Section 41 (England), and nearly 200 species on Section 42 (Wales) of the Natural Environment and Rural Communities Act (2006), plus nearly 400 species in Scotland on the Scottish Biodiversity List of the Nature Conservation (Scotland) Act 2004, listed as being of principal importance for the conservation of biological diversity. N.B. It should be noted that Section 42 is in the process of being revised under new Welsh legislation, and the new list will be known as Section 7. Additionally, there are 15 invertebrate species occurring in Britain that are afforded protection internationally by being listed on Annexes II, IV or V of the European Community (EC) Habitats Directive, and are recognised locally in the Conservation of Habitats and Species Regulations 2010.

As knowledge of invertebrates improves, it is likely that additional species in Great Britain will be recognised as being of international conservation significance. Currently, the dead wood invertebrate faunas of Windsor Forest and the New Forest are regarded as being of international importance, as is the exceptional assemblage of invertebrates on coastal shingle at Dungeness (which includes unique and distinctive subspecies). Other habitats in Britain which support distinctive assemblages of invertebrates that in future may increase in significance include wetlands, heathlands and coastal soft cliffs. However, further studies are required to assess the invertebrate faunas of prime examples of such habitats, both in Britain and abroad, before sites can be evaluated and then designated as being of international importance.

It is important that SSSIs are notified for all the coincident international invertebrate site features where they are present, regardless of their importance at the national level. This is necessary to conserve Special Area of Conservation (SAC) and Ramsar invertebrate features regarding land management changes and operations likely to damage features of special interest, and to maintain overall favourable conservation status.

In addition to the EC Habitats Directive, the Council of Europe has supported several initiatives to conserve threatened invertebrates, including assessments of threatened European bees, non-marine molluscs, butterflies and dragonflies, and saproxylic (dead wood) faunas (http://www.iucnredlist.org/initiatives/europe/publications). The 'Bern' Convention (see B, 3.2.3) includes invertebrates in its appendices, and the 'Ramsar' Convention (see B, 3. 2. 1) has provision for designating sites based on a wide range of wildlife including invertebrates (see C.14, Appendix A). This is evidence of an increased awareness of the need to conserve invertebrates and with greater international co-operation there will be further opportunities to advance invertebrate conservation in Britain in a wider biogeographic context.

3 Site selection requirements

Ideally, site selection for species and assemblages should be based on stable populations that have been resident for at least three years. However, since many threatened species are experiencing severe declines this approach should be used as a guideline only and there may be ample justification for the selection of species and assemblages in unfavourable condition. Advice should be sought from the relevant Country Agency specialist.

3.1 Limitations of site-based conservation for safeguarding invertebrates

Many scarce and threatened invertebrates have populations within SSSIs, but there are some limitations to site-based conservation of invertebrates. For example, while many species occur in highly localised populations indefinitely, many others are highly mobile and opportunistic and can exploit early successional, ephemeral or dynamic habitats; Section 1.2 gives more detail on this. It can be difficult to apply site-based conservation to such species due to their mobility and the rapidly changing habitat. One way could be to select a large area for such species and ensure that rotational management or natural processes always provide suitable habitat for the species concerned. However, in some situations this may mean that a large part of the site is likely to be of non-SSSI quality, for the invertebrates concerned at least, which may cause problems for those unfamiliar with the concept of ephemeral habitats and the special invertebrates which utilise them. If this option is used, the reasoning should be made clear and such rotational management used to accommodate such invertebrate species.

There are also some area-specific difficulties with site-based invertebrate conservation. For example, the richest invertebrate faunas occur in south-east England and there is a general decrease in species richness further north and west. The south-east has seen the most modification of semi-natural habitats and most areas with significant invertebrate assemblages are small and isolated, making them relatively easy to identify and protect. Further north, there are more extensive areas of semi-natural habitat remaining and these may support invertebrate assemblages of considerable interest. Such assemblages may be associated with a variety of habitats that occur extensively over a large area, and these may be difficult to define accurately in terms of a contained site. In such instances, a contained site should be identified that accommodates all the required habitats, even if it does not include the whole area over which they occur.

3.2 Species of Least Concern

Based on current knowledge, it can be assumed that the more common, non-threatened invertebrate species (e.g. IUCN species of Least Concern; IUCN 2016) will occur in viable

populations on sites selected based on habitat representation, or will occur sufficiently widely elsewhere not to need protection by site-based conservation measures. Such species therefore do not need to be represented in the SSSI series as specific notified features (though they may feature as part of an assemblage), and it is the rare, threatened and more specialised invertebrate species that require particular attention.

3.3 Representation of International site features

As noted above (Section 2), all invertebrate SAC features (i.e. those that are listed on Annex II of the Habitats Directive) should be selected in their own right as part of the relevant SSSI interest, even if they would not qualify as notifiable features at the national level. This is to ensure that Annex II species (whether or not they are SAC features) are suitably protected against land management changes and other operations likely to damage said features, and thus to maintain Favourable Conservation Status across their range in the UK.

Where populations of Annex II species occur on non-designated land, such sites should be considered for notification. For species which are also considered rare or threatened (including Nationally Rare/ Scarce species as well as those which are Critically Endangered, Endangered or Vulnerable; IUCN 2016) all sites supporting viable breeding populations should be considered for notification. For widespread Annex II species (those occurring in more than 100 hectads,) up to 15 localities per country may be selected.

Invertebrates forming the principal RAMSAR selection criteria for international site designations must also appear as SSSI features in their own right.

3.4 Representation of Nationally threatened species

All sites that support species assessed as Critically Endangered, Endangered and Vulnerable for Great Britain using IUCN criteria (IUCN 2016) should be considered for notification.

This is based on the critical standards principle in Part 1 of the SSSI Guidelines (Bainbridge *et al.* 2013; Section 4.6, p.11-12; 4.8 p 12). These revised criteria are based on the internationally accepted guidelines developed by the International Union for Conservation of Nature and Natural Resources (IUCN) (IUCN, 2012, 2016) but modified slightly to take better account of British invertebrate ecology and our current understanding of status and distribution. They are an objective assessment of extinction risk as opposed to spatial rarity.

For Critically Endangered, Endangered and Vulnerable species qualifying under criteria B, C and D, all sites should be considered for notification. For species in these three categories qualifying under criteria A and E, up to 15 sites per country may be selected. This is to ensure adequate protection of the species concerned and 15 sites per country will not be required in all cases. The reason for the difference is that species potentially notified only under criterion A (based on decline) or E (likelihood of extinction) may still be widespread and perhaps common in places (e.g. white-letter hairstreak *Satyrium w-album* or V-moth *Macaria wauaria*), making notifying all sites where they occur impractical.

For Near Threatened species near to qualifying under IUCN criteria B, C or D, up to 15 localities per country may be selected to protect the status and current range of these Near Threatened species.

3.5 Representation of Nationally Rare and Scarce species

Nationally Rare species, known or estimated to occur in 1-15 10 km grid squares (hectads) in Britain, should also be represented, where possible, in each Area of Search (AoS) where they occur. If they occur in 15 sites (as opposed to hectads) or fewer in any country, then all sites where such species occur in that country may be selected.

Nationally Scarce species, known or estimated to occur in 16-100 hectads in Britain should also be represented in the SSSI series, and one site per AoS may be selected for this purpose where the species has particular ecological requirements that could be affected adversely by generic habitat management. In other cases, Nationally Scarce species are best conserved as part of an appropriate, habitat-based invertebrate assemblage.

Threatened species (Critically Endangered, Endangered, Vulnerable) take precedence with regard to notification; the inclusion of Nationally Rare/Scarce species is to ensure that such species that are not currently threatened are represented.

3.6 Species of country conservation priority

Locations with large populations of rapidly declining and localised species which are listed in Section 41 (England) or Section 42 (Wales) of the Natural Environment and Rural Communities Act (2006), or are afforded special protection under the Wildlife & Countryside Act 1981 (as amended) (Scotland), and which are poorly covered by SSSIs, should also be considered where notification is an appropriate mechanism for their conservation. It is suggested that up to 15 populations in each relevant country may be selected. N.B. See note on Section 42 (Wales) in section 2 (first paragraph).

3.7 Species endemic to Great Britain

For species/subspecies/races endemic to Britain, up to 15 populations may be selected. The case needs to be made that a distinct genetic species resource exists in Britain which has not been found elsewhere. In the instances where this is met, site selection is appropriate.

3.8 (Re)-introduced populations of threatened species

Sites supporting populations of threatened species that are the result of long-established (re)-introductions should be considered for notification on a case by case basis, following assessment and evaluation using the IUCN criteria.

3.9 Species with disjunct ranges and those at the edge of their range

Where a threatened or Nationally Rare/Scarce species (as defined by the new IUCN guidelines) shows a disjunct range (i.e. has distinct areas of occupancy within its overall British range - such as NW Scotland and Southern England) then each disjunct population should be treated separately and both considered for selection according to the criteria listed above.

Such species occurring at the edge of their British range may be considered for notification on a case by case basis. But species that are currently on the edge of their British range but are expanding their range, or are predicted to do so (for example due to climate change) should not be considered for selection.

3.10 Species assemblages

All sites that support assemblages which are of either national or international importance should be selected.

Sites with assemblages which, because of the nature of the supporting habitat, are scarce and/or poorly represented within the biological SSSI series may all be selected within the AoS. The species within the assemblages may be few, and may show high site fidelity. This would include cave and mine faunas, faunas of aquifers, metalliferous and chemically rich sites, including those of post-industrial origin. These will always be rare within the SSSI series in the UK. Though the sites will be few, the ability to fully understand the range of quality may be hampered by difficulties in sampling. Nevertheless, some attempt should be made to assess the proposed site and its assemblage within a suitable regional or national context.

The 1989 guidelines were keen to promote assemblages, noting that 'the process of analysing species assemblages, combined with assessing the presence of rare species at localities within major habitat types, is likely to provide a sound basis for selecting important invertebrate sites in the future.' These guidelines for notifying assemblages are based on the exemplary site principle, as described in Part 1 of the SSSI Guidelines (Bainbridge *et al.* 2013; Section 4.6, p.11-12; 4.8 p 12).

The country agencies are keen to promote invertebrate conservation by selecting habitat-based assemblages as well as single species. The assemblages are based on ecological coherence, either at a macro-habitat scale (e.g. sand dune, calcareous grassland, woodland) or at a micro-habitat scale (e.g. arboreal canopy, bare ground, caves and mines, aquifers). In England, an online analytical tool for assessing invertebrate interest, known as Pantheon is being developed, which will be instrumental in identifying and assessing nationally important assemblages, both at a macro-habitat and micro-habitat scale. In Wales, assemblages are selected at both the macro-habitat scale (dune, woodland, coastal soft cliff) and the micro-habitat scale (saproxylic, myrmecophile) and nationally important assemblages will be determined by the presence of specialist and threatened species. In Scotland, a similar system will operate to that in Wales, and there will be an emphasis on the micro-habitat scale in defining assemblages within the macro-habitat type.

In each country, sites that are being considered for inclusion of invertebrate assemblages as notified features should be discussed with the relevant invertebrate specialists, to ensure a consistent approach.

Those SSSIs which currently have dragonfly assemblages as notified features will continue to maintain these as notified features, and monitor them as such, at least until they may become re-notified. At such time, any such assemblages would be replaced with an appropriate habitat-based assemblage. Any new SSSIs that are notified using this updated guidance will not have dragonfly (or any other taxonomically limited) assemblages, but will have appropriate ecological assemblages.

Ecological assemblages are collections of invertebrates characteristically associated with a particular environmental factor and/or habitat. Assemblages may be defined in many ways and at different scales and are often not absolute. It is possible to list assemblages by broad habitat types (e.g. phase 1 or priority habitats) such as heathland, grassland or woodland, or by micro-habitats or resources, such as dead wood, bare sand or dung.

Habitat-based assemblages that should be represented in the series are:

- those whose quality is high when compared to similar sites in the same geographical area or AoS. The selected sites will often be associated with large and heterogeneous examples of their supporting habitats;
- those assemblages which are the sole representative within the AoS are eligible for selection if they pass a minimum threshold, as defined by a specialist through expert judgement; and
- where invertebrate quality indices for Great Britain exist, those whose score indicates that the assemblages are of national importance are eligible for notification. Current examples include wood-pasture and parkland, which use various saproxylic indices, such as the Saproxylic Quality Index (Fowles *et al.* 1999) and the revised Index of Ecological Continuity (Alexander, 2004). There are also provisional indices for assemblages on exposed riverine sediments (ERS) and coastal soft cliffs, although these are still in draft and require completion.

4 Setting SSSI boundaries

4.1 Meta-populations

A meta-population is described as a group of con-specific populations that exist at the same time, but in different places, with some level of interaction between individuals of the various populations. It has been determined that some species require conservation at a meta-population level if they are to retain long-term viability.

Such conservation will often result in establishing a complex of archipelago sites containing suitable habitat within dispersal distance of the species. This will require a good ecological knowledge of the species in question and a successful site complex for any given species should consider the following:

- all areas supporting breeding populations within the defined meta-population landscape should be considered for notification, and areas currently unoccupied but containing suitable habitat within the meta-population landscape should also be considered;
- the total functional area should be based on modelling and real situations that are appropriate to the species;
- all the functional area must be contained within a landscape of appropriate size, based on dispersal data, modelling or real-life situations. The functional area should be easily reached from, or bridged by, other sites to form links or 'stepping stones';
- the functional area must contain adequate amounts of all required resources for all the life stages of the species - e.g. larval food plant, adult forage resource, shelter, etc; and
- localised extinctions within the complex are natural under the meta-population model and any such sites that do not support the species at a particular time should still be managed for it.

4.2 Resources, mosaics and habitat patches

Many invertebrates utilise different habitats at different life-stages e.g. a saproxylic beetle may require old trees for its larval stage but the adults of many tend to congregate on scrub and flowers; dragonflies are also good examples of this, requiring water for their aquatic larval stage, but often requiring a variety of terrestrial habitats for adult feeding.

Although Table 1 is far from complete it should give a steer as to the types of habitat mosaics that are valuable for invertebrates:

Table 1. Habitat mosaics of value to invertebrates.

Habitat Type	Habitat patches for consideration of inclusion in SSSI boundaries
Woodland	Woodland edge consisting of grassy, herb dominated areas, regenerating scrub, wetland and sandy deposits
Grassland and Heathland	Adjoining scrub, woodland, tall ruderal and wetland systems, old sand and marl pits
Wetlands and pools	The catchment as a whole, connections with river systems, muddy areas, accumulations of leaf litter, and trees (e.g. willow clumps).
Coastal habitats	Connections with all other habitats (e.g. the ecotones between saltmarsh and heathland/grassland or with freshwater wetlands, the ecotones between beach and dune etc. Also, the interconnectivity of different coastal habitats (such as saltmarsh and intertidal sediment).
Rivers	The floodplain, including seasonally flooded pools, ditches, ox-bow lakes, floodplain trees and meadows (see also Chapter 6).

5 The application of these guidelines and their future development

The overall approach adopted here is to safeguard the strongest populations of threatened invertebrates and to protect those sites supporting assemblages of scarce, 'specialist' invertebrates, to represent the full range of Britain's invertebrate fauna best.

At this stage in the development of invertebrate conservation in Britain it is not generally possible to apply strict numerical scoring systems to select SSSIs (there are a few exceptions, as stated in section 3.10). However, estimates of population sizes are becoming available for some threatened species, particularly within well-studied groups such as butterflies, and for many groups the number of sites supporting rare species is becoming better known. Therefore, in some cases it is now possible to select the strongest populations or sites with the best assemblages of scarce and threatened species, as is done for birds and vascular plants.

These guidelines should be used with discretion and, where candidate invertebrate sites for SSSI selection are identified which do not qualify on the grounds of other biological interest, the Country Agency invertebrate specialists should be consulted.

It is expected that, in future, more detailed knowledge of the status and distribution of invertebrates, combined with an improved understanding of the nature of the assemblages associated with the main habitat formations, will allow the development of more robust techniques for assessing the quality of sites for invertebrates. However, this will inevitably proceed faster for some invertebrate groups, as well as for some habitat types and geographical areas, than for others.

Also, there are several invertebrates that we know or strongly suspect have declined significantly over the past few decades but we either don't yet have the data to support this or (in the case of the macro-moths and some butterfly species) they are still very widespread, despite some species having suffered declines of more than 90%. Site protection may not always be appropriate for such species, but in the future, it may be possible to identify particularly strong populations in some areas that would merit such site-based selection.

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