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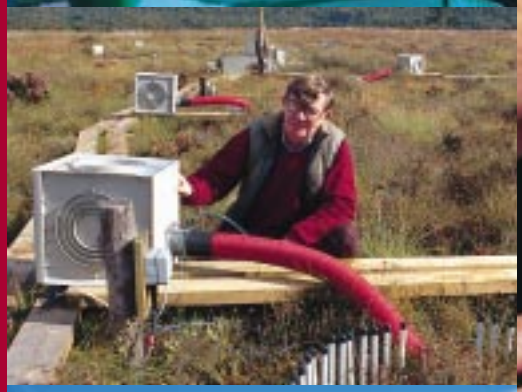

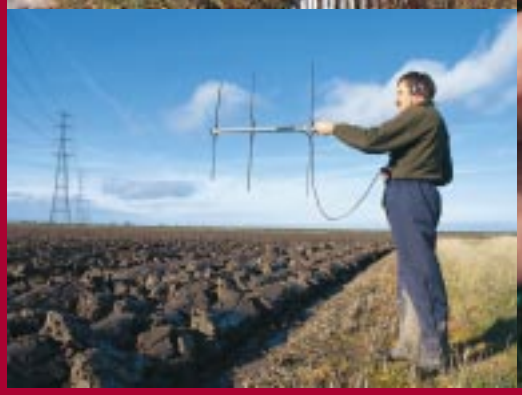

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A review of seepage invertebrates in England

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Contents

Executive summary

The contractor was commissioned by English Nature to carry out a review of the invertebrate fauna of seepage systems in England. Five main types of seepage habitat have been identified in England, these being slumping cliff seepages, stable cliff seepages, woodland seepages, acid-neutral seepages and calcareous seepages. For each of these, a list of invertebrates showing a strong fidelity for seepages has been prepared. Only those invertebrate taxa with sufficient ecological and distributional data have been included within this review.

In all, 170 "key" invertebrate species have been identified that show a strong fidelity to seepage habitats. Of these, 53 are Red Data Book species, 10 are included in the UK BAP as priority species, and three are listed at Annex II of the EC Habitats and Species Directive. Calcareous seepages and slumping cliff seepages have the highest representation of important species, with soldierflies and craneflies predominating in the former and beetles in the latter habitat type. Woodland has the highest total of key species, with many of these being craneflies. The diversity and importance of the invertebrate assemblages of stable cliff and acid-neutral seepages is somewhat lower, but they are still of significant interest.

There is currently very little information on the distribution and ecology of seepage invertebrates in England, and in some cases undoubtedly important groups have had to be omitted from this review due to lack of information. There is an urgent need to collect further information, and to collate existing work, such as the data collected by the Tipulid recording scheme. Upland calcareous seepages are considered to be a particular priority for further survey, though the claims of lowland calcareous, slumping cliff and woodland types are hardly less pressing.

1. Introduction

1.1 Project aims

The author has been contracted by English Nature to produce a review of seepage systems in England, and to describe the invertebrate assemblages they support, their importance in nature conservation terms, and recommendations on the way forward to ensure the continued conservation and enhancement of that interest. The aims of the project as stated in English Nature's Project Brief for the contract are as follows:

- To describe the habitat and its variations.
- To review the invertebrate fauna associated with the various seepage types.
- To devise a method of showing the degree of fidelity of the species to the habitat.
- To recommend survey methods.

1.2 Defining seepages

In talking about seepages, the first challenge is to define what it is we are talking about. In essence, seepages are very small, flowing waterbodies. They are characterised by generally slow rates of flow, and by being extremely shallow, sometimes no more than a film of water over the substrate. This means that they are most often associated with the uppermost sections of waterbodies, being transitional to streams and rivers as they gather water lower in the catchment. They are also very often derived from springs.

Springs have their own distinctive invertebrate fauna, comprising a small suite of stenotopic invertebrates that are at least partially subterranean. Those species that live almost entirely underground, such as the crustaceans *Bathynella stammeri*, *Niphargus aquilex* and *Niphargellus glenniei* are relatively easily defined. These are all true cavernicoles, lacking eyes and body pigment. However, a number of the other invertebrates associated with springs are also frequently encountered in the upper sections of seepages, and lack these specialised adaptations to underground life. These may be species that are still in a relatively early stage of adaptation to a subterranean existence. Examples of such species would include the water beetles *Hydroporus ferrugineus and H obsoletus* and the flatworms *Dendrocoelum lacteum* and *Phagocata vitta*. In practical terms, it is difficult to distinguish these species as a community distinct from other seepage invertebrates. I have therefore included them for consideration where they meet the criteria laid out in section 1.5.

There are a number of pertinent factors to consider in examining the invertebrate communities of seepages. Firstly, spring-fed seepages tend to be relatively nutrient rich in comparison to the surrounding land through which they pass, because they have accumulated nutrients leached down through the bedrock. This effect is particularly marked in the uplands, where surrounding soils have often been extensively leached by the very high rainfall they are subjected to. Secondly, despite the low volume of flow, spring-fed seepages are generally derived from very extensive underground aquifers, and are therefore not greatly affected by short term fluctuations in rainfall (Kirby, 1992). By contrast, surface water fed seepages will tend to be subject to relatively frequent desiccation during periods of drought, and will generally be more nutrient poor. In practice this means that invertebrate diversity in spring fed seepages tends to be very much greater than it is in those derived from surface

water run-off, and it is the former type that comprises the habitat of the vast majority of species considered in this report. The low flow volume of most seepages allows the development of a thick muddy substrate on all but the steepest gradients - such as seepages on vertical rock faces (see section 2.2). Rich organic material combined with well oxygenated water provides a highly productive resource for a surprisingly diverse invertebrate community. Very little detailed work has been carried out on the invertebrate fauna of seepages, but Elton (1966) in his pioneering study of animal communities reports on a study of the spring-fed calcareous streams and seepages of Wytham Hill that yielded an impressive total of 121 invertebrate species.

1.3 The range of seepage habitats in England

As will be seen from the following sections of this report, it is misleading to talk about a seepage community. Seepages occur across a wide range of habitat types, and the invertebrate assemblage in each of these habitat types is generally very different. For example, there is little similarity between the invertebrate fauna of a woodland seepage with that of a coastal cliff. In section 2 of this report, I have attempted to identify the main seepage invertebrate communities, and to briefly outline the range of variation within these communities.

In section 2 below, I have defined five main habitat types in which distinct assemblages of seepage invertebrates occur. These are slumping cliff seepages, stable cliff seepages, woodland seepages, acid-neutral seepages and calcareous seepages. Whilst some of these habitats (eg stable cliff seepages) have a relatively small and well-defined invertebrate community, others (particularly woodland) encompass a wide range of variation and include a number of distinct invertebrate communities.

Seepages occur across a very wide range of habitats in England, and in the past, because of their small size, have often been considered as elements of the wider habitat in which they occur (eg uplands, woodlands, coastal cliffs etc). Botanists have for some time recognised that, though they may only represent very small constituents of the total area of a site, they are abundantly distinct in the vegetation that they support, and should be considered as distinct communities in their own right. The National Vegetation Classification (NVC) volume on mires and heaths (Rodwell, ed., 1991) includes descriptions of a range of botanical communities that are associated to varying degrees with seepages in the UK. Where NVC communities are known to have a strong association with seepage habitats, they are listed in section 2 under the relevant seepage habitat type.

In moving towards an understanding of the invertebrate communities of seepages in England, the NVC provides a useful point of reference, but is only one of a number of factors that influence the distribution of seepage invertebrates. As an example, the southern damselfly *Coenagrion mercuriale* shows a close association with the M29 bog pondweed *Potamogeton polygonifolius* – marsh St John's-wort *Hypericum elodes* NVC community at many of its British sites. However it also occurs around the margins of chalk streams and in calcareous seepages. Provided that there are shallow, slow-flowing areas of neutral to basic water, with abundant "soft herbs" in which the female can oviposit, this damselfly is indifferent to the species composition of the vegetation. In the case of seepages in woodlands and on coastal cliffs, NVC communities have not been defined. This is chiefly because they are often only sparsely vegetated.

1.4 Taxonomic coverage

In compiling the lists of seepage invertebrates included in the Tables of the following section, the two following criteria have been used in deciding which taxa should be considered.

- *Taxa for which there is adequate information on habitat preferences.* This is obviously the key criterion in judging whether a given species is a specialist inhabitant of seepages.
- *Taxa for which we have information on UK distribution and conservation status.* Because this review is intended to provide a qualitative assessment of the conservation importance of the various kinds of seepage habitats, it is essential that we are able to evaluate the rarity and threat status of the communities with which we are dealing.

Taxa meeting these criteria and covered in this review are; flatworms (Tricladida), terrestrial and freshwater snails and slugs (Mollusca), stoneflies (Plecoptera), dragonflies (Odonata), beetles (Coleoptera), caddisflies (Trichoptera), craneflies (Tipulidae and Ptychopteridae), soldierflies (Stratiomyidae), snipeflies (Rhagionidae) and hoverflies (Syrphidae). A number of taxa have had to be omitted as they failed to meet the above criteria. Especially important are the Dolichopodid and Empidid fly families, which undoubtedly contain a number of seepage specialists, but for which there is a dearth of ecological information. Other Diptera families containing a number of undoubted seepage associates, but lacking sufficient ecological information are the Chironomidae, Thaumaleidae, Psychodidae and Ephydridae.

The main references used in compiling this review have been the various monographs published on the British invertebrate fauna and the reviews of scarce and threatened invertebrate taxa published by the Nature Conservancy Council (NCC) and its successor bodies. A full list of references is given in section 7. A list of all those species that are deemed to be seepage specialists, and which are of Red Data Book, UK BAP or EC Habitats and Species Directive status, is included at Appendix 1.

1.5 Fidelity of invertebrates to seepage habitats

One of the requirements of this contract was to give an indication of the fidelity of the various invertebrates discussed to seepage habitats. Given the limited information on habitat preferences for many of the invertebrate taxa under consideration, this can currently be no more than a rough guide. For each of the five major seepage habitats, a list of "key" invertebrates has been compiled, which are all considered to be species of relatively high fidelity to seepage habitats. In addition to true aquatics, occurring in at least some stage of their life cycle on or in the seepage, in its substrate or on submerged vegetation, I have also included species that occur at seepage margins, or phytophagous species associated with wetland plants, where the degree of fidelity meets that of the grades set out below.

These key species are listed in Tables 2.1-2.5, and each is assigned a fidelity rating. Three fidelity grades from A to C have been created, and 167 invertebrate species from the taxa under consideration have been judged to be strongly associated with seepages based on these criteria (see Tables 2.1-2.5). The definition of the three fidelity grades is as follows:

Grade A – *Seepage obligates. Species that are exclusive inhabitants of seepages and their margins, with almost all of their British records referring to these habitats.*

Grade B – *Seepage specialists. Species that are primarily found in seepages and their margins, but which occasionally occur in other situations. Generally in excess of 75% of British records refer to these habitats.*

Grade C – *Seepage associates. Species found in and around other types of running and shallow water, but which nonetheless have a strong association with seepages and their margins. Generally in excess of 50% of British records refer to these habitats.*

It should be noted that the fidelity grade assigned to each species refers to its fidelity to the whole range of seepage habitats covered in section 2. This is because a number of the invertebrates included in Tables 2.1-2.5 are found in more than one of the seepage habitats discussed. Also, it was felt that the level of information on fidelity to the individual seepage habitats was inadequate to justify such a detailed level of analysis. It should also be understood that the lists of species given in the Tables are by no means a full description of the invertebrate community of each of the habitat types discussed. This would have necessitated the inclusion of very much longer lists of more widespread wetland "generalists". Also, as has been mentioned above, this review aims to assess the importance of the seepage invertebrate assemblage, and the focus has therefore been towards the scarce and threatened elements of that fauna. The description of full invertebrate communities for seepages has still barely begun, and is well beyond the scope of this review.

2. Seepage habitats

2.1 Slumping cliff seepages

Slumping cliff seepages generally occur in areas where unusually soft rock strata are being actively eroded by both the sea and by freshwater running over the strata. Frequently these freshwater bodies take the form of networks of seepages arising towards the upper part of the cliff. These seepages tend to be very actively eroding the soft strata over which they flow, and in consequence vegetation tends to be very patchy, with considerable quantities of bare sandy or clayey substrates. The botanical communities are therefore very fragmented, with small patches of maritime grassland and wetland communities being interspersed with areas of open ground, with more ruderal vegetation. Slumping cliff seepages are difficult to classify botanically using the NVC, and for this reason their importance has historically been undervalued by the nature conservation community. Because of their relatively low botanical diversity, they were, until recently underrepresented in designated nature conservation sites. Some sites are of outstanding importance for the fossil-bearing rock strata that are exposed as the cliffs erode, these sites have been designated on account of their national or international geological importance (see below).

Table 2.1 Key invertebrates of slumping cliff seepages in England

Species:	**Status:**	**Fidelity:**
Cliff Tiger Beetle *Cicindela germanica* (Col: Carabidae)	BAP, RDB3	A
Asaphidion pallipes (Col: Carabidae)	Nb	C
Bembidion genei (Col: Carabidae)		C
Bembidion pallidipenne (Col: Carabidae)	Nb	C
Bembidion saxatile (Col: Carabidae)	Nb	A
Bembidion stephensi (Col: Carabidae)		B
Tachys micros (Col: Carabidae)	BAP, Na	A
Chlaenius nitidulus (Col: Carabidae)	RDB1	A
Drypta dentata (Col: Carabidae)	RDB1	A
Georissus crenulatus (Col: Hydrophilidae)		C
Aloconota planifrons (Col: Staphylinidae)	RDBK	B
Bledius crassicollis (Col: Staphylinidae)	RDBI	A
Bledius dissimilis (Col: Staphylinidae)	RDBI	B
Bledius filipes (Col: Staphylinidae)	RDB1	A
Bledius occidentalis (Col: Staphylinidae)	RDBK	C
Bledius tricornis (Col: Staphylinidae)	Nb	C
Stenus fossulatus (Col: Staphylinidae)	RDB1	A
Stenus guttula (Col: Staphylinidae)		C
Scopaeus laevigatus (Col: Staphylinidae)	RDBI	B
Scopaeus minutus (Col: Staphylinidae)	RDB1	A
Lathrobium angustatum (Col: Staphylinidae)	Nb	B
Sphaerius acaroides (Col: Sphaeriidae)	RDBK	B
Longitarsus aeruginosus (Col: Chrysomelidae)	RDB1	B
Baris analis (Col: Curculionidae)	RDB2	A
Grypus equiseti (Col: Curculionidae)	Nb	C
Hylobius transversovittatus (Col: Curculionidae)	RDB1	C
Eubria palustris (Col: Psephenidae)	RDB3	A
Limnephilus hirsutus (Trich: Limnephilidae)		B
Plectrocnemia brevis (Trich: Polycentropodidae)	N	A
Arctoconopa melampodia (Dip: Tipulidae)	RDB2	C
Idiocera bradleyi (Dip: Tipulidae)	RDB2	A
Limonia lackshewitzi (Dip: Tipulidae)	RDB1	A
Symplecta scotica (Dip: Tipulidae)	RDB2?	A
Tipula lateralis (Dip: Tipulidae)		B
Tipula maxima (Dip: Tipulidae)		C
Liverwort Snipefly *Spania nigra* (Dip: Rhagionidae)	N	A
White-barred Soldier *Oxycera morrisii* (Dip: Stratiomyidae)	N	A
Hill Soldier *Oxycera pardalina* (Dip: Stratiomyidae)	N	A
Pygmy Soldier *Oxycera pygmaea* (Dip: Stratiomyidae)	N	A
Four-barred Major *Oxycera rara* (Dip: Stratiomyidae)		B
Three-lined Soldier *Oxycera trilineata* (Dip: Stratiomyidae)		C
Banded General *Stratiomys potamida* (Dip: Stratiomyidae)	N	B

As can be seen from Table 2.1 above, slumping cliff seepages support an outstanding invertebrate fauna, which includes a number of extremely scarce species. Slumping cliff seepages have a very localised distribution around the coast of England, with major concentrations being on the Jurassic coast of Lyme Bay in Dorset and Devon, around the southern coastline of the Isle of Wight and on the glacial boulder clays of east Norfolk and south- and north-east Yorkshire. Of particular importance in the make up of the specialist invertebrate assemblage are ground beetles (Carabidae) and rove beetles (Staphylinidae). In addition to the commoner species, slumping cliff seepages can also support rarities such as the cliff tiger beetle *Cicindela germanica*, and another ground beetle, *Tachys micros*, both priority species in the UK BAP. These require very warm conditions, and are largely

restricted in Britain to the slumping cliffs of the Lyme Bay and Isle of Wight coast. A number of the other invertebrates listed in Table 2.1 are similarly confined to these areas, and include the beetles *Drypta dentata*, *Chlaenius nitidulus* (possibly now extinct), *Bledius crassicollis*, *Scopaeus laevigatus*, *S minutus*, *Sphaerius acaroides*, *Longitarsus aeruginosus* and *Baris analis* and the cranefly *Limonia lackshewitzi*. In addition to these rarities, there are also a large number of other uncommon species that are of more widespread distribution on slumping cliff seepages around the British coast. Collectively the invertebrate community present on the Lyme Bay and Isle of Wight coast is very distinctive, with the combination of geology and extreme warmth allowing the occurence of what is essentially a thermophilous invertebrate community at the extreme limits of its European range.

L aeruginosus and *B analis* are both phytophagous beetles, feeding on hemp agrimony *Eupatorium cannabinum* and common fleabane *Pulicaria dysenterica* respectively. Both foodplants are common throughout Britain in a range of wetland habitats. These two species have been included because they are virtually confined to stands of their foodplants growing in and at the margins of slumping cliff seepages. This is a good illustration of the extreme sensitivity of many rare invertebrates, even including those phytophagous species feeding on relatively widespread foodplants, to the physical and chemical factors that they encounter.

A second particularly important invertebrate community occurs on the east Norfolk and east Yorkshire coast. This includes the beetles *Nebria livida*, *Bledius dissimilis* and *Bledius filipes* and the craneflies *Idiocera bradleyi* and *Symplecta scotica*. These are all species that are largely confined to the boulder clays of the eastern English coast. It has been suggested that this is a relict fauna remaining from the period after the last glaciation when this area was still connected to continental Europe. On the continent, species such as *N livida* and *B filipes* are more characteristic inhabitants of the banks of large rivers such as the Rhine.

The invertebrate fauna of seepages at Castle Eden Dene is also of note, and includes rarities such as the rove beetle *Stenus fossulatus* and the caddisfly *Plectrocnemia brevis*.

The communities of invertebrates found on soft rock cliffs show quite strong affinities with those of calcareous flushes discussed in section 2.5. In particular, the soldierflies (Stratiomyidae) show considerable crossover between these two habitats. Given that the seepages on most slumping cliffs arise from calcareous boulder clays and sands, this relationship is not surprising. All of the soldierflies listed in Table 2.1 are also found on calcareous flushes.

2.2 Stable cliff seepages

This habitat is defined as being one where shallow trickles or films of water run over hard, stable rock surfaces. Very often the water runs almost vertically down the face of such strata. On close inspection, the rock surface will generally be seen to have a film of alga growing on it, and this forms the base of the food chain for a small, but exceptionally specialised invertebrate assemblage. There may also be a scattering of other plants, especially mosses and liverworts that are inhabited by some of the invertebrates that constitute this assemblage. Stable cliff seepages are found scattered around the whole of the British coast, wherever the geology is suitable for their development. They are also found inland, particularly in the north and west of Britain, where upland rock exposures provide the necessary substrates.

Because of the limited vegetation cover of stable cliff seepages, they are poorly defined in the NVC. This is especially true of maritime cliff communities, where no stream or seepage communities are identified (Rodwell, 2000). On upland rock exposures, better vegetated seepages running over calcareous rocks may be referable to the M31 *Anthelia julacea – Sphagnum auriculatum* spring or the M32 *Philonotis fontana – Saxifraga stellaris* spring (Rodwell, 1991). Botanists have for long recognised the importance of upland calcareous seepages where they trickle over calcareous rocks as a habitat for a diversity of rare higher plants, bryophytes and lichens. For this reason, such sites have frequently received conservation designations, though seepages on siliceous upland exposures, and coastal seepages of this type have received scant attention due to the lower interest of their plant communities.

Table 2.2 Key invertebrates of stable cliff seepages in England

Species:	**Status:**	**Fidelity:**
Ochthebius poweri (Col: Hydraenidae)	BAP, RDB3	A
Lesteva hanseni (Col: Staphylinidae)	N	B
Lathrobium angustatum (Col: Staphylinidae)	Nb	B
Gabrius astutoides (Col: Staphylinidae)	RDBI	B
Adicella filicornis (Trich: Leptoceridae)	RDB3	A
Ernodes articularis (Trich: Beraeidae)	N	A
Tinodes assimilis (Trich: Psychomyiidae)		A
Tinodes maclachlani (Trich: Psychomyiidae)		C
Dicranomyia aquosa (Dip: Tipulidae)	N	A
Dicranomyia goritiensis (Dip: Tipulidae)	RDB3	A
Gonomyia conoviensis (Dip: Tipulidae)	N	A
Helius hispanicus (Dip: Tipulidae)	RDB1	A
Orimarga virgo (Dip: Tipulidae)	RDB3	A
Tipula cheethami (Dip: Tipulidae)	N	B
Liverwort Snipefly *Spania nigra* (Dip: Rhagionidae)	N	A

Compared to the invertebrate fauna of slumping cliff seepages, that of stable exposures is relatively modest. However, this may indicate the very small amount of sampling that has taken place in this habitat rather than lower interest *per se*. Certainly, such sites do support some extremely rare and important invertebrate species, of particular note is the water scavenger beetle *Ochthebius poweri*, which is a priority species in the UK BAP.

Though sampling is far too limited to start defining communities, it seems likely that the nature of the substrate and, related to this, the pH of the seepage water will be key factors in defining the invertebrate communities of stable cliff seepages. For example, the Old Red Sandstone cliffs of Devon support an outstanding invertebrate assemblage that includes the water scavenger beetle *Ochthebius poweri* (also known from the Old Red Sandstone in Pembrokeshire, west Wales) (Foster, 1990), the rove beetle *Gabrius astutoides* and the cranefly *Helius hispanicus*.

While all these three species are exclusive inhabitants of coastal sites, some of the other species listed in Table 2.2 above are only found on inland rock exposures. An example of this would be the cranefly *Tipula cheethami*. However, the majority of the species seem to be equally at home on both inland and coastal sites. In addition to the algal films, that are probably the main food source for *O poweri* and some of the caddisflies, brypohyte tufts in and around the seepage are important, with larvae of *T cheethami* and the liverwort snipefly *Spania nigra* having been found in the moss *Rhynchostegium riparioides* (Falk, 1991) and the

liverwort *Pellia neesiana* (Stubbs and Drake, 2001) respectively. In the case of the cranefly *Dicranomyia goritiensis*, its larvae have been found in saturated grass tufts in and around seepages on coastal cliffs (Stubbs, 1998). As mentioned above, water pH is clearly of vital importance in determining the composition of the invertebrate community of stable cliff seepages. In particular, a number of the species listed above appear to be obligate calcicoles, examples being the caddisfly *Adicella filicornis* (Wallace, 1991) and the cranefly *Orimarga virgo* (Falk, 1991; Stubbs, 1998).

This habitat has clear affinities to the invertebrate community that occurs in the splash zone of fast-flowing streams and waterfalls. A number of rove beetles such as *Dianous coerulescens*, *Stenus guynemeri*, *Quedius auricomus* and *Lesteva pubescens* occur in such situations. Whilst they also occur around stable cliff seepages, this is not considered to be a sufficiently strong association to justify their inclusion in Table 2.2.

2.3 Woodland seepages

This is probably the most widespread, and yet little known seepage habitat in Britain. It also encompasses a tremendous range of variation, from extensive networks of branching runnels in wet carr woodlands, through to isolated spring-fed seepages in drier woodland types. In combination with other physical and chemical factors, this produces a wide variety of environments that are exploited by an important and exceptionally diverse invertebrate assemblage.

Seepages within woodland are generally not differentiated in the NVC from the surrounding woodland vegetation. This is because vegetation in woodland seepages tends to be poorly defined, and often the level of shade results in no vegetation at all. Despite the lack of vegetation, such woodland seepages support very diverse invertebrate assemblages occurring in mud and detritus in and around the watercourse. There is a clear differentiation of such assemblages into well-defined communities depending on the physical and chemical milieu experienced. Again, this provides a good illustration of the perils of relying too heavily on botanical criteria in assessing invertebrate communities of seepages (or most other habitats for that matter). Though seepages can occur in almost any sort of woodland, they are particularly well represented in carr woodlands of the NVC types listed below.

W1 *Salix cinerea – Galium palustre* woodland.

W2 *Salix cinerea – Betula pubescens – Phragmites australis* woodland.

W3 *Salix pentandra – Carex rostrata* woodland.

W4 *Betula pubescens – Molinia caerulea* woodland.

W5 *Alnus glutinosa – Carex paniculata* woodland.

W6 *Alnus glutinosa – Urtica dioica* woodland.

W7 *Alnus glutinosa – Fraxinus excelsior – Lysimachia vulgaris* woodland

Table 2.3 Key invertebrates of woodland seepages in England

Species:	**Status:**	**Fidelity:**
Crenobia alpina *(Tricladida: Planariidae)*		C
Phagocata vitta *(Tricladida: Planariidae)*		C
Acicula fusca *(Mollusca:Aciculidae)*	Nb	B
Leiostyla anglica *(Mollusca: Pupillidae)*		B
Spermodea lamellata *(Mollusca: Valloniidae)*		B
Phenacolimax major (Mollusca: Vitrinidae)	Nb	C
Nemoura dubitans (Plec: Nemouridae)	N	A
Nemurella picteti (Plec: Nemouridae)		B
Hydroporus discretus (Col: Dytiscidae)		B
Hydroporus longicornis (Col: Dytiscidae)	Nb	B
Acrotrichis lucidula (Col: Ptiliidae)	RDBK	B
Atheta aquatilis (Col: Staphylinidae)	N	C
Adicella filicornis Trich: Leptoceridae)	RDB3	A
Beraea maurus (Trich: Beraeidae)		B
Crunoecia irrorata (Trich: Lepidostomatidae)		A
Diplectrona felix (Trich: Hydropsychidae)		B
Limnephilus bipunctatus (Trich: Limnephilidae)		C
Dicranomyia lucida (Dip: Tipulidae)	N	A
Dicranomyia stigmatica (Dip: Tipulidae)	N	A
Dolichopeza albipes (Dip: Tipulidae)		C
Eloeophila submarmorata (Dip: Tipulidae)		B
Erioptera flavissima (Dip: Tipulidae)		A
Gonomyia abbreviata (Dip: Tipulidae)	RDB3	C
Gonomyia alboscutellata (Dip: Tipulidae)	RDB1	A
Gonomyia bifida (Dip: Tipulidae)	N	B
Limnophila glabricula (Dip: Tipulidae)	N	B
Lipsothrix errans (Dip: Tipulidae)	N	C
Lipsothrix nervosa (Dip: Tipulidae)	BAP, RDB5	C
Lipsothrix nigristigma (Dip: Tipulidae)	RDB1	C
Molophilus bifidus (Dip: Tipulidae)		B
Molophilus corniger (Dip: Tipulidae)	N	A
Molophilus czizeki (Dip: Tipulidae)	RDB3	A
Neolimnophora filata (Dip: Tipulidae)		B
Numantia fusca (Dip: Tipulidae)		B
Orimarga virgo (Dip: Tipulidae)	RDB3	A
Ormosia staegeriana (Dip: Tipulidae)	N	A
Paradelphomyia dalei (Dip: Tipulidae)		C
Paradelphomyia ecalcarata (Dip: Tipulidae)	RDB2	A
Paradelphomyia nielseni (Dip: Tipulidae)	N	A
Paradelphomyia senilis (Dip: Tipulidae)		A
Pedicia unicolor (Dip: Tipulidae)	N	A
Tasiocera jenkinsoni (Dip: Tipulidae)	RDB1	A
Tasiocera laminata (Dip: Tipulidae)	N	A
Thaumastoptera calceata (Dip: Tipulidae)	N	A
Tipula fulvipennis (Dip: Tipulidae)		C
Tipula lateralis (Dip: Tipulidae)		B
Tipula limbata (Dip: Tipulidae)	RDB3	A
Tipula luteipennis (Dip: Tipulidae)		C
Tipula maxima (Dip: Tipulidae)		C
Tipula subnodicornis (Dip: Tipulidae)		A
Tipula yerburyi (Dip: Tipulidae)	N	C
Ptychoptera lacustris (Dip: Ptychopteridae)		C
Ptychoptera longicauda (Dip: Ptychopteridae)		B
Ptychoptera paludosa (Dip: Ptychopteridae)		C

Species:	Status:	Fidelity:
Ptychoptera scutellaris (Dip: Ptychopteridae)		B
Liverwort Snipefly *Spania nigra* (Dip: Rhagionidae)	N	A
Banded General *Stratiomys potamida* (Dip: Stratiomyidae)	N	B
Dark-winged Soldier *Oxycera analis* (Dip: Stratiomyidae)	RDB2	B
Twin-spotted Major *Oxycera leonina* (Dip: Stratiomyidae)	RDB1	A
Delicate Soldier *Oxycera nigricornis* (Dip: Stratiomyidae)		A
Arctophila superbiens (Dip: Syrphidae)		B
Chrysogaster virescens (Dip: Syrphidae)		B
Chrysogaster solstitialis (Dip: Syrphidae)		A

Of the 61 key species listed in Table 2.3, 38 are craneflies (Tipulidae and Ptychopteridae). They generally have soft-bodied larvae that thrive in cool, saturated, shaded conditions, and are clearly a key group in understanding the invertebrate communities of wooded seepages.

Perhaps because of these climatic requirements, craneflies are unusual amongst invertebrate taxa in being as diverse in north and west England as in the south (AE Stubbs, pers. comm.). The division between "southern" and "northern" species forms one of the major divisions in the cranefly assemblages of wooded seepages in England. Species such as *Dicranomyia lucida, Gonomyia abbreviata*, *G bifida, Lipsothrix nervosa, Tasiocera jenkinsoni, Thaumastoptera calceata* and *Tipula yerburyi* are essentially southern species, while *Dicranomyia stigmatica*, *Limnophila glabricula, Lipsothrix errans, Molophilus czizeki, Orimarga virgo, Ormosia staegeriana, Pedicia unicolor* and *Tipula limbata* show a markedly northern and western distribution pattern. Also of major importance in delineating cranefly assemblages is the pH status of woodland seepages. Some species such as *T limbata* and *T yerburyi* show a marked preference for acidic sites (Falk, 1991; Stubbs, 1992), whilst others such as *G abbreviata, G bifida, Molophilus corniger, O virgo, Paradelphomyia ecalcarata, Ptychoptera longicauda* and *P scutellaris* are clearly calciphiles (Falk, 1991; Stubbs, 1993). Though the cranefly recording scheme has amassed a very large quantity of data, this has yet to be analysed. Once this work has been undertaken, it should be possible to begin to delimit cranefly communities of woodland seepages and to identify sites of particular importance.

Another Diptera family showing a strong association with calcareous seepages is the soldierflies (Stratiomyidae). Though most species occur in open habitats, the four species listed in Table 2.3 are found frequently in woodland. While *O nigricornis* and *S potamida* are also found around open seepages, *O analis* and *O leonina* appear to be restricted to calcareous seepages in woodland and at woodland edges.

In northern and western Britain, seepages derived from siliceous bedrock support distinctive flush vegetation dominated by opposite-leaved golden saxifrage *Chrysosplenium oppositifolium*. Though still of only moderate pH, the water is sufficiently rich in calcium to support diverse communities of molluscs, which are found amongst the *Chrysosplenium* plants and in saturated leaf litter. The four species listed at the top of Table 3 are particularly closely associated with this habitat type, though all can on occasions be found in other places. A striking feature of all of these four snails, and indeed a number of the commoner and more widespread molluscs that also occur in these woodland flushes is their extreme west European distribution. *L anglica* for example is virtually endemic, being otherwise known only from a tiny area of western France. In all cases, the populations occurring in Britain form a major part of the world total. Because none of these species has very high conservation status in Britain (nationally scarce at most), the exceptional importance of this assemblage has been overlooked.

The woodlands of the Kent and Sussex Weald are known to support "relict" populations of a number of plants and animals that are more characteristic of northern Britain. Invertebrates are no exception to this, with the molluscs *L anglica* and *S lamellata* both occurring in woodland seepages well to the south and east of their main population centres (Foster, 1983). Another interesting example is provided by the diving beetle *Hydroporus longicornis*, which is primarily an inhabitant of open, boggy runnels in the uplands. In the Weald it occurs in densely shaded spring-fed seepages, where the water temperature remains cool enough for it to thrive (Foster, 1984). This phenomenon is also exhibited by the flatworms *Crenobia alpina* and *Phagocata vitta*, which are both restricted to spring-fed waters in southern England, whilst being found more widely in a range of aquatic habitats towards the north (Reynoldson, 1978).

2.4 Acid-neutral seepages

There is a continuous range of flush pH types, and the decision to split them into major categories separated at around pH 7.0 is essentially arbitrary. Having said this, there are well defined invertebrate assemblages associated with acidic and calcareous seepage environments, and many of the species are exclusive to such conditions. This is another widely distributed seepage type in England (and even more so in Scotland and Wales), particularly in the siliceous uplands of the north, Welsh borders and south west.

A number of NVC communities are primarily associated with acid-neutral seepages and these are listed below.

M6 *Carex echinata – Sphagnum recurvum*/*auriculatum* mire.

M14 *Schoenus nigricans – Narthecium ossifragum* mire.

M29 *Hypericum elodes – Potamogeton polygonifolius* soakway.

M31 *Anthelia julacea – Sphagnum auriculatum* spring.

M35 *Ranunculus omiophyllus – Montia fontana* rill.

M36 *Chrysosplenium oppositifolium* flush.

Table 2.4 Key invertebrates of acid-neutral seepages in England

Species:	**Status:**	**Fidelity:**
Nemurella picteti (Plec: Nemouridae)		B
Southern Damselfly *Coenagrion mercuriale* (Odo: Coenagriidae)	BAP, ECII, RDB2	B
Small Red Damselfly *Ceriagrion tenellum* (Odo: Coenagriidae)	Nb	B
Keeled Skimmer *Orthetrum coerulescens* (Odo: Libellulidae)		A
Hydroporus discretus *(Col: Dytiscidae)*		B
Hydroporus ferrugineus (Col: Dytiscidae)	Nb	A
Hydroporus longicornis (Col: Dytiscidae)		B
Hydroporus longulus (Col: Dytiscidae)	Nb	B
Hydroporus obsoletus (Col: Dytiscidae)	Nb	A
Agabus guttatus (Col: Dytiscidae)		C
Chaetarthria seminulum (Col: Hydrophilidae)		B
Laccobius atratus (Col: Hydrophilidae)		C
Cyphon pubescens (Col: Scirtidae)	Nb	B
Apatania muliebris (Trich: Limnephilidae)		B
Limnephilus centralis (Trich: Limnephilidae)		C
Plectrocnemia geniculata (Trich: Polycentropodidae)		C

Species:	Status:	Fidelity:
Dolichopeza albipes (Dip: Tipulidae)		C
Erioptera nielseni (Dip: Tipulidae)	N	A
Dicranomyia distendens (Dip: Tipulidae)	N	A
Molophilus occultus (Dip: Tipulidae)		C
Tipula holoptera (Dip: Tipulidae)	N	B
Tipula maxima (Dip: Tipulidae)		C
Trigoma trisulcata (Dip: Tipulidae)	RDB3	B
Arctophila superbiens (Dip: Syrphidae)		B
Chrysogaster cemiteriorum (Dip: Syrphidae)		B
Chrysogaster virescens (Dip: Syrphidae)		B
Eristalis abusivus (Dip: Syrphidae)		C
Bog Hoverfly *Eristalis cryptarum* (Dip: Syrphidae)	BAP, RDB2	A
Eristalis rupium (Dip: Syrphidae)	N	B
Lejogaster metallina (Dip: Syrphidae)		B
Melanogaster aerosa (Dip: Syrphidae)	N	B
Orthonevra geniculata (Dip: Syrphidae)	N	A
Platycheirus amplus *(Dip: Syrphidae)*		B
Platycheirus ramsarensis (Dip: Syrphidae)		B
Sericomyia lappona (Dip: Syrphidae)		C
Sericomyia silentis (Dip: Syrphidae)		C

A striking feature of Table 2.4 is that whilst there are a good number of key species of acid seepages, comparatively few of them are rare, with only three having Red Data Book status. This is probably a result of the relatively large resource of acid-neutral flushes in Britain.

The two most important species in Table 2.4, the bog hoverfly *Eristalis cryptarum* and the southern damselfly *Coenagrion mercuriale* both exhibit a relatively southern lowland distribution in England. Both are priority species in the UK BAP, and the southern damselfly is also a species of European importance, listed at Annex II of the EC Habiats and Species Directive (EC II). Another species of interest is the cranefly *Dicranomyia distendens*. This is essentially an upland species, but has a relict outpost on lowland boggy flushes in the New Forest.

The majority of the species in Table 2.4 are relatively widespread across acid-neutral flushes in England, and the communities associated with upland and lowland sites are not as well defined as are those occurring in woodland and calcareous seepages. Upland acid-neutral seepages in particular, are of relatively low conservation interest, with most of the rarer seepage invertebrates of the uplands being associated with calcareous water. Discussion of the relative merits of different seepage systems in England can however only be regarded as tentative pending more detailed surveys and analysis of existing datasets, such as that held by the Tipulid recording scheme.

2.5 Calcareous seepages

Though widely distributed in England, calcareous seepages are not common features. They are generally linked to areas of England with calcareous bedrock, though they can also be associated with seepages arising from springs in glacial clays and sands, where these are sufficiently rich in calcium carbonate. Many of the calcareous seepage systems of southern England have been damaged or destroyed, either as a result of agricultural improvement, or through excessive abstraction of groundwater for agriculture or human usage. Calcareous seepages also occur in the north and west, but limestone uplands are comparatively localised,

and upland calcareous seepages are therefore of much more scattered occurrence than are the acid-neutral seepages derived from siliceous rocks that are discussed above.

A number of the NVC communities listed by Rodwell (1991b) have a strong association with calcareous seepages. These are listed below.

M10 *Carex dioica – Pinguicula vulgaris* mire.

M11 *Carex demissa – Saxifraga aizoides* mire.

M13 *Schoenus nigricans – Juncus subnodulosus* mire.

M32 *Philonotis fontana – Saxifraga stellaris* spring.

M37 *Cratoneuron commutatum – Festuca rubra* spring.

M38 *Cratoneuron commutatum – Carex nigra* spring.

Table 2.5 Key invertebrates of calcareous seepages in England

Species:	**Status:**	**Fidelity:**
Catinella arenaria (Mollusca: Succineidae)	BAP, RDB1	B
Vertigo genesii (Mollusca: Vertiginidae)	BAP, ECII, RDB1	A
Vertigo geyeri (Mollusca: Vertiginidae)	BAP, ECII, RDB1	A
Southern Damselfly *Coenagrion mercuriale* (Odo: Coenagriidae)	BAP, ECII, RDB2	B
Hydroporus ferrugineus (Col: Dytiscidae)	Nb	A
Hydroporus longulus(Col: Dytiscidae)	Nb	B
Hydroporus marginatus (Col: Dytisicdae)	Na	A
Agabus biguttatus (Col: Dytiscidae)	Nb	B
Cyphon pubescens (Col: Scirtidae)	Nb	B
Eubria palustris (Col: Psephenidae)	RDB3	A
Adicella filicornis (Trich: Leptoceridae)	RDB3	A
Apatania muliebris (Trich: Limnephilidae)		B
Beraea maurus (Trich: Beraeidae)		B
Ernodes articularis (Trich: Beraeidae)	N	A
Hydropsyche fulvipes (Trich: Hydropsychidae)	N	B
Limnephilus bipunctatus (Trich: Limnephilidae)		C
Plectrocnemia brevis (Trich: Polycentropodidae)	N	A
Tinodes dives (Trich: Psychomyiidae)	N	B
Dicranomyia occidua (Dip: Tipulidae)	N	A
Dicranomyia sp B (Dip: Tipulidae)		A
Dicranomyia stylifera (Dip: Tipulidae)	RDB2	A
Eloeophila submarmorata (Dip: Tipulidae)		B
Erioptera meijeri (Dip: Tipulidae)	RDB2	B
Molophilus obscurus (Dip: Tipulidae)		C
Orimarga juvenilis (Dip: Tipulidae))	N	A
Orimarga virgo (Dip: Tipulidae)	RDB3	A
Tipula coerulescens (Dip: Tipulidae)	RDB3	A
Tipula gimmerthali (Dip: Tipulidae)	RDB3	B
Tipula lateralis (Dip: Tipulidae)		B
Nemotelus nigrinus (Dip: Stratiomyidae)		C
Nemotelus pantherinus (Dip: Stratiomyidae)		A
Odontomyia argentata (Dip: Stratiomyidae)	RDB2	B
Odontomyia hydroleon (Dip: Stratiomyidae)	BAP, RDB1	A
Oplodontha viridula (Dip: Stratiomyidae)		B
Oxycera dives (Dip: Stratiomyidae)	RDB3	A
Oxycera fallenii (Dip: Stratiomyidae)	RDB1	A
Oxycera morrisii (Dip: Stratiomyidae)	N	A
Oxycera nigricornis (Dip: Stratiomyidae)		A

Species:	Status:	Fidelity:
Oxycera pardalina (Dip: Stratiomyidae)	N	A
Oxycera pygmaea (Dip: Stratiomyidae)	N	A
Oxycera rara (Dip: Stratiomyidae)		B
Oxycera trilineata (Dip: Stratiomyidae)		C
Stratiomys chamaeleon (Dip: Stratiomyidae)	RDB1	A
Stratiomys potamida (Dip: Stratiomyidae)	N	B
Vanoyia tenuicornis (Dip: Stratiomyidae)	N	B
Lejogaster tarsata (Dip: Syrphidae)	N	B
Melanogaster hirtella (Dip: Syrphidae)		B
Orthonevra brevicornis (Dip: Syrphidae)	N	A
Orthonevra nobilis (Dip: Syrphidae)		A

The invertebrate fauna of calcareous seepages is outstanding, with sixteen Red Data Book species listed in Table 2.5 above, of which three are also of EC II status, and five are priority species in the UK BAP. Very distinctive assemblages of species are present in both upland and lowland situations.

In the lowlands, the most important element of the fauna is perhaps the soldierflies (Stratiomyidae). Of particular note are *Stratiomys chamaeleon*, known only from Cothill Fen, Oxfordshire in England (though it also occurs at two sites in Wales and one in Scotland) and *Odontomyia argentata*, known from Thompson Common and East Walton Common in Norfolk and the chalk streams of south Hampshire. Cothill Fen also supports southern damselfly at one of its calcareous seepage sites.

However it is the fauna of upland calcareous seepages that is truly outstanding. Three extremely important snails, *Catinella arenaria*, *Vertigo geyeri* and *Vertigo genesii* are all found in this habitat, the former two occurring together at Sunbiggin Tarn, Cumbria while the latter occurs at a single British site at Widdybank Fell, Teesdale, County Durham.

At Moor House National Nature Reserve (NNR), Cumbria in the northern Pennines, an outstanding assemblage of craneflies occurs in seepages emanating from Carboniferous limestone. This includes three Red Data Book species *Dicranomyia stylifera*, *Tipula coerulescens* and *T gimmerthali*.

More recently, survey of calcareous seepages on the southern fringes of the North York Moors has revealed a remarkable stratiomyid assemblage that includes *Oxycera fallenii* at its only British site, *O dives* and *Odontomyia hydroleon* at its only English site (it is otherwise known from a single site in Wales).

3. Discussion

Section 2 demonstrates that all of the main seepage habitats are home to diverse assemblages of invertebrates, many of which are of very high conservation status. In all, 170 key invertebrates have been identified that show a strong association with seepage habitats in England with 53 of these having Red Data Book status. Three are internationally threatened species listed on EC II, these being the snails *Vertigo genesii* and *V geyeri* and the southern damselfly, *Coenagrion mercuriale*. Ten of the key species listed in Tables 2.1-2.5 are UK BAP priority species, these being the three ECII species listed above, plus *Catinella arenaria, Cicindela germanica, Tachys micros, Ochthebius poweri, Lipsothrix nervosa, Odontomyia hydroleon* and *Eristalis cryptarum*. All of the RDB, BAP and EC II species are listed in

Appendix 1, with brief notes on their ecology and distribution in the UK. Table 3.1 shows the total number of key species identified in each of the habitat types, and the number of these that are of high conservation status.

Table 3.1 Diversity and importance of key invertebrates in seepage habitats

Seepage Habitat:	Total No. Key Species	No. RDB/BAP/ECII Species
Slumping cliff seepages	42	21
Stable cliff seepages	15	6
Woodland seepages	63	13
Acid-neutral seepages	36	3
Calcareous seepages	49	16

From this it is clear that stable cliff seepages and acid-neutral seepages appear to be of somewhat lower importance than the other three types. This may partly reflect lack of survey effort, particularly in the case of stable cliff seepages, but is probably chiefly a function of the relatively large resource and low rate of loss of these habitats. Acid-neutral seepages still occur in abundance in the uplands of western and northern Britain, but are less frequent in lowland situations, where they are mostly confined to southern heathland areas in Dorset and the New Forest. Surprisingly, very few of the key species of acid-neutral seepages are confined to lowland sites, with most being found across a wide range of climatic conditions. Even the southern damselfly and the bog hoverfly are also found in more upland situations, on the Preseli Hills, Pembrokeshire, Wales and on Dartmoor respectively. The primary management requirement in acid-neutral seepages is to maintain grazing on sites, as this prevents the seepages becoming smothered by tall vegetation such as purple moor-grass *Molinia caerulea* and rushes *Juncus* spp. Retention of some scrub around the seepages may also be important, particularly in upland situations, as this will provide shelter for adult insects.

Seepages on stable cliffs are probably of wide occurrence both around the rocky coasts of Britain, and inland in upland areas where there are significant areas of rock exposures. This is currently a very poorly known habitat, and further survey work is required before we will be able to categorise the invertebrate communities and their ecological requirements more precisely.

The extremely high number of key species recorded from woodland seepages is a result of the presence of a large number of craneflies that specialise in this habitat. Cranefly larvae of woodland seepage habitats tend to favour shaded conditions, so little management may be required in such cases. By contrast, it is thought that the larvae of the soldierflies recorded from this habitat, including the rare *Oxycera analis* and *Oxycera leonina* favour seepages in partial shade. In this case some "opening up" of the woodland canopy may be very important to their survival. Woodland seepages are clearly an extremely important habitat for a very large number of specialist invertebrates, and given the considerable losses of wet woodland habitats that have occurred in Britain in the last century, this must be considered to be a threatened invertebrate assemblage. The invertebrate fauna of woodland seepages is very poorly known, and more survey work is urgently required in order to better inform our decision-making.

Slumping cliff seepages have an exceptional invertebrate fauna that includes a large number of important species. They are naturally very localised habitat features, with the main areas of interest in England being in Lyme Bay, and on the North Sea coast of Yorkshire and

Norfolk. They have been comparatively well recorded for their invertebrate fauna, with the coleopteran assemblage being especially diverse. The main requirement needed to safeguard their invertebrate assemblage is that natural erosive forces be allowed to continue operating. Some sites have been damaged or destroyed in the past by cliff stabilisation schemes. Recent storms and wet weather have resulted in very active erosion taking place at most of these sites. With further stormy weather and sea level rise predicted as a result of global warming it seems certain that considerable erosion will continue to occur, and this may increase the pressure to carry out further stabilisation works.

The other outstanding seepage habitat for invertebrates is calcareous seepages. Lowland calcareous seepages support very diverse assemblages of associated invertebrates, with the soldierflies being particularly characteristic. Upland calcareous seepages are better still, with molluscs, craneflies and soldierflies all being represented by a number of very important species. Because they are small and localised features, calcareous seepages are quite easy to overlook. In the uplands particularly, there are considerable areas of limestone country which have never had invertebrate surveys undertaken, and which could well have invertebrate assemblages of comparable interest to those known from sites such as Sunbiggin Tarn and Moor House NNR. Further survey of upland calcareous seepages is considered to be the top priority arising out of this review, given the exceptional number of species of national and international interest that this habitat supports. As with acid-neutral seepages, the main management requirement for upland seepages would appear to be adequate grazing, as this prevents the watercourses becoming swamped with coarse vegetation. It may also be important to retain some scrub around the seepages, as this may provide valuable shelter, particularly in more upland situations.

4. Recommendations for further work

- Carry out further surveys of the invertebrate fauna of upland calcareous seepages. The botanical survey of base-rich upland seepages in England commissioned recently by English Nature (Hallam, 2001) provides an excellent starting point for drawing up a list of priority sites to be surveyed.
- Carry out targeted surveys of lowland calcareous seepage invertebrate assemblages (including wooded seepages) in areas known to have a high level of interest, such as the Hamble, Test and Itchen valleys in south Hampshire, the Corallian limestone springs west of Oxford and the seepage pingo systems of east Norfolk.
- Carry out surveys of the slumping cliff seepages of the east Yorkshire and east Norfolk coast in order to assess the current status of rarities such as *Nebria livida* and *Bledius filipes*, and their management requirements.
- Collate information collected by the Tipulid Recording Scheme. Use this to define important tipulid assemblages in seepages. It is anticipated that this will be particularly valuable in categorising cranefly communities in woodland seepage habitats.
- Collect and collate information on the Dolichopodid and Empidid assemblages of seepages.
- Carry out surveys of stable cliff seepage systems on the south Devon coast in order to begin to build up a picture of the community structure of this habitat, and to provide further information on the distribution and ecology of the water scavenger beetle *Ochthebius poweri*.

- Collect and collate further information on the ecology of seepage invertebrates. Currently, there is very little information on this subject, and without it we cannot build up an accurate picture of the conservation requirements of seepage invertebrate assemblages. This includes the continuing work on BAP priority species of seepage systems, such as southern damselfly and bog hoverfly.
- Ensure that management of existing sites holding important assemblages of seepage invertebrates takes into account the needs of these species. Of particular importance will be incorporating the requirements of the seepage invertebrate fauna into the HAPs for priority habitats such as fens and wet woodland.

5. Survey methods

The five priority habitats are listed below, and for each one, the invertebrate taxa considered most likely to yield important information are identified, along with the optimum time of year for sampling them, and the methods by which they are best sampled.

Slumping cliff seepages

Coleoptera (April-July). Pitfall trapping, sweeping, hand-searching, vacuum sampling.
Tipulidae (April-October) & Stratiomyidae (May-July). Sweeping, netting and hand-searching for larvae.

Stable cliff seepages

Coleoptera (April-May). Hand-searching.
Tipulidae (April-October). Sweeping, netting and hand-searching for larvae.

Woodland seepages

Tipulidae (April-October). Sweeping, netting and hand-searching for larvae.
Stratiomyidae (May-July). Netting and hand-searching for larvae.

Acid-neutral seepages – Not a priority for survey currently.

Calcareous seepages

Stratiomyidae (May-August). Netting and hand-searching for larvae.
Tipulidae (May-October). Sweeping, netting and hand-searching for larvae.
Mollusca (all year). Hand searching.

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Appendix 1 Red Data Book, BAP Priority and ECII invertebrate species associated with seepage habitats in England.

Mollusca:

The sandbowl snail *Catinella arenaria* (Bouchard-Chantereaux) (Succineidae) **BAP, RDB1.** The sandbowl snail is so named because of the occurrence of a large population of this species around slacks in sand dunes at Braunton Burrows, Devon. However, its other site is at Orton Fell, Westmorland, where it occurs in fen irrigated by calcareous springs. A second endangered mollusc, *Vertigo geyeri* also occurs at this site (see below) (Bratton ed., 1991).

Round-mouthed Whorl Snail *Vertigo genesii* (Gredler) (Vertiginidae) **ECII, RDB1.** This tiny snail is known from just one site in Britain, in Teesdale, County Durham. Its habitat is in calcareous flushes at altitudes of around 500 metres (Bratton ed., 1991).

Geyer's Whorl Snail *Vertigo geyeri* Lindholm (Vertiginidae). **ECII, RDB1.** Until recently this species was only known from Orton Fell, Westmorland, where it occurs in calcareous flush fen in association with *Catinella arenaria* (Bratton ed., 1991). It is now additionally known in Britain from two sites on Anglesey, north Wales where it also occurs in calcareous flushes.

Odonata:

Southern Damselfly *Coenagrion mercuriale*(Charpentier) (Coenagriidae). **ECII, RDB2.** The southern damselfly occurs in two main types of seepage habitat in Britain. The majority of its colonies are in acid-neutral seepages in Devon, Dorset, Hampshire (New Forest) and in Pembrokeshire (Mynydd Preseli), west Wales. However, it also occurs in calcareous seepages at Dry Sandford Pit, Oxfordshire and at two sites on Anglesey, north Wales. Further colonies occur in the Test and Itchen valleys in Hampshire, where it inhabits calcareous streams and drains.

Coleoptera:

Cliff Tiger Beetle *Cicindela germanica* (Carabidae) **BAP, RDB3.** The Cliff Tiger Beetle is currently confined to slumping coastal cliffs in Devon, Dorset and the Isle of Wight. There is additionally an old record from the south Wales coast. The larval burrows are found in areas of bare sand and clay at the margins of slumping cliff seepages.

Tachys micros (Carabidae) **BAP.** This tiny reddish ground beetle is found at a handful of sites on the southern English coast between Sussex and Dorset. There is also a recent record from the south coast of the Lleyn Peninsula at Porth Neigwl in north Wales. In all cases, the beetle has been found in bare areas of very wet sand and clay at the edge of slumping cliff seepages.

Chlaenius nitidulus (Carabidae) **RDB1.** Formerly *C nitidulus* was known from the margins of slumping cliff seepages in Sussex, the Isle of Wight and Dorset. Unfortunately the last record of this beautiful ground beetle was from the latter county in 1930.

Drypta dentata (Carabidae) **RDB1.** Another great rarity of slumping cliff seepages on the southern English coast. Fortunately good populations of this stunning blue-green metallic ground beetle are still known to occur in both the Isle of Wight and Dorset. Adults are generally found in less eroded seepage areas, where they occur in litter of common reed *Phragmites australis*, great horsetail *Equisetum telmateia* and other wetland plants.

Ochthebius poweri (Hydraenidae) **BAP, RDB3.** This small water scavenger beetle is known from two places on the south Devon coast, and from a single site in Pembs, Wales. In all cases, the habitat in which it is found is shallow trickles of water running over vertical faces of coastal Old Red Sandstone cliffs (Foster, 1990).

Acrotrichis lucidula Rosskothen (Ptiliidae) **RDBK.** This tiny featherwing beetle has recently been found at only one site in England, in Cheshire and there is also a recent record from Merioneth in Wales. There are older records from a scatter of English sites, from Sussex to north-east Yorks. The two recent captures both relate to individuals found by woodland seepages, though the old records include a wider range of wetland habitats.

Aloconota planifrons Waterhouse (Staphylinidae) **RDBK.** An aleocharine rove beetle, it has recently been found in England only on the Isle of Wight, where it is thought to be associated with slumping cliff seepages, though there are a number of older records from various counties in southern England. There is also a surprising recent record from the Hebrides in Scotland.

Bledius crassicollis Boisduval & Lacordaire (Staphylinidae) **RDBI.** This fossorial rove beetle has only recently been found at a single site on the Isle of Wight. There is additionally an older record from east Kent. It constructs its burrows in damp sand and clay at the edge of slumping cliff seepages.

Bledius dissimilis Erichson (Staphylinidae) **RDBI.** The strongest extant population of this rove beetle is in slumping boulder clay cliffs in south-east Yorks, where the burrows of this species can be found in damp clay at the edge of seepages. It also occurs in sandy riverbanks in Berks, and there is an old record from Scotland.

Bledius filipes Sharp (Staphylinidae) **RDB1.** *B filipes* has only ever been known from a handful of sites on the boulder clay cliffs of the east Norfolk coast. It is currently known to occur at just a single site, where its burrows are found in wet clay at the edge of slumping cliff seepages.

Bledius occidentalis Bondroit (Staphylinidae) **RDBK.** This rove beetle is currently known from a handful of sites in Kent, Sussex and Yorks. It inhabits sandy slumping coastal cliffs, where its burrows are found around freshwater seepages. It is also found in sand dune systems, at the margin of streams and slacks.

Stenus fossulatus Erichson (Staphylinidae) **RDB1.** Only known from the slumping cliffs of Castle Eden Dene National Nature Reserve (NNR), Durham. The beetle occurs around seepages running down the slopes.

Scopaeus laevigatus (Gyllenhal) (Staphylinidae) **RDBI.** *S laevigatus* is currently known from just two sites, in Dorset and Sussex. At the former site, this rove beetle is found on bare

sand and clay at the edge of slumping cliff seepages. There is also an earlier Devon record from similar habitat. The Sussex site is on the muddy fringes of a reservoir.

Scopaeus minutus Erichson (Staphylinidae) **RDB1.** A specialist inhabitant of the bare sandy and clayey margins of slumping cliff seepages, *S minutus* has only ever been known from the south Dorset coast.

Gabrius astutoides (Strand) (Staphylinidae) **RDBI.** This rove beetle has only recently been found in a single site on the south Devon coast. It was found at the edge of a seepage on an Old Red Sandstone cliff. There are old records from Devon, Kent and Surrey from other habitats.

Sphaerius acaroides Waltl (Sphaeriidae) **RDBK.** A minute scavenger beetle that has only recently been found at Eype's Mouth in Dorset, where it can be found in moss and plant litter at the edge of slumping cliff seepages. There are however a scatter of records from other sites throughout England that include other wetland habitats such as fens.

Longitarsus aeruginosus (Foudras) (Chrysomelidae) **RDB1.** A flea beetle whose host plant is hemp agrimony *Eupatorium cannabinum*. It has not been recorded in Britain since 1930, when it was found around seepages on the slumping cliffs at Charmouth in Dorset. It had previously been recorded in similar habitat on the Isle of Wight. There are also some old records from riverbanks in Surrey and Hants.

Baris analis (Olivier) (Curculionidae) **RDB2.** A weevil whose foodplant is common fleabane *Pulicaria dysenterica*. It is only known from patches of the foodplant growing at the margins of slumping cliff seepages in Dorset and on the Isle of Wight.

Hylobius transversovittatus (Curculionidae) **RDB1.** The larvae of this weevil feed at the roots of purple loosestrife *Lythrum salicaria*. This species is currently only known from the peat moors of the Somerset Levels. However, it was formerly also known to occur around slumping cliff seepages on the south Devon coast.

Trichoptera:

Adicella filicornis (Pictet) (Leptoceridae) **RDB3.** The larvae of this caddisfly are found in shallow streams and seepages where the water is calcareous. They have been found in both open and wooded habitat inland, and also occur on limestone sea cliffs at a single site in south Devon. In Britain this species shows a wide, but very sparse distribution, with most records originating from Wales.

Diptera:

Arctoconopa melampodia (Loew) (Tipulidae) **RDB2.** There are a number of records of this cranefly from shaded, sandy river banks in northern and western England and Scotland. However, the most recent record is from slumping cliff seepages on the Dorset coast.

Dicranomyia goritiensis (Mik) (Tipulidae) **RDB3.** A cranefly of coastal cliff seepages in western Britain, with most records originating from south-west England and Wales. The larvae occur in waterlogged vegetation around seepages that are overhanging the cliffs.

Dicranomyia lackschewitzi (Tipulidae) **RDB1.** A very rare species of cranefly, it is only known from a single site on the Isle of Wight. The larval habitat is seepages over mud with sparse mosses on slumping coastal cliffs. This species is also considered to be extremely rare in Europe (Stubbs, 1998).

Dicranomyia stylifera (Lackschewitz) (Tipulidae) **RDB2.** A rare cranefly of calcareous upland seepages. Most sites are in Scotland, but it is also known from Moor House NNR, Cumbria.

Erioptera meijeri Edwards (Tipulidae). **RDB2.** This cranefly occurs in a wide scatter of sites throughout England. The larval habitat is wet fenland, especially around springs and seepages.

Gonomyia abbreviata Loew (Tipulidae). **RDB3.** *G abbreviata* has a scattered distribution in England north to Yorkshire, and in Wales. It occurs in calcareous seepages in wet woodland (Falk, 1991).

Gonomyia alboscutellata (von Roeser). **RDB1.** In Britain, *G alboscutellata* is only known to occur in three sites; Haugh Wood in Herefordshire, the Wyre Forest, Worcestershire and Whitewell, Yorkshire. At Haugh Wood, it appears to be associated with mossy calcareous seepages running through the wood (Falk, 1991).

Helius hispanicus (Tipulidae) **RDB1.** This cranefly was only discovered in Britain in 1989. It is known from a single site in Devon, where it occurs by small streams and trickles on coastal cliffs (Stubbs, 1998).

Idiocera bradleyi (Edwards) **RDB2.** Recent records of this cranefly come from two sites, on the east Yorkshire coast, and from Cardiganshire in west Wales. In both cases, the records are from slumping coastal cliff seepages.

Lipsothrix nervosa (Tipulidae). **BAP, RDB5.** An endemic cranefly that is locally common in southern England and Wales. The larvae occur in wet dead wood in woodland streams and seepages.

Lipsothrix nigristigma Edwards (Tipulidae). **RDB1.** A very rare cranefly that has only recently been recorded in Shropshire. There is an additional old record from Lancs. The larval habitat is thought to be wet dead wood in wooded streams and seepages.
Molophilus czizeki Lackshewitz (Tipulidae). **RDB3.** A northern cranefly, with most British records originating from Scotland, though there are also sites in Wales, and in Lancashire and Cumbria in northern England. The larvae are believed to develop in seepages in woodland.

Orimarga virgo (Zetterstedt) (Tipulidae). **RDB3.** A cranefly of calcareous seepages, both in open and wooded habitats. A number of the sites are on limestone cliffs, both on the coast, and inland on quarries. The distribution is very scattered through western England, Wales and Scotland.

Paradelphomyia ecalcarata (Edwards) (Tipulidae). **RDB2.** There are only three records of this cranefly in Britain, two from north Wales, and one old record from Exmoor, Devon. This species is thought to be associated with calcareous seepages in woodland.

Symplecta scotica (Tipulidae). **RDB2** This cranefly occurs on slumping cliff seepages in Yorkshire and on the Cheviot. It is also known from near Dingwall in Scotland, and from the Lleyn Peninsula, Caerns., north Wales.

Tasiocera jenkinsoni Freeman (Tipulidae). **RDB1.** There are only two records of this cranefly in Britain, both of which derive from areas of seepage alder carr in Sussex (Falk, 1991).

Tipula coerulescens Lackshewitz (Tipulidae). **RDB3.** A rare cranefly of upland calcareous seepages in Scotland and northern England. It is known from flushes derived from upland Carboniferous limestone at Moor House NNR, Cumbria.

Tipula gimmerthali Lackshewitz (Tipulidae). **RDB3.** This cranefly has its main centre of distribution in the Scottish Highlands. It is also known from a single site in northern England, at Moor House NNR, Cumbria. The larval habitat is thought to be base rich upland seepages (Falk, 1991; Stubbs, 1992).

Trigoma trisulcata (Schummel) (Tipulidae). **RDB3.** A cranefly of upland seepage bogs and streams. The larvae hook themselves onto aquatic mosses such as *Acrocladium cuspidatum* and *Fontinalis antipyretica*. An upland species occurring in Scotland, north Wales and Yorkshire and Lancashire in northern England (Falk, 1991).

Tipula limbata Zetterstedt (Tipulidae). **RDB3.** A northern cranefly, most often encountered in boggy woodlands in Scotland. There are also records from the Pennines in northern England, where the species has been found on acid flushes on moorland (Falk, 1991, Stubbs, 1992).

Silver Colonel *Odontomyia argentata* (Fabricius) (Stratiomyidae). **RDB2.** A very rare soldierfly, with recent records from East Anglia, Hants and Berks. The larvae have been found in very shallow pools that dry up in the summer, and its association with seepages must be regarded as provisional pending further information on the ecology of the species.

Barred Green Colonel *Odontomyia hydroleon* (Linnaeus) (Stratiomyidae) **RDB1.** Regarded as doubtfully British until it was discovered at a site in mid-Wales in 1986. In 1988, the species was recorded on the southern edge of the North York Moors. In both cases, the habitat is calcareous seepage fen.

Dark-winged Soldier *Oxycera analis* Meigen (Stratiomyidae) **RDB2.** A very scarce soldierfly known from a scatter of sites in southern England. Recent studies indicate an association with calcareous seepages in open structured woodland and woodland edges (Stubbs and Drake, 2001).

Round-spotted Major *Oxycera dives* Loew (Stratiomyidae) **RDB3.** A northern soldierfly, that has been found in a number of sites in the Pennines and on the southern edge of the North York Moors. Also known from Scotland and Wales. A specialist inhabitant of calcareous seepages, often where there is some shelter from adjacent woodland and scrub.

Irish Major *Oxycera fallenii* Staeger (Stratiomyidae) **RDB1.** As its vernacular name indicates, this was thought to be an exclusively Irish species, known from a cluster of sites to the south west of Dublin. However, in 1997 it was found on the southern fringes of the North

York Moors in association with calcareous seepages where there is shelter from adjacent woodland and scrub.

Twin-spotted Major *Oxycera leonina* (Panzer). (Stratiomyidae) **RDB1.** First recorded in Britain in 1989, when it was found in Norfolk and Suffolk. The ecology is uncertain, but it may have an association with calcareous seepages in woodland.

Clubbed General *Stratiomys chamaeleon* (Linnaeus) (Stratiomyidae) **RDB1.** This spectacular soldierfly is only known from a single English site, in Oxfordshire. It is also known to occur at two sites on Anglesey, Wales, and one on the Black Isle, Scotland. Its exclusive habitat is calcareous seepages.

Bog Hoverfly *Eristalis cryptarum* (Fabricius) (Syrphidae) **BAP, RDB2.** This drone-fly was formerly known from a scatter of sites in southern England in Cornwall, Devon, Dorset and Hampshire. It is now only known to occur at a handful of sites on Dartmoor, having entirely disappeared from the rest of its former range, including its former stronghold in the New Forest. The larvae are thought to inhabit acid flushes, where cattle and pony grazing pressure maintains open, poached conditions. There may be an association with animal dung, as a female has been seen ovipositing in cattle dung at one of the sites.

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Peter Wakely/English Nature 17,396
Middle left: Co_2 experiment at Roudsea Wood and Mosses NNR, Lancashire.
Peter Wakely/English Nature 21,792
Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.
Paul Glendell/English Nature 23,020
Main: Identifying moths caught in a moth trap at Ham Wall NNR, Somerset.
Paul Glendell/English Nature 24,888