Invertebrates of Exposed Riverine Sediments

Entomological Monitoring Services (EMS)

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EXECUTIVE SUMMARY

The invertebrates of exposed riverine sediments (ERS) are known to be a potentially important conservation resource but the information concerning the distribution of both ERS and ERS invertebrate species and assemblages was limited and localised. The distribution of ERS was investigated using a questionnaire and by reference to the River Habitat Survey (RHS). Invertebrate data were collated from nature conservation bodies and from individuals with an interest in the field.

ERS are a product of river flow, geology and drift and the distribution and extent depends on topography and the effects of river management and land use. The rougher, coarse sediment ERS are found in the more upland areas with faster flowing rivers whilst silt and other small particle ERS are limited to lowland rivers with slow flow. Channel straightening and bank regrading are likely to reduce the abundance of ERS; other procedures can alter the nature of ERS. Adjacent land use and developments within catchments can also have important effects. The results of river corridor surveys and aerial photographs are of limited use in identifying ERS whilst the RHS data was good at giving an initial idea of ERS in a catchment. However, there were discrepancies between RHS data and known ERS distributions.

Rare and notable invertebrate records were abstracted from the Invertebrate Site Register but this data was not comprehensive. More useful species assemblage data was forthcoming from Wales, Northumbria and the Soar catchment in Leicestershire. Sufficient information was collated to produce two classifications of ERS habitats. A Britain and Ireland ground beetle classification and one using ground and rove beetles from the River Soar generated structures which could be used to investigate environmental change and conservation potential. These classifications gave an insight into the effects of river management procedures on invertebrate assemblages. The effects of bank regrading take about five years to stabilise, into relatively poor habitats, but if the sediment features are not totally removed recovery to a more natural state is possible.

A system based on species rarity proved viable in assessing the conservation value of sediments. Quantifications of rarity enabled sediments to be ranked in the habitat groups of the classifications. Some account of the number of the rarer species was shown to be possible.

It was concluded that ERS are likely to be one of the few relatively natural habitats present in highly managed landscapes. The knowledge of both ERS and invertebrates is not comprehensive but even so it is obvious that they are especially important in invertebrate conservation. It is possible to define conservation quality based on invertebrate recording. It is recommended that a systematic, structured survey throughout England and Wales is required to fully understand the distribution of ERS, of ERS invertebrates, their contribution to conservation and the effects of river management.

KEY WORDS

Exposed Riverine Sediments; Invertebrates; Conservation; River Management

1. INTRODUCTION

It has been known for some time that exposed riverine sediments (ERS) are interesting and potentially important wildlife habitats. Large sediments can be important as nesting sites for birds but it is likely that their greatest importance in both regional and national contexts will be as invertebrate habitats. The invertebrate communities of ERS have until recently not received the attention they deserve in river conservation initiatives. There is now a wider acceptance of the need to conserve good quality ERS sites and in particular to consider the impact of river management practices on their fauna.

One of the primary aims of this report is to explore the distribution of ERS in England and Wales and the extent of ERS invertebrate species and records from these habitats in relation to other work in Europe. The work of the national conservation bodies by instigating such programmes as the Invertebrate Site Register as been important in identifying the more upland, shingle type ERS as being hot spots for rare invertebrates. However, it is apparent that soft ERS in both upland and lowland areas also support a specialist fauna containing many invertebrate species of conservation significance.

The distribution of rare and notable invertebrate species on ERS leads to the possibility of using invertebrates in conservation assessments. To use invertebrates as tools for conservation and environmental assessment, standardised procedures are required and the potential for sampling invertebrates with reproducible and efficient methods is investigated.

This report also outlines what is known about the effects of various river management practices on ERS invertebrates. Research in this area has been extremely limited but we know that ERS invertebrates are sensitive to changes in management. Furthermore, our knowledge of the ecology and life cycles of these animals is sketchy and often open to conjecture. This makes prediction of the effects of management very difficult. Clearly much more research is required on this subject. Recommendations regarding survey and analysis of ERS invertebrates for their use in assessing environmental change are given.

The objectives of the work as set out in the contract specification are given in Appendix A.

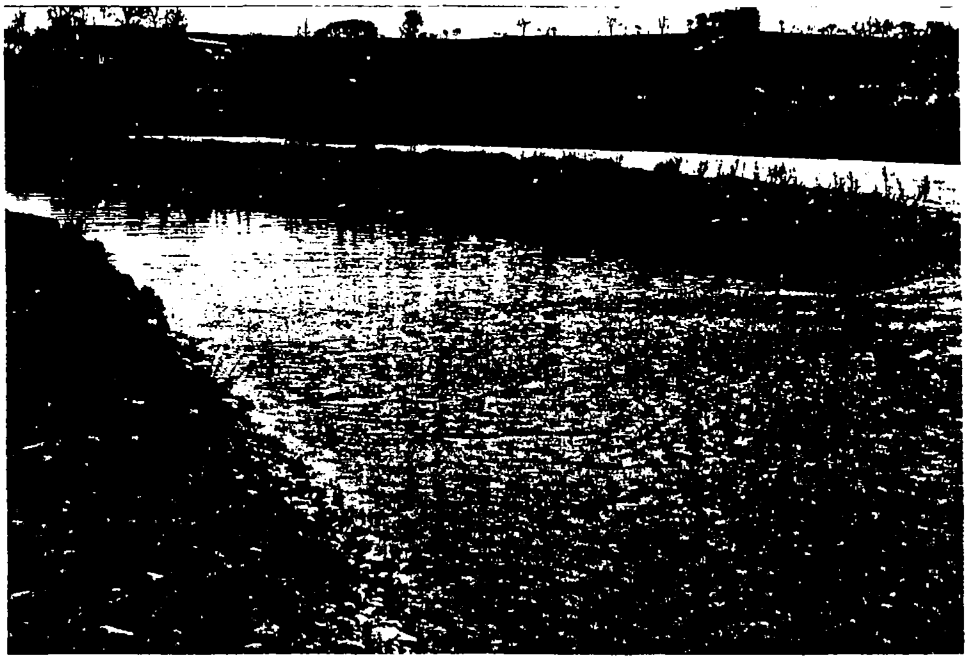

Figure 2.1 Photographs of a typical river flowing off hills (top, River Coquet) giving rise to large sediment ERS and bars on bends (bottom)

2. EXPOSED RIVERINE SEDIMENTS

2.1 Definition

Exposed riverine sediments (ERS) are deposits of sediment in channels of flowing water subsequently exposed by reduced water levels. A variety of terms are used for them including shoals, bars, berms, spits, sandbanks and shingle-banks. ERS are mainly found under the main riverbank and there is often an easily observable boundary between an ERS and the adjacent floodplain. These sediments are dynamic and can change in extent, in composition and in location within a single flood event. The geomorphology of ERS is discussed in such publications as Lewin (1981), Sear and Newson (1991, 1994) and Petts and Gurnell (1995).

Figure 2.1 shows the configuration of a river flowing off an upland area, in this case the River Coquet in Northumberland off the Pennines. ERS are present on all the river bends and an example of a large particle ERS and a sediment bar in the river is also shown in Figure 2.1. An example of an ERS composed of smaller particles, especially sand, is shown in Figure 2.2 as well as an example of a partially vegetated sand/silt ERS. These are ERS more associated with lowland rivers, in this case the River Till in north Northumberland.

There has been large scale fluctuations in ERS frequency, composition and extent in the last 200 years because of periods of increased flood activity resulting from climatic changes and increased sediment supply with land use change. More recently, river engineering involving bank regrading, maintainance and river regulation has reduced the extent of ERS by removal or modification of the hydrological regime.

ERS are subject to repeated scouring by floods followed by fresh sedimentary deposition. Consequently, ERS vegetation undergoes a cycle regulated by frequency of flooding. During floods, any plants present can be either removed or covered with fresh deposits to leave areas of bare ground. The vegetation then grows up again until it is removed by the next flood. At the top of large ERS flooding may be relatively infrequent and here vegetational succession may become quite advanced, leading to the presence of trees such as sallow and willow.

ERS also occur along secondary channels. These channels may only become filled during high floods and then ERS become difficult to distinguish from floodplain habitats. Vegetational succession may be advanced on ERS in secondary channels and in headwaters which suffer from relatively infrequent and mild flooding. Large ERS can have considerable topographic complexity. Large continental rivers such as the Loire in France are bordered by ERS which can be several hundred metres wide and contain a bewildering array of sandhills, old channels and remnant pools.

Limestone and chalk streams, winterbournes and headwaters, may dry up on the surface in the summer. Technically, the entire riverbed then becomes ERS.

Figure 2.2 Photographs of a sand and small particle ERS (top) and of a partially vegetated sand/silt ERS by a lowland river (bottom, River Till)

2.2 ERS formation

The location, composition and extent of ERS is dependent on local gradient, which affects the ability to transport sediments, and the relative sediment supply to a river reach. Brookes (1995) shows a map of channel slope in England and Wales (Figure 2.3) giving a pattern which reflects the basic distribution of ERS and of ERS type. Low gradient channels, usually with a good supply of sediment, will tend to deposit sediments in transport leading to ERS accumulation. The steeper gradient rivers, with less sediment supply, may produce ERS through channel scour and exposure of marginal sediments. The composition of ERS is a product of the size of the sediment particles and the morphology of the river channel, especially planform and cross-section shape (National Rivers Authority 1994a). Wide, shallow channels tend to lead to ERS deposition whilst narrow, deeper sections often only have ERS on the inside of meanders. In upland areas, ERS may occur away from the present river channel because of changes of river course or there may be dissection of sediments into more complex structures. Large flood events can lead to deposition of sediment above the height of the channel banks. In these cases, the sediment may quickly become a relict feature with innundation only occurring in exceptional flood conditions. Sediments deposited in the flood plain tend to be short lived as they tend to be dominated by fine sediments and they vegetate rapidly.

There is relatively little knowledge about ther ERS of lowland sand and silt river channels. These sediments tend to be taken over quickly by vegetation, which in winter dies back to reveal sandy or silt benches. Most silt-clay lowland rivers and streams have been modified, usually by dredging to improve land drainage. River restoration may be the only approach to find what has been lost to the river channel in terms of naturally occurring ERS. In the absence of river maintainance, ERS soon re-establish by either the scouring of the bed to expose stranded sediments or through accumulation of sediments as they are deposited in the modified reach. Although ERS may reform, the particle size may be changed. In overwidened channels or where there is regulated flood peaks, ERS may be dominated by finer sands and silt. Larger particle ERS may be produced where local stream energy has been increased or where hydropower regulation dominates the flow regime.

The composition of ERS tends to be complex because the sediment particles deposited are a product not only of the gradient and the geology of an area but also of past flood events. In general, ERS have coarser sediment particles at their upstream end and finer sediments in the downstream reaches. However, similar ERS structures are, for instance, found in the upland regions of the north Pennines, in north Wales and in the south-west of England even though the underlying rocks in the north Pennines are sandstone and limestone, contrasting with the older, harder rocks in north Wales and the south-west of England.

There is also vertical sediment particle segregation with, usually, finer sediments dominating the upper surfaces of the ERS. Further variability occurs when a coarse layer covers the surface of ERS. This layer may be breached during flood events and fine sediments re-exposed or buried, giving rapid changes in surface sediment size. Progressive changes in sediment particle size in ERS have been described for rivers experiencing regulation, with silting of marginal ERS and coarsening of mid-channel ERS, or where extensive land use change have released sediments of varying size into the system. Fine particulate sediments have been depoisted on ERS because of afforestation or from clear felling existing trees.

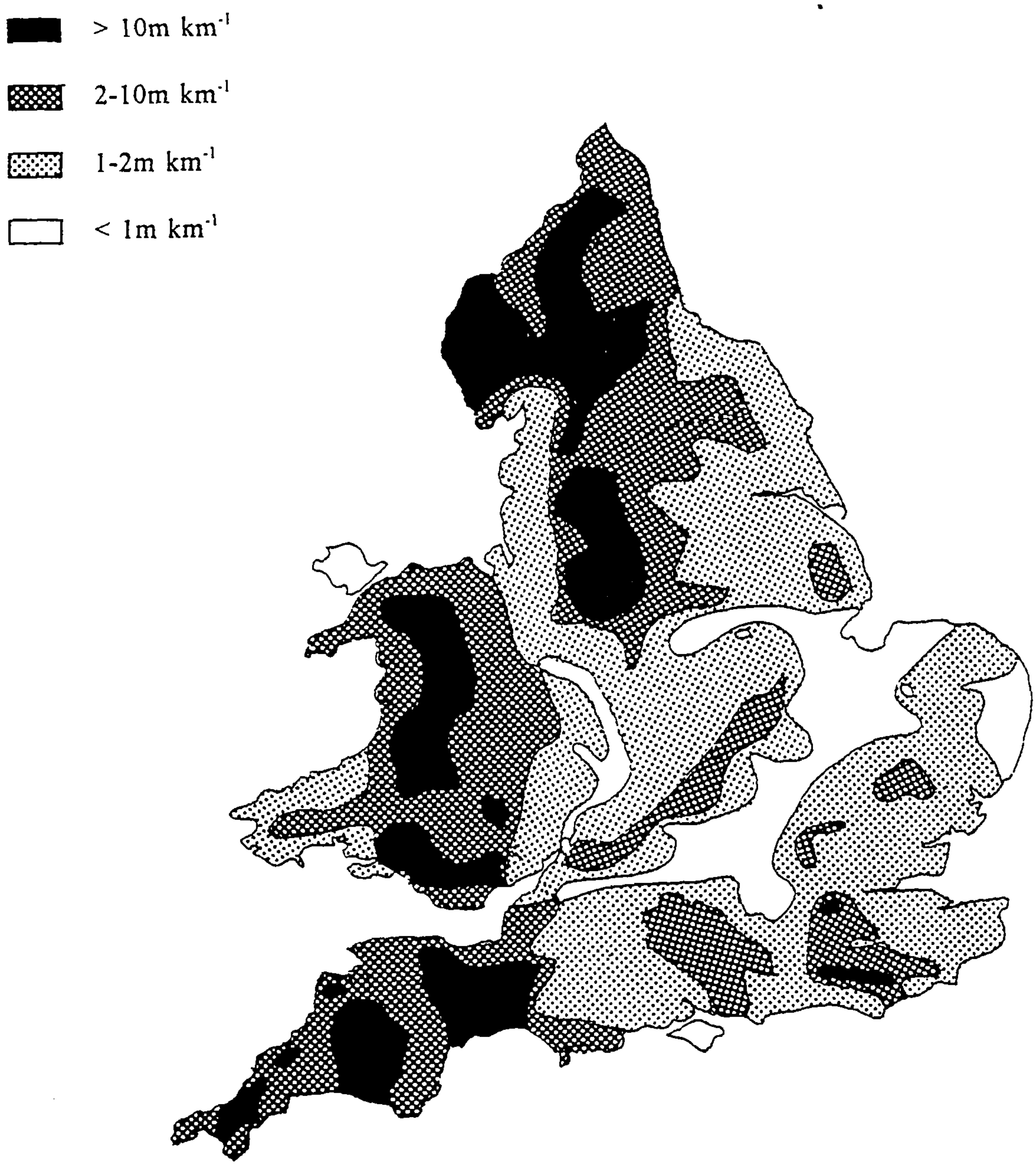

Figure 2.3 River channel slope in England and Wales (adapted from Brookes 1995)

Some features which look like ERS have a different origin. Steep eroding banks may slump into the channel either because they contain a spring or because they are poached by cattle. Even several years after cattle have been removed from a riverbank the results of their presence can still be evident in collapsed banks.

2.3 ERS wildlife importance

ERS are important because, in landscapes, they provide one of the few relatively natural wildlife habitats. They are an important feature of river corridors, even if little effort has yet been put into assessing their actual value. There is little, for instance, about the wildlife of ERS in the recent New Rivers and Wildlife Handbook (RSPB, NRA and RSNC 1994). River corridors have been rightly assessed as being important corridors for wildlife and their value has been highlighted by studies such as Rushton, Hill and Carter (1994) who found a high incidence of breeding birds in these corridors. However, within river corridors ERS were not singled out as being of any importance and the data collection in the Waterways Bird Survey carried out by the British Trust for Ornithology does not include specific ERS recording. The incidence of breeding birds on ERS is limited to large sediments with little human disturbance but they are important as nesting areas for species such as little ringed plover and oystercatcher. In areas of upland mineral extraction a number of ERS have specialised metalophyte plant communities able to withstand high heavy metal levels in soil. The flora of marginal habitats was included by Holmes (1983) in a national survey of river vegetation. ERS in lowland areas have a diverse flora which form part of the various communities identified in the Holmes classification. However, ERS are not normally recognised as areas of high botanical interest.

The invertebrate communities of ERS are by far the most important wildlife attribute. Most attention has focused on the beetles of ERS, especially ground beetles (e.g. Andersen 1968, 1969, 1984; Reid and Eyre 1985; Plachter 1986; Luff, Eyre and Rushton 1989; Luff 1995). Other beetle families such as the Staphylinidae (rove beetles) have also been shown to be highly characteristic of ERS (e.g. Fowles 1989; Lott 1992, 1993). A number of ground, rove and water beetle species found on ERS (*Badister anomalus, Bembidion testaceum, Lionychus quadrillum, Perileptus areolatus, Thinobius newberyi, Bidessus minutissima*) are included in the middle list of species of the recent UK biodiversity steering group action plans whilst there is another rove beetle species and a click beetle species (*Meotica anglica, Negastrius pulchellus*) in the long list of species (Department of Environment 1995). Figure 2.4 shows an example of a ground beetle (Carabidae) in the genus *Bembidion* (*B.bruxellense*) and species in this family are important in assessing habitat type and conservation quality of ERS. Species in the genus *Bembidion* occur on all types of ERS with some restricted to bare, large particle ERS and some found on lowland, vegetated sediments.

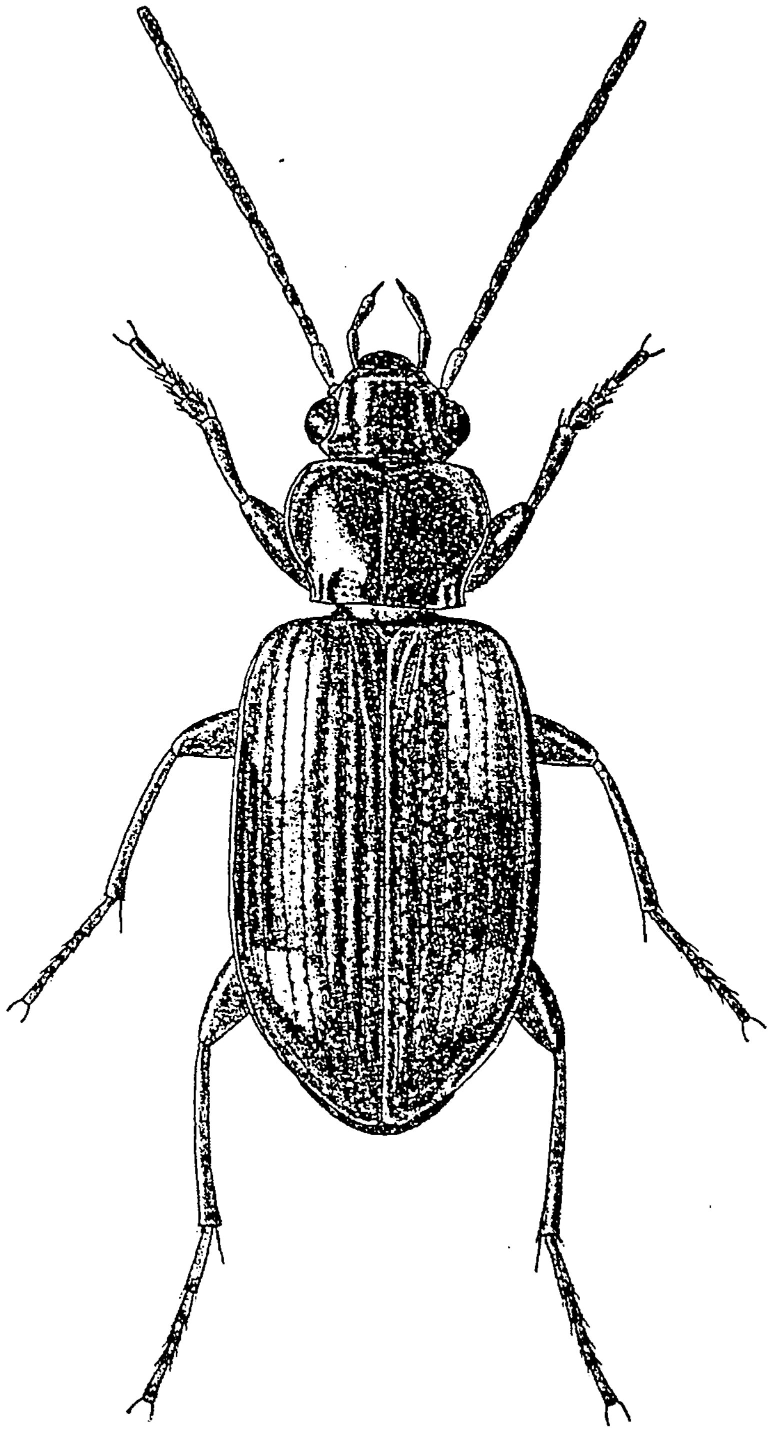

Figure 2.4 *Bembidion bruxellense*, a ground beetle species in a genus with many species occurring on ERS of all types

Rove beetles (Staphylinidae) are the other group of invertebrates where the potential for assessing habitat type and quality has been investigated. There are species which occur on ERS of all types but some, such as *Thinobius newberyi* (Figure 2.5), are only found in bare shingle ERS.

A number of other invertebrates are also known to be specific to ERS including some fly (Falk 1991), bug (Kirby 1992) and spider species (Locket, Millidge and Merrett 1974). A crane fly of ERS, *Rhabdomastix hilaris*, is included in the middle list of the biodiversity steering group action plans (Department of Environment 1995). Hyman (1992, 1994) lists a considerable number of rare beetle species found only on ERS and this report brings together the information on the status and distribution of these species, and of species in other invertebrate groups. The invertebrate species known to occur on ERS of all types are listed in Appendix B and the literature containing information about these invertebrates is given as a bibliography in Appendix C.

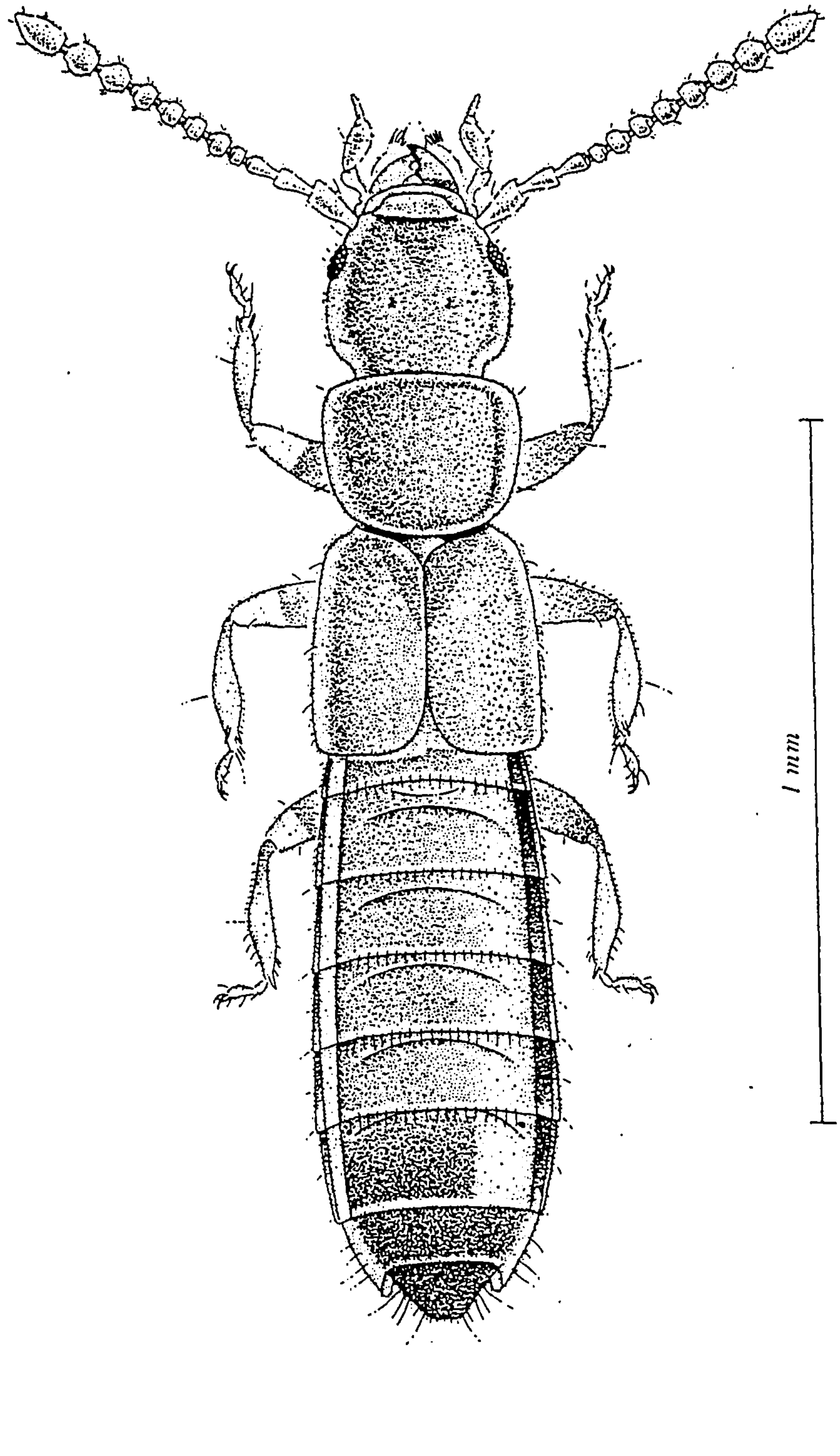

Figure 2.5 *Thinobius newberyi*, a rove beetle found in shingle ERS. This species has not been found outside the British Isles

3. ERS DISTRIBUTION IN ENGLAND AND WALES

3.1 ERS Identification

Information on the types and distribution of exposed riverine sediments (ERS) in England and Wales was generated using a number of methods.

3.1.1 Questionnaire

A questionnaire was sent to National Rivers Authority (now the Environment Agency) biologists and others requesting information on the type and extent of ERS in their Region. There were four frequency categories (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread) of four types of ERS (silt=<0..2mm; sand=0.2-2mm; shingle/gravel/pebbles=2mm-5cm; cobbles/boulders=>5cm) to be estimated in the hydrometric areas in their region. The questionnaire and covering letter are shown in Appendix D. Other information requested on the questionnaire were data relating to the type and amount of river and water management practices, the major land uses in the Region and the extent of coverage of rivers by river corridor surveys and aerial photographs.

A summary of the information on the type and extent of ERS in the National Rivers Authority (NRA) Regions based on information from the questionnaire and EMS experience is given in Appendix Tables E.1-E.10. Maps showing the distribution of cobble/boulder and shingle/gravel/pebble ERS types in England and Wales, based on the questionnaire, are shown in Figure 3.1 whilst the distribution of sand and silt ERS are shown in Figure 3.2.

The information from the Northumbria Region indicated that most ERS were boulders/cobbles and pebbles/gravel, especially by the rivers flowing off the northern Pennines. Silt ERS are confined to rivers such as the Skerne and Pont which are in the lowland near the coast whilst the greatest amounts of sand are by the Till in north Northumberland. There is a similar pattern in Yorkshire where the larger sediment particles form most of the sediments by the rivers flowing off the Pennines with the lowland rivers such as the Ouse and Hull have more silt ERS. The information from North West Region was derived from EMS experience only since no questionnaires were received. The rivers flowing off the Pennines and in the Lake District have ERS with large sediment particles and similar to those on similar rivers in Northumbria and Yorkshire.

Most of the rivers in the Welsh Region have large particle ERS and flow off the hills but there are sand and silt ERS by rivers in the south and south-west. Rivers in the upper Severn area are similar to most Welsh, as are the ones in the rivers flowing off the Peak District into the Trent with ERS comprised mainly of boulders/cobbles and pebbles/gravel. In the lower Severn and the lowland Trent, most ERS are deposits of silt with some sand. Thames and Southern Region rivers have little in the way of boulders/cobbles ERS but some of the rivers have reasonable amounts of pebble/gravel ERS. As the rivers become larger, there are more silt and some sand ERS but, in general, there are relatively few sediments. This is a pattern also seen in Anglian Region but there appears to be more sand and silt ERS than in Thames region. Data from South West Region was limited to large areas.

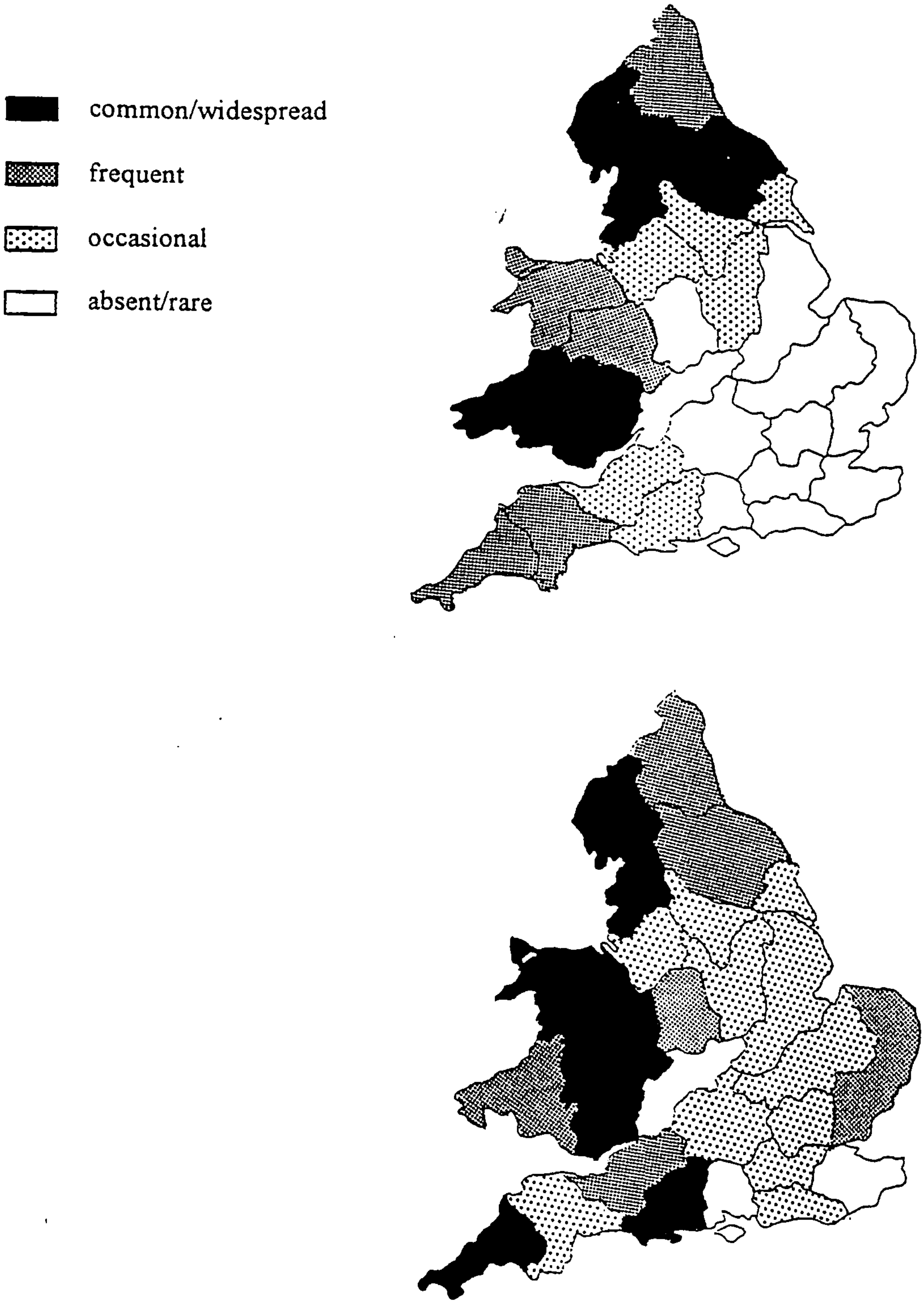

Figure 3.1 The distribution of cobble/boulder (top) and shingle/gravel/pebble (bottom) ERS in England and Wales based on the questionnaire

Figure 3.2 The distribution of sand (top) and silt (bottom) ERS in England and Wales based on the questionnaire

Considerable amounts of ERS, especially of the smaller sediment particles, were indicated for south Wessex with a fair amount of pebbles/gravel in south Wessex. Cornwall has more ERS than Devon, particularly of pebbles/gravel but there were few ERS of sand or silt indicated for both counties.

3.1.2 River Habitat Survey

Data from the River Habitat Survey (RHS), co-ordinated by Peter Fox in North West NRA region, was received. The RHS provided an estimate of the frequency of ERS by recording point bars, side bar and mid-channel bar totals for each site sampled in similar categories to those in the questionnaire (boulders; cobbles; gravel/pebbles; sand; silt; clay). The relative amounts of ERS in four categories (boulders/cobbles; pebbles/gravel; sand; silt/clay) were calculated as proportions of the total number of bars recorded. The sites were chosen as the nearest river to the centre of 10km national grid squares and were a sample of sites and not a comprehensive survey.

A summary of the information on the type and extent of ERS in catchments in the NRA regions from the RHS is given in Appendix Tables F.1-F.10. Maps showing the distribution of cobble/boulder and gravel/pebble ERS types in England and Wales, as proportions of the total derived from the RHS, are shown in Figure 3.3 whilst the distribution of sand and silt/clay ERS are shown in Figure 3.4.

Most of the ERS indicated by the data in the RHS from Northumbria were either boulders/cobbles or pebbles/gravel, a pattern seen with the questionnaire data. However, the records from the Tweed catchment, including the rivers Till and Breamish, show no boulder/cobbles and little sand. The Till and Breamish both have considerable sand ERS and the relative proportions of ERS types in the Tweed catchment seem to be at variance with field experience. Another anomaly appears to be in the Blyth catchment where no silt ERS are indicated although they are known from field work. The Yorkshire data indicate a lot of boulders/cobbles and pebbles/gravel but no sand ERS and silt ERS only on the Aire. Whilst most of the ERS in Yorkshire are composed of the larger deposits, there are still likely to be more sand and silt than is indicated by the RHS data. The data from North West Region rivers indicate little sand or silt on the Pennine and Lake District rivers, as with the questionnaire data. There were more sand and silt ERS by the rivers in the south of the region but there were still more of the larger sediment deposits on these rivers.

The Welsh Region RHS data indicate more boulders/cobbles than pebbles/gravel on most of the rivers with very little sand and silt ERS. If the Mawddach catchment is a reasonable example of the rivers in the north of the region, it appears that there are more pebbles/gravel ERS than the RHS data indicates and certainly more sand ERS near the coast. The Severn sediments are fairly equally split between the two larger types whilst the rivers flowing off the Peak District have mainly boulders/cobbles ERS. The other rivers in Severn-Trent have mainly pebbles/cobbles ERS with some silt but little sand ERS were recorded throughout the region.

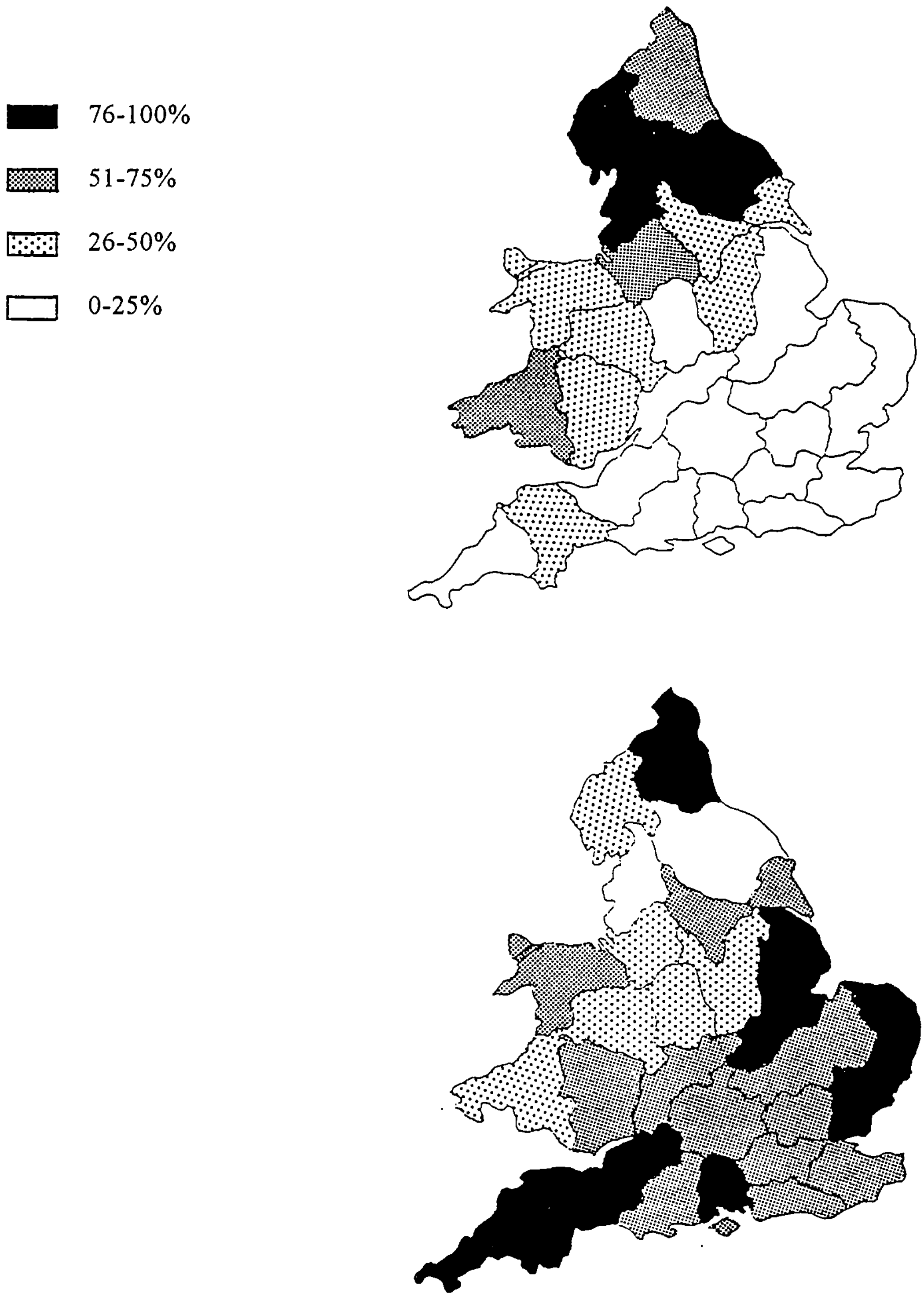

Figure 3.3 The proportion of cobble/boulder (top) and gravel/pebble (bottom) ERS in the totals recorded in the River Habitat Survey of England and Wales

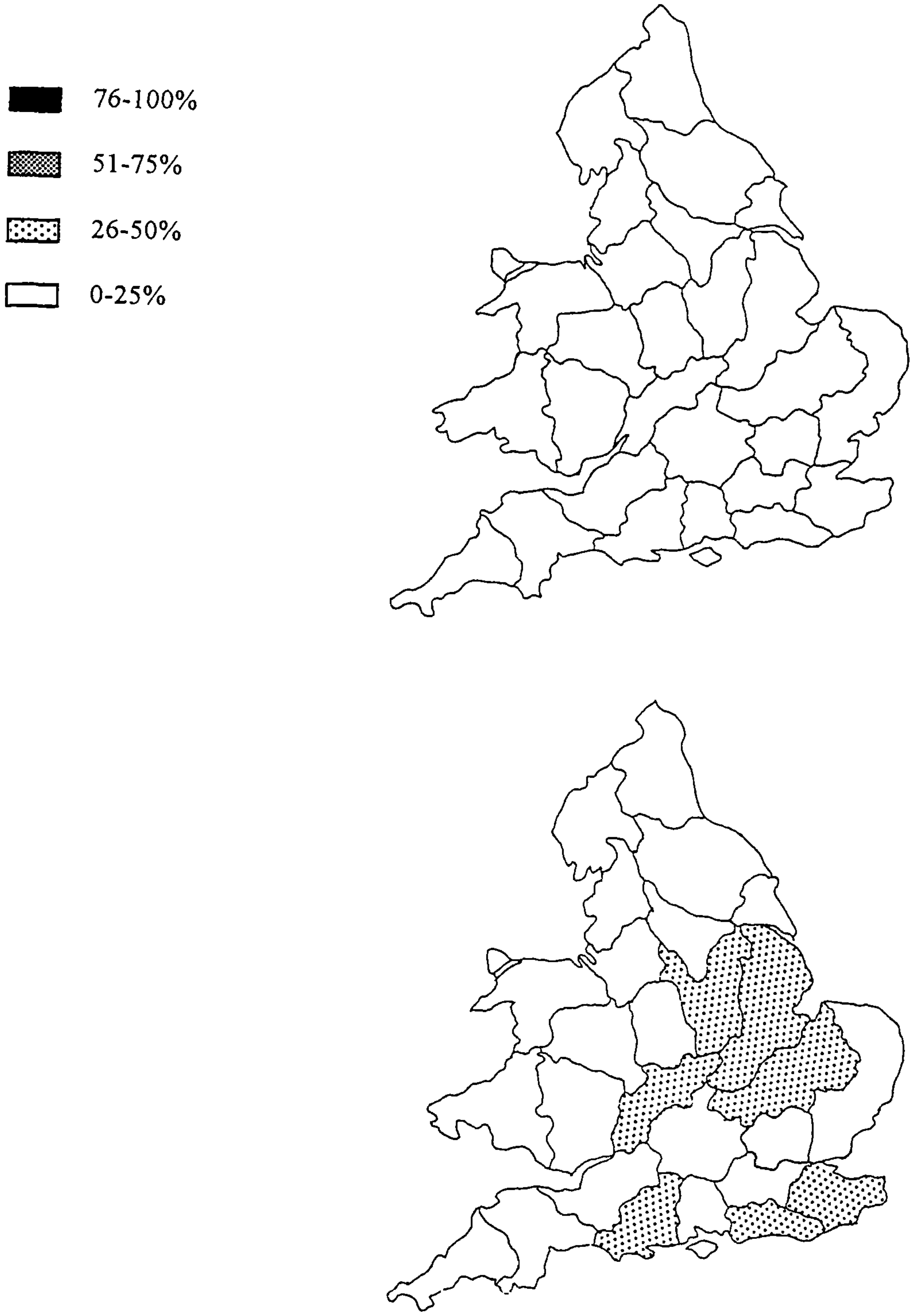

Figure 3.4 The proportion of sand (top) and silt/clay (bottom) ERS in the totals recorded in the River Habitat Survey of England and Wales

The pattern of data from the ERS for the Anglian, Thames and Southern Regions were similar. There were relatively few data from Thames Region, indicating a lack of ERS, but as with the other two regions the majority of sediments appear to be pebbles/cobbles with silt ERS making up most of the others. Sand bars were recorded rarely in all three regions. Relatively more sand sediments were recorded from Wessex rivers where there few boulders/cobbles, some silt and mainly pebbles/cobbles. In the South West, there were curious distributions of sediments on the Torridge, where they were all boulders/cobbles, and the Fal where they were all sand. Most of the other sediments in this region were pebbles/cobbles with a little silt by the Tamar and Exe. The data from Wessex and South West broadly agree with the limited questionnaire data.

In general, there appears to be a bais in the recording of sediment bars in the RHS towards cobble/boulder and, especially, gravel/pebble ERS. Relatively few sand ERS were recorded, as is reflected in the map in Figure 3.4, but there are few catchments where sand ERS make up more than 25% of the total sediments. However, it is likely that there will be more silt ERS in the catchments of central and southern England than is indicated in Figure 3.4.

3.1.3 River corridor surveys

River corridor surveys have been carried out to various degrees in the different NRA Regions and the England and Wales coverage is shown in Figure 3.5 and the extent of river corridor surveys in catchments is given in Appendix G. Coverage is best in Northumbria and Anglian and more than half of the rivers have been surveyed in Severn-Trent and Welsh Regions. Few river corridors have been surveyed in Yorkshire, Thames, Wessex and South West whilst the coverage is not accurately known for North West and Southern.

Vegetation types appear to be very important in recording features of river corridors in these surveys, although large areas of sediment and bare ground also tend to be recorded. However, in surveys of the River Soar (Lott 1992) some sediments present in the system were not recorded on survey maps. There were also areas of obvious vegetation types, e.g. *Phragmites* beds, not recorded. There is obviously a problem that this kind of survey only takes one visit and that since water levels fluctuate apparently obvious features may not be apparent on the survey day. There may be also a problem if the surveyor is on the opposite bank of the river, which may restrict observation. There is some evidence that different surveyors record river corridor features in different ways to different levels of accuracy

One obvious flaw in the recording of most river corridors that may affect the distribution and quality of ERS is the lack of information on the land use next to the river. This is particularly important on lowland systems where stock, especially cattle, can have access to the river and to sediments. Cattle poaching can have a profound effect on ERS structure and quality (Lott 1992) and not only is it necessary to know the land use but also if stock are fenced off from the river. This sort of information tends to be absent from surveys.

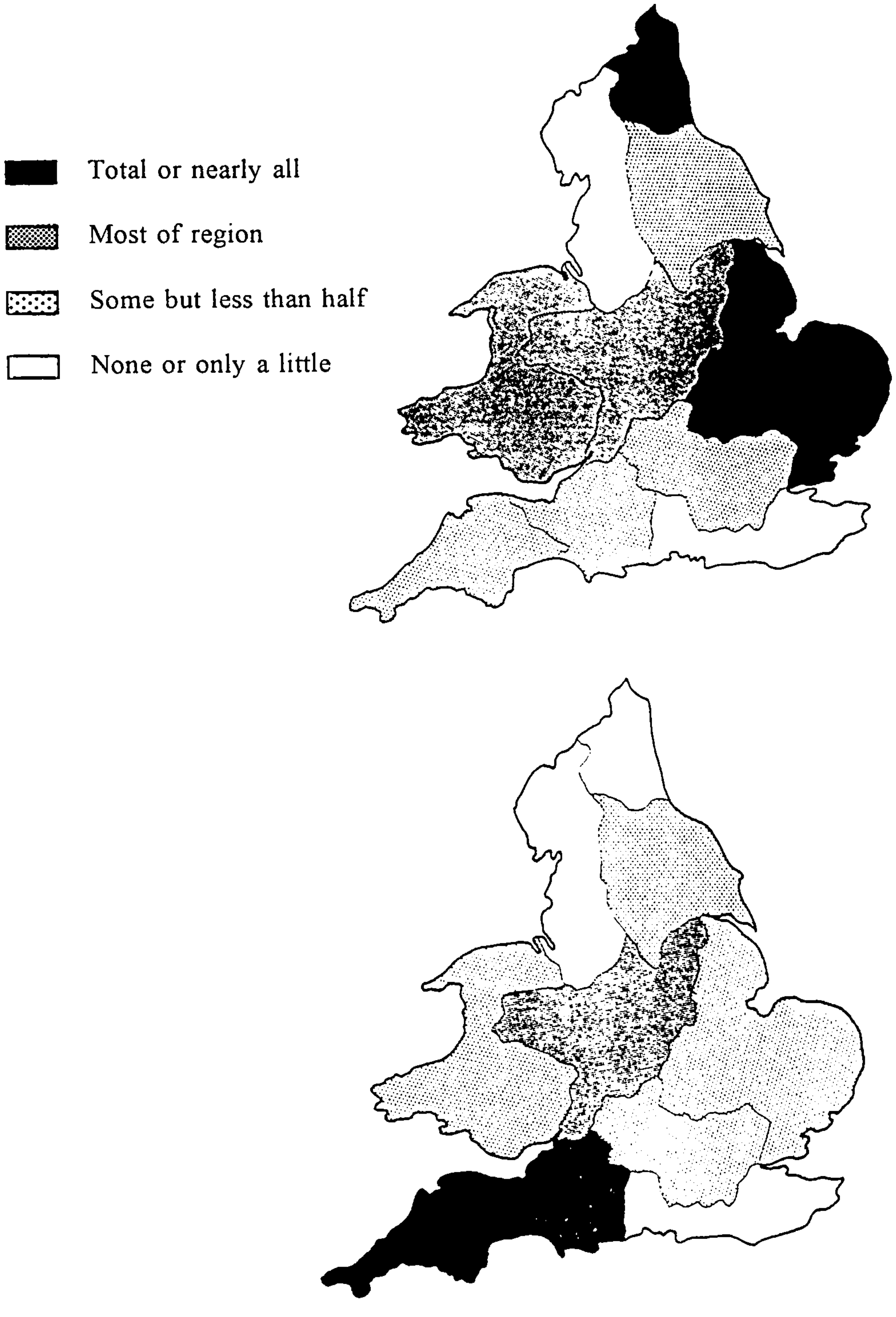

Figure 3.5 The coverage of NRA Regions by river corridor surveys (top) and aerial photographs (bottom)

3.1.4 Aerial photographs

As with river corridor surveys, the coverage of rivers by aerial photographs held by the NRA varies between NRA Regions (Figure 3.5, Appendix G). Rivers in Wessex and South West has been totally covered and more than half have been photographed in Severn-Trent. Thames region has about one-third of the rivers covered but there are only very limited photographs for rivers in Yorkshire, Anglian, Welsh and Southern Regions and none in Northumbria. There are other sources of aerial photographs, such as CCW in Wales and the Ordnance Survey, so there is scope for finding appropriate coverage if required.

Monochrome photographs of some river systems may show sediments, if they are large enough in the more upland regions but there are problems with lowland, slow-flowing systems. It is difficult to differentiate between vegetation under water and that on land and between vegetated and open areas, especially in canalized or impounded systems. Good colour photographs are better and are particularly good in the more upland systems where, for instance, sediments show up as white patches by the channel in the catchments of the Mawddach and Wnion in Wales. However, other features such as embankments and tracks also show up white and care is needed. One other feature that shows up the same colour as sediments is bedrock. These outcrops tend to be in straighter stretches of the river and should be identified by using maps in conjunction with the photographs. The other problem is that shading by trees can limit the identification of sediments, especially the smaller sites in the more upland areas.

The use of good colour photographs of a catchment should enable the identification of the general distribution of sediments. However, not all sediments will be able to be identified and photographs do not give any information about sediment structure. One major problem is that aerial photographs are a point sample in time. If, for instance, the photographs are taken after rainfall, sediments could be under water. This sort of limitation will also be a problem with satellite-derived remotely sensed imagery. Whilst the pixel signature of sediments is distinct from other land covers, it will not differentiate between sediments and bedrock and if wet will give a similar image to such features as wet roads and tracks. However, both aerial photographs and remotely-sensed imagery could be of considerable use in identifying the distribution of ERS.

3.1.5 Maps and walking

Recent ERS mapping work in the Mawddach, Gain and Wnion catchments in west Wales in September 1994 has indicated that the use of large scale maps and walking by the river are as good a method as any of identifying the distribution of sediments and their structure. Surveys of this sort should be restricted to times when the water levels are as low as possible. Obviously this takes more time than the study of river corridor maps or photographs but the increased knowledge and the limitation of mistakes are considerable positive attributes.

Large scale maps are the basis of a methodology for auditing the sediments in river channels by Sear and Newson (1994). This is an approach could be especially valuable because it not only takes into account the contemporary position but also the long term view of river morphology and may be used for quantifying changes in sediment distribution and sensitivity of ERS to environmental change.

3.2 ERS knowledge

The knowledge of ERS types and their distribution in England and Wales is a product of the questionnaire, the RHS and of field work experience. The extent of knowledge in the NRA Regions are shown in Figure 3.6. Most is known about the ERS of Northumbria and in the Welsh Region, whilst Yorkshire and Severn-Trent are nearly as well known. ERS in North West and Anglian are moderately well known but there is a need for much more information on the ERS in Thames, Southern, Wessex and South West Regions.

The differing levels of coverage by river corridor surveys and by aerial photographs in the regions means that, even if they were useful, they are unlikely to be used as a major source of information about the distribution of ERS. The problems associated with inconsistent recording of features in corridors mean that it is unlikely that these surveys will be an accurate source of information. There is little point in becoming dependent on systems and methods that are so incomplete. Better coverage of ERS types and distribution is likely to be generated with experienced workers using maps and walking the riversides.

The responses to the questionnaire varied from very useful and complete, through incomprehension to no reply. The knowledge requested by the questionnaire should have been readily available to NRA biologists and others and the poor responses from some regions may be a reflection on the lack of knowledge and importance attached to ERS by some workers.

Data from the River Habitat Survey (RHS) was especially useful when questionnaires were not returned or filled in. However, it would be foolish to be too dogmatic with the RHS data. These are from sites throughout England and Wales and although the RHS provides a random unbiased sample, this represents a subset of the complete picture at present. There were some differences between the estimates from the RHS and those from the questionnaire and there are discrepancies between what is known about the distribution of ERS from invertebrate survey work on several systems and the data in the RHS. However, as a first estimate of ERS distribution the RHS data was good and it should get better as the number of sites in the data set approaches the 5000 anticipated in 1996-97.

No source of information about ERS type and survey was satisfactory. If these habitats are to be taken seriously in river conservation and management procedures, a formal and standardised methodology is required.

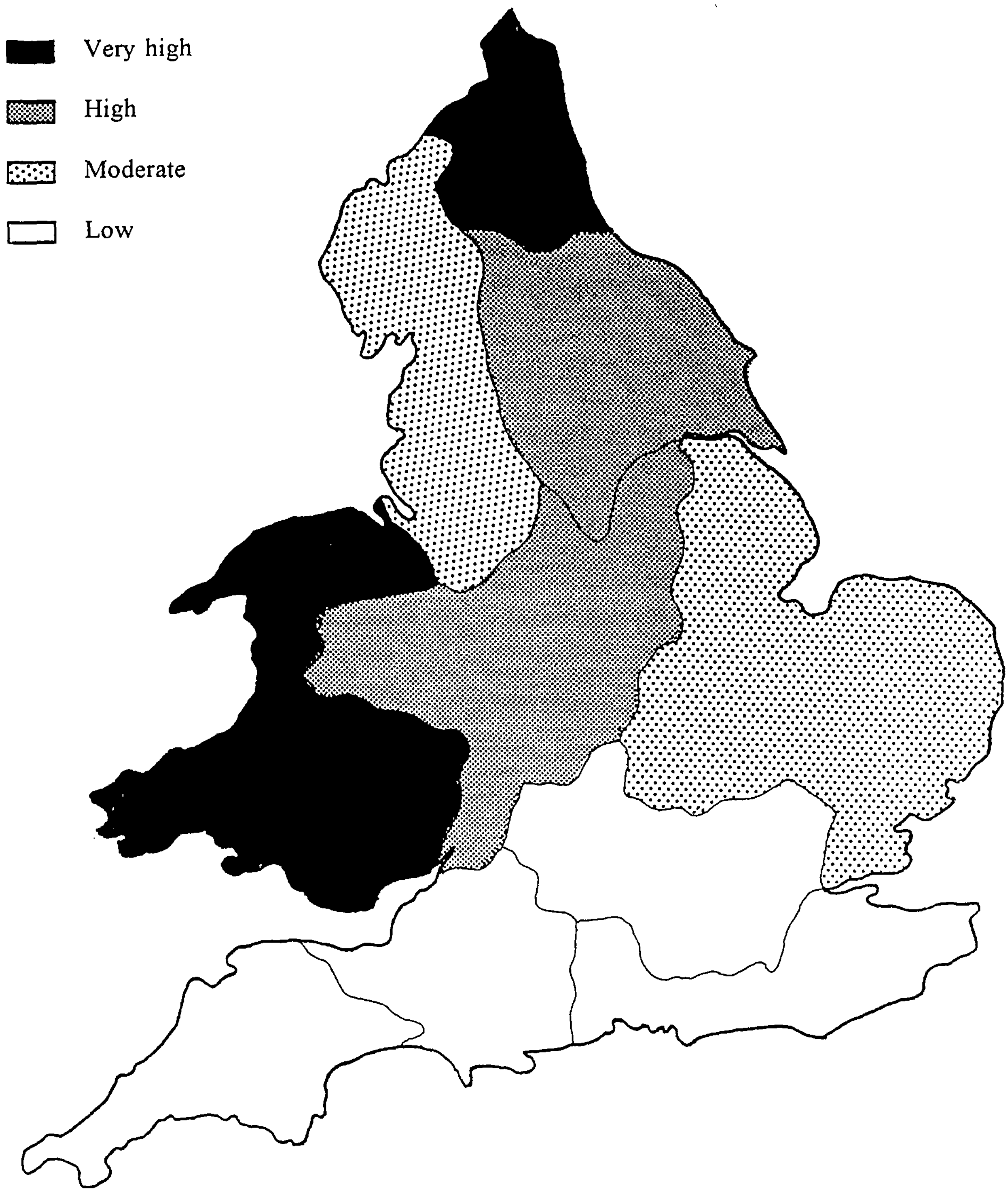

Figure 3.6 The overall knowledge of ERS type and extent in the NRA Regions

3.3 ERS Information Generation

It is obvious that ERS information has had no priority in data collection for any NRA activity. There is little point in trying to assemble the available data from the various disparate sources. It is also very likely that there would be considerable problems with consistency if different workers in the various regions assess the ERS types in each region given the example of the responses to the questionnaires. However, the only practical approach may be to ally the generation of ERS data with the generation of standardised invertebrate data, possibly by different workers in the various regions.

The full information required from each sediment sampled for invertebrates is given in Appendix H. The list of data required is based on that requested in the River Habitat Survey with suitable amendments, additions and omissions.

Background and location information is required to put the sediment into both a regional and national context. Various valley, channel and bank attributes are needed as a basis for placing the sediment in a river type. Sediment substrate and vegetation characteristics are required for assessing the preferences of invertebrate species and assemblages. The extent of shade and of potential hibernation sites is also important for sustaining invertebrate assemblages. Evidence of river management affecting banks and channels is needed to assess the effects of these procedures on both the sediments and the invertebrates. Allied to these factors are evidence of navigation and of other recreational pastimes. Knowledge of the land use adjacent to the sediment is also needed to assess the potential effects of such activities as cattle grazing on the structure of ERS and on the distribution of invertebrates.

4. ERS INVERTEBRATES IN ENGLAND AND WALES

4.1 Invertebrates of ERS

A list of the invertebrates known to occur on exposed riverine sediments (ERS) was compiled. The conservation status, fidelity to ERS and the substrate preference for each species, where known, were ascertained. A full list of species is shown in Appendix B, where the life stage of each species utilising ERS is also shown.

The list was compiled from our knowledge of riverine habitats, with particular contributions from M L Luff on ground beetles, G N Foster on water beetles and D A Lott on the other beetles. The knowledge of flies (Diptera) on ERS is limited and there has been little systematic collecting or recording of flies on ERS although it is likely that some species will be limited to these areas. What information we do have is mainly from Invertebrate Site Register information. The list of spiders has been compiled with the help of S P Rushton and J Daws, but again the information on this group is incomplete and would benefit from a standardised survey.

4.1.1 Conservation status

The conservation status of species is as given by the various publications of the Joint Nature Conservation Committee. Red Data Book 1 (RDB1) species are rated as Endangered. They are those species thought to be in danger of extinction with only one population known, live in especially vulnerable habitats or in rapid decline in five or less 10km squares. Red Data Book 2 (RDB2) species are rated as Vulnerable. These include species which are likely to move into the Endangered category in the near future, species which are declining throughout their range and species in vulnerable habitats. Red Data Book 3 (RDB3) species are Rare. These are species with small populations at risk of getting rarer, are restricted to limited geographical areas or habitats or are estimated to occur in less than 15 post-1970 10km squares. In addition, there are Red Data Book Indeterminate (RDBI) species which are considered to be Endangered, Vulnerable or Rare but there is not enough information to say which RDB1 to RDB3 category is applicable. Red Data Book K (RDBK) is a category for species which cannot be categorised because of lack of information.

There are other categories for rarity. Nationally Notable A species (Na) are those are thought to occur in 30 or fewer 10km squares. Nationally Notable B species (Nb) are thought to occur in 31-100 10km squares. Where the knowledge of species distribution is not sufficiently known, in groups that tend to be poorly recorded, the split into Na and Nb has not been attempted and these species are rated as Notable.

Table 4.1 shows the number of species in each invertebrate family in each of the conservation categories. There are 19 species of beetle which are RDB1-RDB3 whilst there are 27 species of rove beetle (Staphylinidae) which are RDBK or RDBI, where distribution information is insufficient for a definite category to be determined. There are also 40 species of rove beetle which are notable and could not be placed in either Notable A or Notable B, unlike 89 other

Table 4.1 The number of ERS invertebrate species, by family, in the various national conservation categories (RDB1, 2, 3, I , K; Notable A (Na), Notable B (Nb), Notable).

Order and Family	Number of Species							
	RDB1	RDB2	RDB3	RDBI	RDBK	Na	Nb	Notable
Coleoptera (beetles)								
Carabidae (ground beetles)	1	1	3	-	-	8	21	-
Haliplidae (water beetles)	-	-	-	-	-	-	1	-
Dytiscidae (water beetles)	-	1	1	-	-	-	10	-
Gyrinidae (water beetles)	-	-	-	-	-	-	2	-
Georissidae (water beetles)	-	-	-	-	-	1	-	-
Hydrochidae (water beetles)	-	-	1	-	-	-	-	-
Helophoridae (water beetles)	-	-	-	-	-	-	3	-
Hydrophilidae (water beetles)	-	-	-	-	1	1	6	-
Hydraenidae (water beetles)	-	-	2	-	-	-	8	-
Ptiliidae	-	-	-	-	1	-	-	1
Staphylinidae (rove beetles)	1	-	2	6	21	4	10	40
Pselaphidae	-	-	-	-	2	-	-	-
Scarabaeidae	-	-	-	-	-	-	1	-
Scirtidae	-	-	-	-	-	-	1	-
Limnichidae	-	-	-	-	-	1	-	-
Dryopidae	-	-	1	-	-	-	-	-
Elmidae (Riffle beetles)	-	2	-	-	-	2	3	-
Elateridae (Click beetles)	-	2	-	-	-	1	-	-
Rhizophagidae	-	-	-	-	-	2	-	-
Coccinellidae (ladybirds)	-	-	1	-	-	-	-	-
Curculionidae (weevils)	-	-	-	-	-	1	2	-
Total Beetles	2	6	11	6	25	21	68	41
Hemiptera (bugs)								
Saldidae	-	-	-	-	-	-	-	1
Total Bugs	-	-	-	-	-	-	-	1

Diptera (flies)								
Asilidae	-	-	1	-	-	-	-	-
Empididae	1	2	2	-	-	-	2	-
Dolichopodidae	-	-	-	-	-	-	5	-
Lauxaniidae	-	1	-	-	-	-	-	-
Micropezidae	-	-	1	-	-	-	-	-
Therevidae	-	-	5	-	-	-	-	-
Tipulidae (crane flies)	1	8	4	1	1	-	-	6
Total Flies	2	11	13	1	1	-	7	6
Araneae (spiders)								
Lycosidae	-	-	-	-	-	-	1	-
Linyphiidae	-	1	-	-	1	-	1	-
Total Spiders	-	1	-	-	1	-	2	-
Total Invertebrates	4	18	24	7	27	21	77	47

beetle species. Only one shore bug (Saldidae) is Notable whilst one spider species is RDB2, one RDBK and two are Notable B. 26 fly species are RDB1-RDB3, 7 are Notable B and 6 are Notable, indicating insufficient distribution information. Two species of rove beetle, *Thinobius newberyi* and *Meotica anglica*. have never been recorded outside Britain and can therefore be regarded as endemic and deserving of conservation attention.

4.1.2 Fidelity

The fidelity of ERS invertebrate species is an estimate of how much each species depends on riverine sediments as a habitat. The fidelity classes were defined as total, where species are only found by on sediments by rivers and high where species are also found in such places as lake and pond margins, gravel pits, trickles on cliffs, all habitats similar to those found by rivers. Moderate fidelity is where the species is strongly associated with rivers at least in parts of the UK but often also found in other habitat types, such as fen, wet grassland or disturbed ground and low fidelity refers to species which are found in a number of different habitats and are in no way confined to ERS.

The number of species in each invertebrate family in each fidelity class, is shown in Table 4.2. A fair number of ground beetle species have low or moderate fidelity (54) to ERS but 44 species have either high or total fidelity and species of this family (Carabidae) constitute a very important proportion of the invertebrates of ERS. A more important, but less well known, family of beetles on ERS are the rove beetles (Staphylinidae). There are proportionately more species with high or total fidelity (123 out of a total of 196) than in any other family, with 24 species where fidelity is not known, showing a gap in the knowledge. A total of 228 beetle species have either high or total fidelity to ERS, indicating the potential

Table 4.2 The number of species in each family in each of the four fidelity groups (Low, Moderate, High, Total) or where the fidelity is not known (?).

Order and Family	Fidelity				
	Low	Moderate	High	Total	?
Coleoptera (beetles)					
Carabidae (ground beetles)	22	32	32	12	-
Haliplidae (water beetles)	2	4	2	1	-
Dytiscidae (water beetles)	17	9	9	5	-
Gyrinidae (whirligig beetles)	2	-	2	-	-
Georissidae (water beetles)	-	-	1	-	-
Hydrochidae (water beetles)	-	-	1	-	-
Helophoridae (water beetles)	7	1	-	1	-
Hydrophilidae (water beetles)	3	7	5	-	-
Hydraenidae (water beetles)	4	2	4	5	-
Ptiliidae	-	2	-	3	-
Staphylinidae (rove beetles)	14	35	85	38	24
Pselaphidae	-	-	-	2	-
Scarabaeidae	-	1	-	-	-
Scirtidae	-	-	1	-	-
Heteroceridae	-	-	2	-	-
Limnichidae	-	-	1	-	-
Dryopidae	1	2	-	-	-
Elmidae (Riffle beetles)	-	-	5	6	-
Elateridae (Click beetles)	-	1	4	-	-
Rhizophagidae	-	1	1	-	-
Cryptophagidae	-	-	1	-	-
Coccinellidae (ladybirds)	-	3	-	1	-
Chrysomelidae (leaf beetles)	4	5	-	-	1
Curculionidae (weevils)	-	5	1	-	-
Total beetles	76	110	155	74	25
Hemiptera (bugs)					
Dipsocoridae	-	-	-	1	-
Saldidae	-	2	1	2	-
Hydrometridae	-	-	1	-	-
Total Bugs	-	2	2	3	-

Diptera (flies)					
Asilidae	-	-	1	-	-
Empididae	-	-	-	-	7
Dolichopodidae	-	-	-	-	5
Lauxaniidae	-	-	-	-	1
Micropezidae	-	-	-	-	1
Therevidae	-	1	4	-	-
Tipulidae (crane flies)	-	-	20	-	3
Total flies	-	1	25	-	17
Araneae (spiders)					
Gnaphosidae	3	-	-	-	-
Clubionidae	1	-	-	-	-
Thomisidae	1	-	-	-	-
Lycosidae	7	-	2	-	-
Argyronetidae	1	-	-	-	-
Hahnidae	1	-	-	-	-
Tetragnathidae	2	-	-	-	-
Linyphiidae	28	8	1	2	-
Total spiders	42	8	3	2	-
Total Invertebrates	118	121	184	79	42

importance of ERS in biodiversity estimates.

There are only 7 bug (Heteroptera) species associated with ERS and only 5 spider species with either high or total fidelity to ERS. Crane fly (Tipulidae) species appear to be the fly family which utilise ERS most. However, the lack of knowledge of the fidelity of a number of fly species is indicative of the poor overall information about the distribution of these animals on ERS. The importance of ERS as invertebrate habitats is reflected in the high number of species with high (184) or total (80) fidelity to these sites. In highly managed landscapes, ERS may be one of the few relatively natural habitats left with a high biodiversity.

4.1.3 Substrate preference

The substrate preference of each species have been assessed and the number of species in each invertebrate family found on the different substrates is given in Table 4.3. The categories are limited to silt, sand and shingle, where shingle includes all the particle sizes above sand. Where species are found on all types of ERS, 'All' is used as a category and if the preference is not known, this is also indicated. Some beetle species have specialised habitats (e.g. subterranean, pools, moss) and the number of these is given under 'Other' in Table 4.3.

Table 4.3 The substrate preferences for ERS invertebrate species in each family. The categories are silt, sand, shingle (anything larger than sand), all (occur on all ERS), *other* (specialised habitats) and ? (preference not known). A species can have more than one preference.

Order and Family	Substrate					
	Silt	Sand	Shingle	All	Other	?
Coleoptera (beetles)						
Carabidae (ground beetles)	55	25	17	22	-	-
Haliplidae (water beetles)	8	5	2	-	-	-
Dytiscidae (water beetles)	28	5	9	-	3	-
Gyrinidae (water beetles)	1	-	1	1	2	-
Georissidae (water beetles)	1	1	-	-	-	-
Hydrochidae (water beetles)	1	-	1	-	-	-
Helophoridae (water beetles)	9	1	1	-	1	-
Hydrophilidae (water beetles)	14	1	1	-	-	-
Hydraenidae (water beetles)	12	-	3	1	1	-
Ptiliidae	3	2	2	-	-	-
Staphylinidae (rove beetles)	100	29	32	25	7	26
Scarabaeidae	-	1	1	-	-	-
Scirtidae	-	-	1	-	-	-
Psephenidae	1	-	1	-	-	-
Heteroceridae	2	-	-	-	-	-
Limnichidae	1	-	-	-	-	-
Dryopidae	2	1	2	-	-	-
Elmidae (Riffle beetles)	6	6	5	-	-	-
Elateridae (Click beetles)	1	1	4	-	-	-
Rhizophagidae	-	-	-	-	2	-
Cryptophagidae		-	-	-	1	-
Coccinellidae (ladybirds)	3	-	1	-	-	-
Chrysomelidae (leaf beetles)	8	-	-	1	-	1
Curculionidae (weevils)	6	-	-	-	-	-
Total beetles	261	78	84	49	16	27
Hemiptera (bugs)						
Dipsocoridae	-	-	1	-	-	-
Saldidae	2	3	-	-	-	-
Hydrometridae	1	1	-	-	-	-
Total Bugs	3	4	1	-	-	-

Diptera (flies)						
Asilidae	-	-	1	-	-	-
Empididae	-	-	-	-	-	7
Dolichopodidae	-	-	-	-	-	5
Lauxaniidae	-	-	-	-	-	1
Micropezidae	-	-	-	-	-	1
Therevidae	-	2	2	3	-	-
Tipulidae (crane flies)	1	15	5	2	-	3
Total flies	1	17	8	5	-	17
Araneae (spiders)						
Gnaphosidae	-	-	-	3	-	-
Clubionidae	1	-	-	-	-	-
Thomisidae	1	-	-	-	-	-
Lycosidae	1	1	1	6	-	-
Argyronetidae	1	-	-	-	-	-
Hahnidae	1	-	-	-	-	-
Tetragnathidae	-	-	-	2	-	-
Linyphiidae	14	-	4	20	-	1
Total spiders	19	1	5	31	-	1
Total Invertebrates	284	100	98	85	16	45

The substrate preferences for each ERS invertebrate species is given in Appendix B and a species can have more than one preference.

Most ERS ground beetle species (77) are found on silt sediments but there are also a fair number found on sand (47) and shingle (39). This pattern is similar with most beetle families, especially with rove beetles (Staphylinidae) where by far the greatest preference is for silt sediments. In all, 309 beetle species have been identified as being found on silt, whilst 126 occur on sand and 132 species on shingle. Most of the bug (Heteroptera) species are found on silt and sand, as are most of the spider species with some wolf (Lycosidae) and money spider (Linyphiidae) species being specific to shingle sediments.

The total number of invertebrates identified as being found on silt sediments is 369, with 185 species on sand and 182 species on shingle. This is an important observation since an underlying assumption by bodies such as the Joint Nature Conservation Committee is that the most important sediments are composed of shingle and sand with little consideration of the importance of silt sediments. Shingle and sand sediments are likely to have species with higher fidelity to ERS than silt sediments and these species are likely to be of considerable conservation importance. The shingle and sand sediments are habitats that have few parallels in the wider landscape whilst silt sediments can be similar to other wetland habitat types such as marshes. However, silt sediments are likely to be of high relevance in the calculation of biodiversity in a river system and greater consideration should be given to these habitats.

4.1.4 ERS invertebrate life histories

The seasonality of the life history of an insect species is often fairly plastic and can vary in different parts of its range. However, some generalisations about ERS species in Britain can be made.

Most ERS ground beetles (Carabidae) breed in the spring, which means that they overwinter as adults either on the highest parts of large ERS or on the riverbank above ERS. Some species fly a considerable distance to hibernation sites in woods and hedgerows. In spring, late April and May, they come down to the ERS to breed. By early July a large proportion of the adults have died off. The larvae develop and pupate on and in the ERS during the summer. On the emergence, the adults leave their pupation sites and seek hibernation sites. This means that peak ground beetle numbers appear in ERS samples between April and June in most years. Many of the species in the genera *Bembidion* and *Agonum*, which are diagnostic ERS species, can be difficult to find after June. Few ground beetle species can be found on ERS in the autumn and winter as larvae. Species in phytophagous families such as the leaf beetles (Chrysomelidae) tend to follow a similar pattern to ground beetles.

Some ground beetle species, notably *Trechus discus* and *Bembidion lunatum*, are summer breeders which overwinter as larvae. The adults usually only emerge in late June or July, after the main peak of spring breeding adults has passed. In Norway the larvae overwinter on the riverbank. The click beetles (Elateridae) also overwinter as larvae, although in several species the adults emerge in the spring. Many flies (Diptera) overwinter in their immature stages although adult emergence times can vary widely between species.

Little is known about the seasonality of the life histories of rove beetles (Staphylinidae). Unlike most ground beetles, many species continue to be represented as adults in samples taken throughout the summer and into the autumn. In Europe several ERS species appear to be spring breeders, although in Britain species in the genus *Lesteva*, which is active in spring, breeds in the autumn and overwinters as larvae. Some rove beetle species overwinter in tussocks and rotten wood on the bank above the ERS like spring breeding ground beetles.

Most of the above groups use ERS for breeding. However, water beetles belonging to the families Haliplidae, Dytiscidae, Gyrinidae, Helophoridae, Hydrophilidae, Hydraenidae and Elmidae normally use ERS for pupation. Their larval and adult stages are generally spent in the water. Consequently, they only use ERS for a relatively short time in the summer, although this period is a crucial stage in their development. Exceptions to this are species such as *Bidessus minutissimus, Hydroglyphus geminus* and some Hydrophilidae which breed in remnant pools on shingle sediments. Other species of Helophoridae and Hydrophilidae, especially in the genera *Helophorus* and *Cercyo*n, live right at the edge of the water. Larvae of the Dryopidae are aquatic but the adult habitats vary from species to species. *Helichus substriatus* is mainly aquatic whilst *Dryops ernesti* can be found in large numbers on alluvial meadows far from the water edge. The hairy whirligig, *Orectochilus villosus*, is nocturnal and often spends the day under particles on ERS.

4.2 ERS invertebrate information

4.2.1 ERS invertebrate records

Some ERS invertebrate data came from the Invertebrate Site Register (ISR) run by the Joint Nature Conservation Committee (JNCC) but most were generated by contacts with relevant individuals interested in the invertebrates of ERS. The data from the ISR was limited to records of rare and notable species, as defined by the JNCC. Ground beetle species assemblage data was forthcoming from A P Fowles at the Countryside Council for Wales, from the extensive work of D A Lott and from less standardised sampling by M D Eyre and M L Luff. The number of rare and notable species in the catchments of England and Wales is shown in Figure 4.1 and the number of ground beetle species assemblages in each catchment in Figure 4.2. A summary of the available invertebrate information in each catchment is given in Appendix G.

The invertebrate information for Northumbria rivers is good, especially for beetles. The Till has a riverside SSSI because of the rare invertebrates and ERS on the Allens, South Tyne and Tyne are also very good for beetles. There are rare and notable records of species on other rivers in the region but coverage is not as good as on those above. The best information on the invertebrates of Yorkshire is from the Wharfe and Ure. There has been little in the way of systematic survey on Yorkshire rivers but what records there are indicate considerable potential for rare species and for a number of different ERS invertebrate assemblages.

The most data for ERS invertebrates in North West region are for the Eden but there has been no systematic survey work. There are other records from the Ribble and Lune on the Pennines and from some of the Lake District rivers and the potential for finding interesting species and assemblages is good. There is a considerable amount of information on Welsh ERS invertebrates, mainly from A P Fowles, and this is the most surveyed region. The Ystwyth is particularly well covered, with other good records of species and assemblages from the Rheidol, Teifi and Tywi. Rare and notable species have also been found on the Wye, Ithon, Usk, Mawddach, Wnion and Conwy and the potential for finding other good invertebrate sites throughout the region is very good. In Severn-Trent region there is a lot of information about the ERS invertebrates of the Soar, because of recent sampling by D A Lott. There is other assemblage data from the Dove, Trent and Teme and other records which indicate that the Severn could be very interesting.

In Thames region there are only a few records of notable species, from the Thames, Windrush and Lee, and this may reflect the lack of potential for finding a lot of ERS and rare species by rivers in this area because invertebrate recording in south-east England has been relatively intensive. The only ERS invertebrates of any note in Anglian region are a few from the Welland and in Southern region there was one assemblage list from the Rother with a few species from the Stour and Medway. The chalk rivers such as the Itchen and Test may well have more potential for ERS invertebrates than silty rivers such as the Medway and Stour.

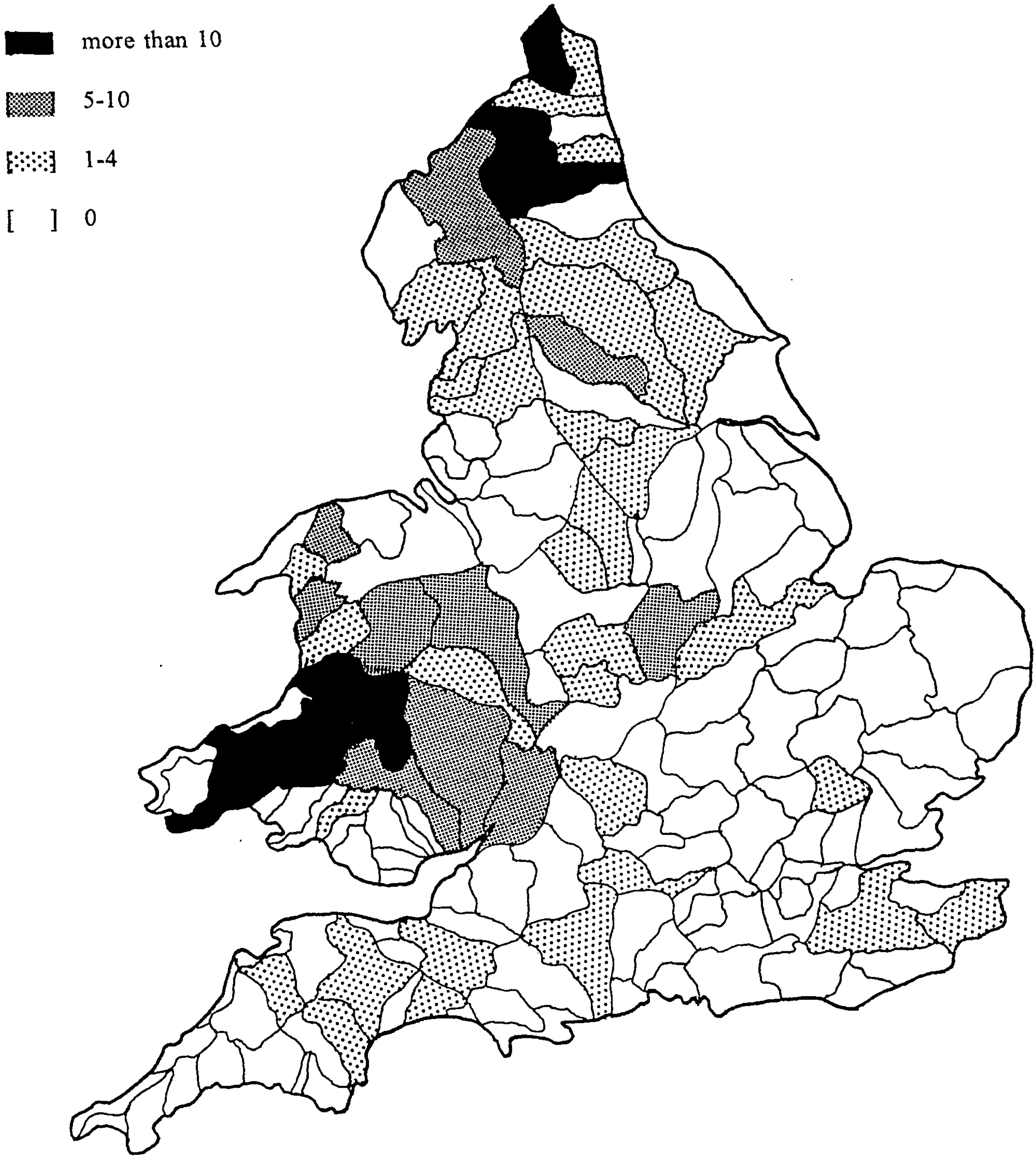

Figure 4.1 The number of rare and notable invertebrate species occurring in the catchments of England and Wales (from the Invertebrate Site Register)

There are only a few records from the Avon and Parrett in Wessex but there appears to be considerable potential on some of the rivers. In South West region there are a few records of ERS invertebrates from the Axe, Exe, Torridge and Teign which indicate that there is some potential in this region. Given the types of ERS indicated above it is likely that ERS will be important for conservation in this region.

4.2.2 ERS invertebrate literature

The entomological literature, mainly journals and conference proceedings, were examined for records of ERS invertebrate species and for records of invertebrates from ERS. The references with relevant information are given as a bibliography in Appendix C.

Most of the literature about invertebrates on ERS is concerned with beetles (Coleoptera), especially ground beetles (Carabidae). The majority of relevant references are short distribution notes in the non-academic entomological journals with only a few publications in the academic press referring to the habitats of ERS invertebrates. The only habitat literature is confined to ground beetles but there appears to be no publications solely concerned with ERS habitats. There are a number of papers in the list below where the habitats of ERS ground beetles constitute part of a larger investigation (e.g. Plachter 1986; Luff, Eyre & Rushton 1989) whilst there is considerable information about the ecology of specific ground beetle species in Norway (J Andersen), Belgium (K Desender) and Italy (C Ravizza).

The rove beetle (Staphylinidae) species distribution notes are the only body of information that tends to be specifically related to ERS (e.g. A A Allen, C Johnson). If there are other beetle records from ERS the information appears to be more 'accidental'. The information about water beetles on ERS also tends not to be in publications limited to this habitat. Most literature about ERS water beetles is concerned with distribution (G N Foster). There is very little on bug species (Heteroptera) but there are only a few species specific to ERS. There are a number of spider (Araneae) species limited to ERS, especially on boulders/cobbles/pebbles, but information tends to be limited to distribution with little on ecology. It is likely that a number of fly species will have a very high fidelity for ERS but the available published information is limited to relatively vague habitat comments and to some distribution data.

Water beetles have been used for some time to estimate the conservation quality of wetlands (G N Foster and M D Eyre). The bibliography contains references to the approach and procedure employed by EMS to assess both wetland and terrestrial sites by using invertebrate data. These are especially relevant as they form the basis to an approach that may be viable with ERS invertebrate data.

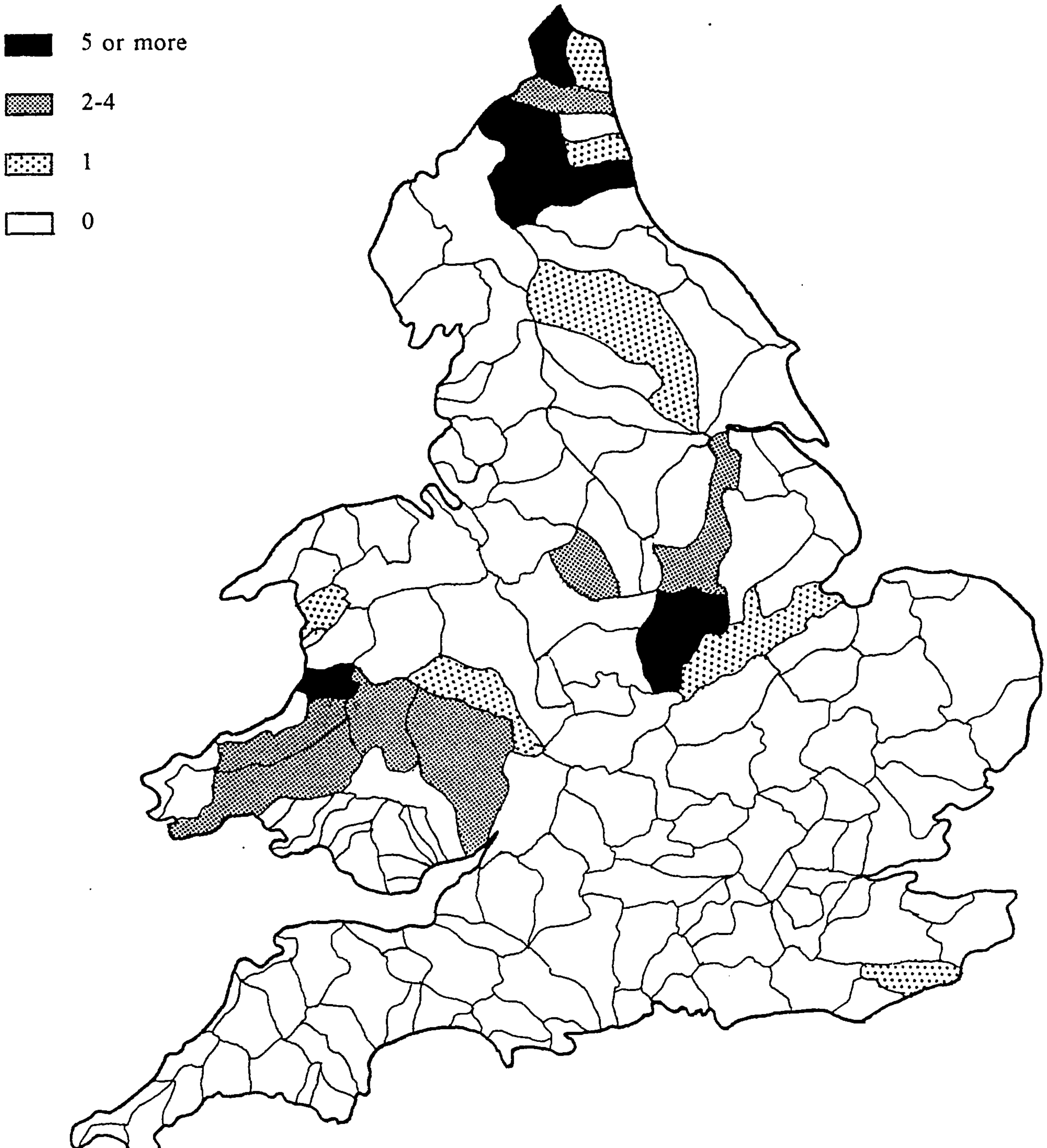

Figure 4.2 The number of ERS ground beetle assemblages from the catchments of England and Wales used in the classification and conservation assessments

4.3 ERS invertebrate classifications

4.3.1 Methods

In order to assess the relative conservation quality of sediments using invertebrates throughout any country or region, a structure based on invertebrate species assemblages is required. It is better to compare sites with similar habitats and species assemblages than to compare sites across the whole spectrum of variation, even if all the sediments occur by rivers. Comparisons of conservation quality, for example, between the rough, exposed, upland sediments found in north-east England and Wales and the silty, vegetated sediments beside lowland rivers in midland and southern England would be spurious because of differences in site structure, species present and the effects of river management. Therefore, a classification of habitat types based on invertebrate data is required.

A total of 198 ground beetle (Carabidae) species lists, with four species or more, were assembled from England, Wales, Scotland and Ireland. Four sites from Wales were from the tidal reaches of mid-Welsh rivers and were omitted from the data set. The 194 remaining presence/absence site data were ordinated using DECORANA (Hill 1979a). The first three axes of the ordination were used a basis for fuzzy-set classification (Bezdek 1981). This has proved to be a better method of classifying species list data than TWINSPAN (Hill 1979b), with the one advantage that no sites are chained off as outliers (Gardner 1991; Eyre 1994). The classification was used as a structure within which to use rarity assessments.

A second data set of sites in Leicestershire, 56 sites by the River Soar sampled in 1991 and 1992, was used to assess whether an input derived from the number of beetles recorded by standardised sampling into the rarity values improved the comparison of site quality. This data set contained both ground beetle and rove beetle (Staphylinidae) species. Each site was hand-sampled for the same time and the number of beetles of each species was recorded. The proportion of each species in the total was calculated and this value was used in the DECORANA ordination. The first two axes of the ordination were used in the classification.

4.3.2 Results

Britain and Ireland ground beetle classification

The classification resulted in a set of assemblage types which can be readily associated with recognisable habitats. The most appropriate classification gave five groups of sites. The frequency of occurrence of ground beetle species in the groups are shown in Appendix I. The groups were

Group 1. 38 mainly Welsh river sediment sites (35) with others from north Yorkshire and Northumberland and one from Ireland. These sites were by small rivers with fast-flowing water and were composed of a good mixture of sediment particle sizes with little or no vegetation. The characteristic species were *Bembidion atrocoeruleum, B.decorum, B.punctulatum* with the presence of the rarer species *Lionychus quadrillum* and *Bembidion andreae.*

Group 2. 28 sediments, mostly from north-east England (19) and some Welsh and Irish. These sites were from by larger rivers than those in group 1 with slower flow. The mixture of sediment types was again comprehensive with large sediments for species like *Nebria gyllenhali* and sand for species such as *Bembidion schueppeli.* The presence of species such as *Elaphrus cupreus* and *Pterostichus nigrita* indicate that there may have been some vegetation cover.

Group 3. 32 sediments, a mixture of sites from the English Midlands (19), north-east England (8), Wales (4) and including one site from the Sussex Rother. These sites were from slow-flowing rivers and were mainly sand with some silt and some larger sediment particles. The species occurring on these sites were a mixture of those that prefer open sites (e.g. *Elaphrus riparius*), a number of shingle *Bembidion* species and species that like more vegetated conditions (e.g. *Bembidion aeneum, B.biguttatum, B.guttula, Pterostichus strenuus*).

Group 4. 27 sediments mainly from north-east England (19) with four Welsh sites, two Scottish and one from Ireland. These were similar to the group 2 sites but had more boulders, less sand and little vegetation. They occurred on rivers intermediate in size between group 1 and group 2 sites and were characterised by the presence of both *Bembidion atrocoeruleum* and *B.tibiale* and a number of other *Bembidion* species.

Group 5. A large group of 69 silty sediments with considerable vegetation, all from lowland, midland England except one Irish site. These was a high incidence of *Bembidion aeneum, B.biguttatum, B.lunulatum, B.dentellum, B.gilvipes* and *Agonum micans.*

River Soar ground and rove beetles classification

The most appropriate classification gave three groups of sites. The frequency of occurrence of ground and rove beetle species in the groups are shown in Appendix I. The groups were

Group 1. This group contained 22 sites. This group was similar to group 3 but there were more *Dyschirius aeneus, D.leudersi, Bembidion articulatum, Gnypeta velata, Chiloporata longitarsis.* These sites were more open and silty with less vegetation than those in group 3, with species such as *D.aeneus* and *D.leudersi* preferring open silt to excavate. Some of these sediments had been subject to river engineering more recently than sites in group 3.

Group 2. These were the most open, least silty sites, some with shingle and all with less vegetation than sites in the other two groups. Characteristic species were *Bembidion punctulatum* and *Elaphrus riparius* and there were more *B.tetracolum* than in the sites of the other groups. These were the most natural sediments in the data set.

Group 3. 18 sediments with the most vegetation, the fewest open areas and no recent management. These sites contained the most *Bembidion biguttatum, Pterostichus strenuus, Agonum micans, Stenus tarsalis* and *Atheta graminicola*, and the only sites with *Agonum fuliginosum.*

4.4 Conservation assessments using ERS invertebrates

4.4.1 Methods

Within a classification, sites can be compared using a number of conservation criteria. The most important of these, and most 'politically' useful, is rarity. However, a considerable knowledge of the distribution of species in any particular group is required in order to generate species quality values. This is especially relevant with invertebrates because few groups have been surveyed to the required level. Ground and water beetles are two groups where the distribution knowledge on a UK scale is sufficient (Foster 1991, Foster and Eyre 1992; Luff 1995). The national data is based on 10km national grid squares but local distribution data based on tetrad (2 x 2km) data has also been used. For instance, north-east England has been comprehensively surveyed for ground and water beetles (Eyre Ball and Foster 1985; Eyre, Luff and Ball 1986) and the data used to generate local species rarity values (Eyre and Rushton 1989). There are also local species rarity values for all beetle species in Leicestershire, which means that other beetle species than ground beetles can be used in assessing site quality.

With the Britain and Ireland data set, species rarity values based on data in the Britain and Ireland ground beetle distribution scheme (Luff 1995) were used to compare and rank sites on conservation quality. Species rarity values were generated depending on the number of 10km squares a species had been recorded from (post 1960). The values were a geometric scale from 1-256 (1=256 and more squares; 2=128-255; 4=64-127; 8=32-63; 16=16-31; 32=8-15; 64=4-7; 128=2-3; 256=1 square). The species values were summed for all the species in a site list and divided by the number of species. This gives a Species Quality Factor (SQF). To get an idea of rarity association, a Rarity Quality Factor (RQF) was calculated by adding all the values of 2 and above, with a reduction of the highest score if this is the only one of this value (see Eyre and Rushton 1989), and adding these to the first total. This new total is divided by the number of species and a large difference between the SQF and RQF indicates good rarity association. The larger the RQF and the better the rarity association, the better the site conservation quality.

As an example, if a list contained species rarity values of 1, 1, 2, 2, 2, 4, 8, 16, 16 and 64 these values would be summed (116) and then divided by the number of species (10) to give a Species Quality Factor (SQF) of 11.60. The additional element for rarity association would be the sum of 2, 2, 2, 4, 8, 16 and 16 plus 16 for the 64 value because there was only one 64. This is an additional 66 to be added to the 116, giving 182. This is then divided by the number of species to give a Rarity Quality Factor (RQF) of 18.20. The difference between the SQF and RQF (in this case 6.60) gives an idea of how many rare species occur in the list by comparison with other lists. This system provides a means of ranking sites in a habitat group derived from a classification based on invertebrate records.

The basis for the species rarity values in Leicestershire was the same as for the Britain and Ireland ground beetle data set but only scores up to 64 were used (1=64 and more tetrads; 2=32-63; 4=16-31; 8=8-15; 16=4-7; 32=2-3; 64=1) because there are less tetrads in Leicestershire than 10km squares in Britain. Each species rarity value (2 or more) was multiplied by the logarithm of the number recorded plus one. These were then summed and the SQF and RQF calculated in the same way as above. This generated Quantified Species

Rarity Factors (QSQF) and Quantified Rarity Quality Factors (QRQF). These values therefore have an input not only from the scores for each species but also from the number recorded. The more rarer species recorded, the higher the quantified rarity values.

4.4.2 Results

Britain and Ireland site ranking

The Species Quality Factors (SQF) and Rarity Quality Factors (RQF) for each of the sites in the five groups of the classification are given in Appendix J and the mean values and ranges are given in Table 4.4.

Group 1, with mainly Welsh sites, had the highest mean rarity values, with the greatest range, and, on average these sites had considerably more conservation value than sites in the other four groups. The sites in groups 2 and 3 had similar rarity values, with those for sites in group 4 slightly higher and those for the silt sites in group 5 the lowest. The results here show that there are likely to be geographical differences in site type, in composition of ground beetle assemblages and in conservation value even with data from a more standardised survey.

In group 1, the three sites with the highest SQF's and RQF's were from sediments by the Rheidol. The first two sites had very similar SQF's but were split better using RQF's. The ranking of a site on the Wye was higher (fifth) than on SQF (seventh), and the difference between the two rarity values show very good rarity association. In groups 2 and 4 one site on the Rivers Rede and Tyne respectively contained rarer species than the other sites in the respective groups and had higher conservation values. The highest RQF of sites in group 3 was a site by the Wye, which was only third in the SQF's. However, in general the ranking of sites by SQF in groups 2, 3 and 4 was similar to the ranking by RQF. The best sites on the River Soar in group 5 all had rarity values considerably less than the best sites in all other groups. Again the rankings by the two values was very similar but it appears any comparison between the rarity and conservation value of silt sites in lowland England and boulder and shingle sites in Wales and north-east England would be spurious.

River Soar site ranking

The Species Quality Factors (SQF) and Rarity Quality Factors (RQF) for each of the sites in the three groups of the classification are given in Appendix J. The Quantified SQF's (QSQF) and the Quantified RQF's (QRQF) values derived from the input of the number of each species recorded are also given, as is the ranking of sites by RQF and QRQF. The mean SQF, QSQF, RQF and QRQF values, and ranges, of sites in the three groups are shown in Table 4.5.

Table 4.4 The mean Species Quality Factors (SQF) and Rarity Quality Factors (RQF) values, with ranges, of sites in the groups derived from the classification of the Britain and Ireland data set.

Group	Mean SQF and range	Mean RQF and range
1	8.08 (2.20 - 35.00)	12.04 (3.80 - 52.00)
2	2.62 (1.00 - 11.50)	3.76 (1.00 - 17.00)
3	2.64 (1.00 - 7.55)	3.67 (1.00 - 11.05)
4	4.31 (1.60 - 16.33)	6.87 (1.60 - 29.00)
5	1.94 (1.20 - 4.82)	3.04 (1.20 - 6.93)

Table 4.5 The mean Species Quality Factors (SQF), Quantified Species Quality Factors (QSQF), Rarity Quality Factors (RQF) and Quantified Rarity Quality Factors (QRQF) values, with ranges, of sites in the groups derived from the classification of the River Soar data set.

Group	Mean SQF and range	Mean QSQF and range	Mean RQF and range	Mean QRQF and range
1	3.02 1.29-5.75	3.82 1.29-11.22	5.14 1.86-8.95	6.57 1.86-14.95
2	3.06 1.13-7.07	3.53 1.22-8.73	4.87 1.13-11.47	6.13 1.22-14.78
3	2.68 1.52-4.74	3.42 1.64-5.32	4.60 2.33-8.52	5.92 2.57-9.61

The mean values for the four indices were similar for sites in groups 1 and 2 whilst the more vegetated sites of group 3 had slightly lower values. In general, the differences between the SQF's and QSQF's and between the RQF's and QRQF's were not very large and in the same range for most of the sites. However, the values for some sites with a lot of relatively rare species did increase considerably. Site 24, for example, had a RQF of 7.62 whilst the QRQF value was 14.95. This changed the ranking of this site from second best to best whilst the first site in group 1 was first on RQF and third with QRQF. The fourth site in group 1 on RQF was tenth with QRQF, showing that little input from quantification can change rankings.

4.5 Discussion

4.5.1 Classification

Given the disparate nature of the ground beetle data from Britain and Ireland, there was a good classification of river sediment types generated. However, it should be seen as preliminary. The species lists used in this analysis represent an uneven coverage of rivers both geographically and ecologically. A more rigorous classification can only be achieved through the analysis of standard samples covering all the variation in river systems. Useful classifications have been seen before with this sort of non-standardised data (e.g. Eyre, Ball and Foster 1986; Luff, Eyre and Rushton 1989) but better classifications with ground beetle data was possible with standardised pitfall trap ground beetle data (Luff, Eyre and Rushton 1992). TWINSPAN (Hill 1979b) was used in these classifications but the use of fuzzy-set classification has improved the placing of sites within groups (Gardner 1991; Eyre 1994).

The classification of the River Soar ground and rove beetle data was more difficult because there was less variation in the area surveyed and in the beetle data. However a structure based on the naturalness of the sediments and on the amount of recent river management was possible. The classification did provide a structure within which to test the potential for using rarity values for ranking sites.

4.5.2 Site ranking

There has been regular use of species rarity values derived from national recording schemes, especially in the assessment of the conservation quality with water beetles (e.g. Foster et al. 1990, 1992; Foster and Eyre 1992). Ground beetle data has also been used on a regional basis (Eyre and Rushton 1989) and this group is now used systematically for conservation quality assessments of terrestrial sites in north-east England and Leicestershire.

The potential for using this sort of system with invertebrate data from ERS can be seen with both of the data sets above. Good differences between sites was seen and the ability to rank sites on conservation quality values could be very useful in assessing the site quality and the potential effects of changes brought about by such practices as channel straightening and other engineering. It may not be necessary to use all the measurements presented here; the use of only one rarity value not taking into account any input for the number of invertebrates recorded may be an adequate approach. The use of more systematically sampled data, as with pitfall traps, will improve this sort of methodology and give an excellent base for measuring the quality of any particular site and of any potential change in site structure.

There are some sediments, for example on the River Till and River Wye, which are of great value for ERS species other than ground beetles. An examination of the ranking of sites according to the rarity of its ground beetles shows that in some cases (e.g. River Wye) they score well. However, several sites of major importance cannot be identified from the ground beetle fauna alone. In order to use rarity scores more effectively, it will be necessary to establish an ERS database covering a wider range of groups. One potential approach, given standardised sampling, may be to use ground beetles for a main ranking system and then use the national conservation status to flag high quality sites. This requires a better knowledge of national rarity status, another potential product of a standardised survey.

The comparison of species rarity values for sediments may give an indication of changes brought about by river management or by land use factors. Lott (1992) found that heavy trampling by cattle reduced the conservation value of sediments in the Soar catchment. Some light grazing, may however, be beneficial for flies (M.Drake pers. comm.), but the highest scoring sites tend to be adjacent to relatively undisturbed land. In general, the more naturally disturbed and the most open sites in the River Soar classification presented here had the highest conservation values, indicating a potential input into management plans.

4.6 ERS Invertebrate information requirements

The most obvious need is for more invertebrate information from all the catchments of England and Wales generated using a standardised sampling technique. The present invertebrate data (see Figures 4.1 and 4.2) is highly localised and has been generated using a number of sampling methods. The extant data show the potential for assessing the quality of ERS using invertebrates and also the potential importance of ERS in biodiversity estimations. A standardised sampling programme would mean a proper coverage of all ERS types in all NRA Regions. This would ensure that invertebrate records from ERS types which have not been sampled such as winterbournes, intermittent streams and chalk streams would be generated. Another priority would be to cover all the ERS types in the regions, mainly in southern England, where knowledge of the distribution of sediments is poor (see Figure 3.1).

Any standardised invertebrate sampling programme will also need to be accompanied by a rigorous assessment of the environmental attributes of each sampled sediment. This is required to understand the basic requirements affecting each species distribution and to get a better idea of sediment fidelity and species substrate preference.

A wide-ranging survey will also help to give a better idea of the conservation status of species. A large number of ERS species were not listed by JNCC as riverside species and some that are not found by rivers were listed as ERS species. The placing of some species in some of the conservation categories appear not to be based on a full understanding of the extant distribution information whilst the actual conservation status of a number of species is not fully understood. A proper survey would also enable appropriate species rarity values to be generated.

4.7 Generating ERS invertebrate information

4.7.1 Sampling ERS invertebrates

Most of the records in the species lists of ERS invertebrates already generated were derived by entomologists using a variety of hand collecting techniques. This activity has established the diverse and distinct nature of ERS invertebrate assemblages but variations in sampling methods, efficiency and effort make it difficult to compare sites.

Andersen (1969) developed a method of repeatable timed hand-collecting for beetles on ERS which was adapted by Plachter (1986), Fowles (1989) and Lott (1992, 1993). However, hand-collecting techniques require good weather and a high level of skill from the individual fieldworker. It is not suitable for inexperienced workers and cannot be considered to be generally applicable as a standard sampling method.

Pitfall trapping is a technique widely used for the sampling of beetles, especially ground and rove beetles, in a variety of habitats. Species in other families, especially leaf beetles and weevils, are also sampled well by pitfall trapping. A beaker with preservative is set into the ground so that invertebrates fall into the trap, producing a sample which can be retrieved later. This method requires less skill than hand-collecting and is less dependent on weather because it operates over a period. Pitfall trap samples are also less likely to be skewed against nocturnal species. A standardised sampling methodology for sampling invertebrates, especially ground beetles and spiders, in grassland and woodland has been developed at the University of Newcastle upon Tyne and has been used in a considerable number of investigations (e.g. Rushton and Eyre 1992; Luff, Eyre and Rushton 1992; Eyre and Luff 1994).

The disadvantages of pitfall trapping are mainly connected with disturbance. They are especially vulnerable to floods and this limits the length of time that can be safely left between collections. They cannot be used on soft sediments which are trampled by cattle because they quickly become displaced and there are problems in regions frequented by the public because of an apparently great desire to interfere with the traps. In well vegetated sites, traps tend to be less visible than in areas of bare ground and some kind of camouflage may be required, a process that may skew the sample.

Pitfall trapping has been used successfully used to sample ERS in Wales, Northumberland and Leicestershire. D A Lott (unpublished results) compared samples from hand-collecting and pitfall traps operated from one week on the same ERS and found that they gave similar results. Specialist species of spiders and bugs were also caught in the pitfall traps. The number of flies caught in the pitfall traps was comparable to the number of beetles but it is not known how the representativeness of pitfall trap fly samples compares with other sampling methods.

Standard repeatable sampling techniques for ERS flies have not been used in Britain, although their use is being developed in Belgium (Pollet and Grootaert 1994). The most widely used trapping methods in other habitats have been Malaise traps and water traps. Malaise traps consist of a tent with one side open and designed so that flying insects which enter the trap are funnelled into a collecting bottle in one corner. The exposed nature of many ERS makes the use of Malaise traps impractical. A water trap consists of a coloured bowl filled with water treated to reduce the surface tension. It can be placed on the ground or up a pole. A further method becoming more widely used is the window trap. This consists of a perspex sheet to intercept flying insects with a collecting tray underneath.

Water traps and window traps have similar advantages to pitfall traps in that they can be operated over a period of time, although they need to be serviced at shorter intervals. They are much more vulnerable to disturbance than are pitfall traps because of their greater visibility and the fact that they are above ground and more easily physically damaged. The effects on weather, especially wind, on the sampling of flying insects above ground does not appear to have been addressed. 'Tourist' species from a considerable distance and other habitats are likely to be sampled by window and water traps given certain conditions. Pitfall traps also contain some 'tourist' species not associated with the sampled habitat but they are likely to be a relatively small proportion of the catch.

A comparison of the various attributes of hand-collecting, pitfall trapping, water traps, window traps and Malaise traps is given in Table 4.6. On present evidence pitfall trapping is the best candidate for standardised sampling of invertebrates on ERS, although its suitability for sampling flies needs to be assessed. A full pitfall trapping methodology for sampling ERS is given in Appendix K.

Table 4.6 A comparison of the various attributes of different methods for sampling ERS invertebrates

Attribute	*Hand-collecting*	*Pitfall trapping*	*Water traps*	*Window traps*	*Malaise traps*
Skill level required	Advanced	Moderate	Moderate	Moderate	Moderate
Comparability of samples	Low	High	Unknown	Unknown	Unknown
Suitability for nocturnal species	Low	High	Unknown	Unknown	High
Sensitivity to weather problems	High	Low	Moderate	Moderate	Moderate
Vulnerability to flooding	None	High	Very high	Very high	Very high
Vulnerability to disturbance by cattle etc	None	High on soft sediments	Very high	Very high	Very high
Vulnerability to human disturbance	None	High on soft sediments	Very high	Very high	Very high
Expense	Low	Moderate	High	High	High

4.7.2 Sorting

The sorting of samples may be thought of as being of little interest or importance. With hand-collecting only the invertebrates tend to be sampled and there is usually little detritus in water traps. However, the ability to differentiate invertebrate species from the detritus encountered in pitfall traps is a highly skilled operation. Considerable experience is required to sort all the specimens from a pitfall sample and this should not be forgotten when this method is being used.

4.7.3 Identification

Correct identification to species level is of the utmost importance in ecological, biogeographical and conservation studies with invertebrates. This is especially true when rarity is used a criterion for conservation evaluation since the presence of a single spurious rare species in a sample list can significantly alter the ranking of a site.

The identification process requires three resources; expertise, a reference collection and relevant, accurate literature. Inexperienced workers often rely too much on identification keys, not all of which are totally accurate or up to date. When using keys to an unfamiliar group, identifications should always be checked against named reference specimens. Identifications using keys alone are unreliable. Voucher specimens of species which are rarely recorded or which are in difficult species groups should always be retained and submitted to a specialist in that group. A list of key references for the identification of ERS invertebrate species is given in Appendix L.

It should be recognised that even when workers are experienced in the identification of invertebrates, the time taken to deal with an unfamiliar group will be several orders of magnitude greater than someone who has a specialist knowledge of that group. Tackling large amounts of material from ERS samples is totally unfeasible for someone inexperienced in invertebrate identification. In order to evaluate someone's ability to carry out identifications it is necessary to scrutinise their published work.

5. RIVER MANAGEMENT AND LAND USE EFFECTS ON ERS AND ERS INVERTEBRATES

5.1 Effects on ERS

5.1.1 River management and land use practices

The formation of ERS is dependent on topography, geology and drift (Newson 1994) and their distribution is affected by the various river management practices required for such activities as impoundment and flood alleviation (Newson 1992). There appears to be little specific information on the effects of river management activities and land use practices on ERS. Brookes (1995) has collated the information on the effects of flow on riverine environments, with any information relating to ERS restricted to comments on point bars and islands. Land use changes have resulted in increases in sediment supply to rivers whilst, in general, river engineering and regulation have reduced the extent of ERS.

It is possible to extrapolate the probable effects of river management activities and land use practices on ERS from the information given by Brookes (1995) and from other sources. Table 5.1. gives the probable effect of various activities on the presence and structure of ERS.

The effects on ERS of the various river management and land use activities can be split into gross and more limited effects. The large-scale engineering work carried out in such developments as flood alleviation schemes or channel works for navigation requires channel straightening, dredging and bank regrading. These are likely to result in the loss of ERS, as does shoal removal for whatever reason. These results are likely to be more pronounced on lowland rivers where flood alleviation is a priority and where the ERS tend to be of small size. Any activity which reduces the sinuous nature of a river will reduce the incidence of ERS. The building of large structures such as bridges usually results in the deposition of sediment downstream of the construction and the formation of ERS. Rivers with large-scale engineering are also likely to be subject to relatively intensive maintenance operations which will also limit the presence and extent of ERS.

Other activities tend to affect river flow rate, which are likely to have a more limited effect on ERS. Impoundments, either by large structures such as dams and reservoirs or by small weirs, will reduce the extremes of water flow and limit the effects of flow on the production and scouring of ERS. It is likely that with less disturbance ERS in impounded stretches of river will become more vegetated and have more surface silt as this will not be regularly removed. Intercatchment transfer of water will reduce and increase flow in the donor and recipient catchments respectively, which will lead to more and less stable ERS in the two areas. Water abstraction for urban use, agriculture and industry will also limit flow rates and may also lead to more stable ERS. There may also be reduction of flow rate because of evaporation from on-line waterbodies, especially in the south of England in the summer. A large number of impounded stretches of river are used for navigation and on well used water boat wash and mooring modify and reduce ERS vegetation (Murphy, Willby and Eaton 1995).

Table 5.1 River management activities and land use practices and their probable effect on ERS

River management activities or land use practice	*Probable effect on ERS*
Channel straightening	Removal of ERS and modification downstream
Channel dredging	Removal of ERS
Bank regrading	Removal of ERS
Shoal removal	Removal of ERS
Dams, reservoirs	Flow regulation and reduction, smaller particles, more vegetation on ERS, scouring downstream. siltation upstream
Impoundments	Silting and more vegetation on ERS upstream
Structures (e.g. bridges)	Formation of ERS downstream
Intercatchment water transfer	Flow reduction, silting and more vegetation on ERS in donor areas; opposite in recipient areas
Water abstraction	Flow reduction, silting and more vegetation on ERS
Increased runoff from roads	Faster flows, more erosion and more potential ERS
Tree clearance	Bank erosion and more potential ERS
Bankside tree planting	Increased ERS stability and shade
Mineral extraction	Silt increase and silting on ERS
Urban sources	Silt increase and silting on ERS
Agricultural and forestry drainage	Sediment increase and silting on ERS
Boat wash	Small-scale vegetation reduction
Angling	Small-scale clearing of vegetation on ERS; some trampling

The other major recreation activity on rivers, angling, can have a positive effect on ERS habitats. The 'pegs' used by anglers are kept clear of vegetation and produce patches of bare ERS, thereby increasing the local habitat diversity. However, there can be trampling of ERS by anglers, especially if the amount of ERS is limited, which may affect structure.

Increased water flow in a river produced by factors such as increased runoff or tree removal from riverbanks may have the opposite effect to impoundment with more scouring, leading to possible vegetation reduction on ERS, and more bank erosion leading to increased channel width and more space for ERS formation. There has been recent plans and action to increase the value of riverbanks for otters, and for some invertebrates, by the planting of trees and shrubs. This planting will stabilise ERS and produce more shaded sediments. There is therefore, likely to be a reduction in open, disturbed ERS and there may be a reduction in the both the diversity and quality of the invertebrate species present.

Highly modified channels, usually in urban areas, can lead to increased spatiness which can lead to more ERS formation but straightened channels can have reduced flow and heterogeneity, leading to less ERS. It is likely that major engineering activities have complex effects on water flow and the local effects on ERS need to be investigated.

A number of land use activities may have some effect on ERS by increasing the silt load in river water. Mineral extraction, such as gravel pits, produces silt in mainly lowland rivers where flow rates are relatively slow and so there is the potential for the silting of ERS and a reduction in the diversity of ERS type. In lowland regions intensive agriculture increases silt loads in rivers and urban areas are sources of effluent and pollution which may also lead to silting and organic enrichment of ERS. However, these effects may be offset by increased spatiness in urban areas because of faster run-off. Upland afforestation leads to soil erosion, especially of peat soil, but whilst there is likely to be some potential for this silt to be deposited on ERS this is only likely where the river flow is slow enough in lowland areas. There is no evidence that the silt from large forests areas is deposited on ERS in upland areas where there are fast flow rates and regular spates.

What is obvious from the above is that there is little hard, precise evidence of the effects of river management and land use activities on the presence and structure of ERS. There is little about the potential importance of ERS in the recent document on flood defence procedures and conservation (National Rivers Authority 1994b) and in the New Rivers and Wildlife Handbook (RSPB, NRA & RSNC 1994) and there has been relatively little attention paid to ERS formation, structure or conservation.

5.1.2 Distribution of river management activities and land use

Information about the distribution and extent of river management practices and land use were requested on the questionnaire sent to biologists and others in the NRA Regions (section 3.1.1, Appendix D). The results of the questionnaire returns and from other sources of information are shown in Appendix M.

River management activities

The distribution and extent of channel engineering, straightening and dredging and of bank regrading in catchments in England and Wales is shown in Figure 5.1. There is a clear correlation with topography and channel slope (Figure 2.3) and this sort of river management, with most activity in the flatter areas with little slope. Therefore, the areas with the most of this sort of extensive river management are the lowlands where there is a requirement for such procedures as flood alleviation. There has been little work of this sort carried out in Northumbria, Wales and probably in the South West NRA Regions. The extent of this type of river management is limited in the lowland areas of Yorkshire, North West, Southern and the Severn part of Severn-Trent but there has been considerable amounts of this sort of management in the catchments of other regions, especially in the Trent part of Severn-Trent, in west Wessex and in Anglian and Thames Regions.

The extent, distribution and pattern of impoundments, navigable water, water transfer and abstraction from rivers in the catchments of England and Wales is similar to that with major channel engineering. Most of these types of river management are in areas of intensive lowland agriculture and urbanisation with Anglian Region an area with considerable activity. Other regions where there is a lot of this sort of river management are Severn-Trent, Thames and west Wessex but it is restricted in North West, Wales, Southern and Yorkshire and very limited in Northumbria. However, in the more upland areas there are hydro-electric power schemes which can have an impact on the frequency of flood events. These impondments can, therefore, have an effect on distribution and composition of ERS.

Land use

The major, broad land uses in catchments in England and Wales are given in Appendix M. There are obvious correlations between land use, altitude and topography and, therefore, with the type of ERS in a given area and the extent of river management. The lowlands with a mixture of intensive agriculture and urbanisation are the areas with probably the least number of ERS and the least variation. Most lowland rivers will have small particle ERS only, generally restricted to pebbles, sand and silt, and the distribution of these ERS will be dependent on the extent of river management practices. A wider variation of ERS type, with a range usually from boulders to sand, are seen in areas where the land use is of less intensive agriculture, moorland, woodland and forestry. The rivers in such regions as Northumbria and Welsh are not subject to especially widespread management because of the less productive nature of the land and have more ERS than those rivers in regions like Anglian and Thames.

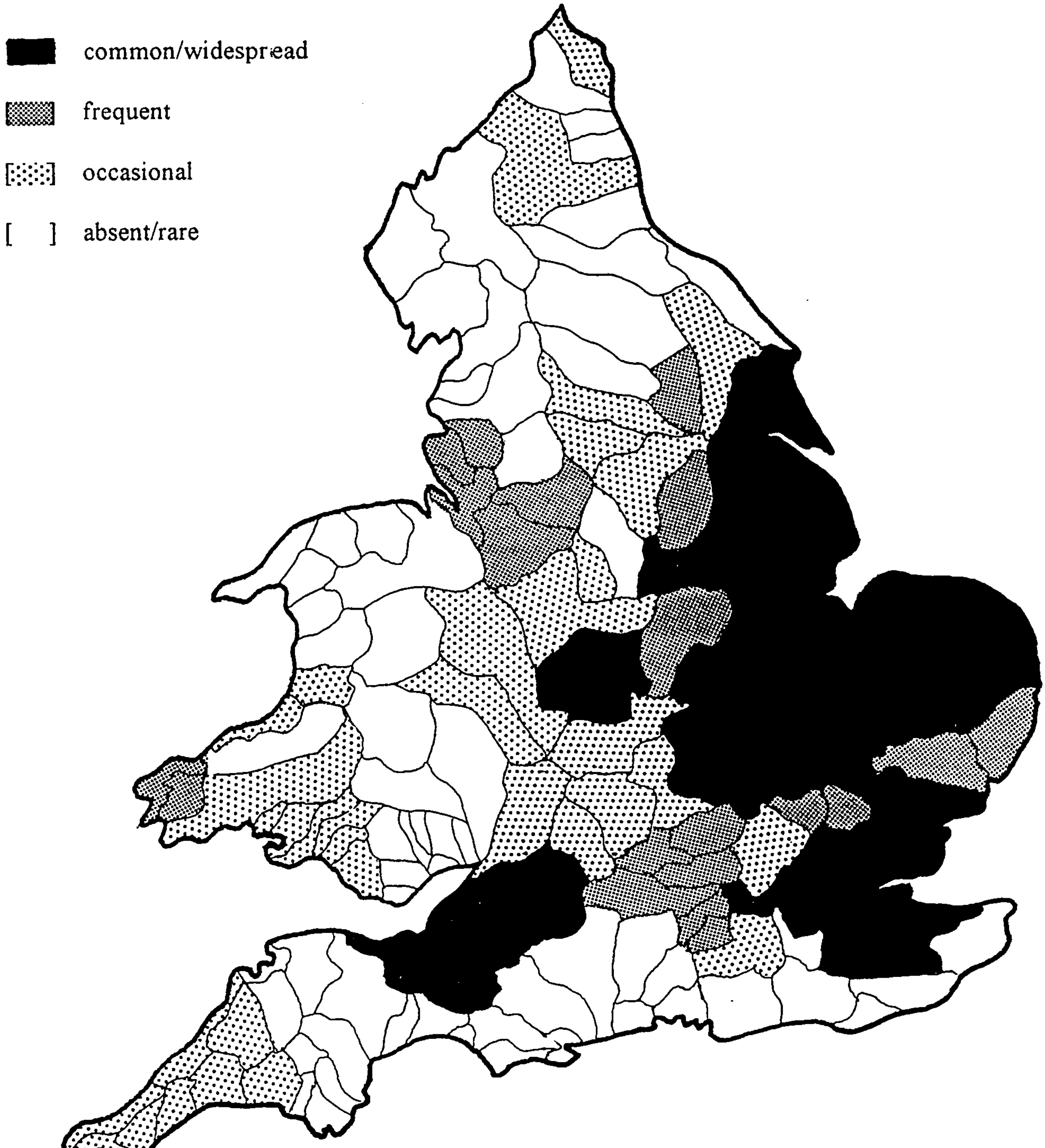

Figure 5.1 The extent of river channel engineering and bank regrading in the catchments of England and Wales as derived from the questionnaire

There is also a relationship between the areas of intensive land use and the knowledge of ERS type and distribution (see Figure 3.6). The relative ignorance of ERS in such regions as Anglian, Thames and Southern may be because they are not an obvious feature of river corridors or because of the small number. The areas where the knowledge is greatest, Northumbria and Welsh, are the ones with less intensive land use and where ERS are very obvious and have attracted the major invertebrate sampling effort.

Specific land uses may have local effects on ERS. Where ERS is next to, or part of, cattle pasture, there may be poaching and trampling of the sediments. This reduces the quality of the sediments as invertebrate habitats (Lott 1992). The effects of sheep grazing are less than those of cattle but heavy use of ERS by sheep will have a detrimental effect on ERS structure. There are few other farming activities that are likely to mechanically affect the structure of ERS and the other land use effects are probably limited to silting and organic matter deposition. Although forestry on peat soils produces particle leaching into rivers, any effects are not obvious in the vicinity of the forests and most silting and organic enrichment are probably prevalent on lowland stretches of rivers, especially in urban areas.

5.2 Effect on ERS invertebrates

Brookes (1995) limits biological information to effects on benthic invertebrates and channel vegetation with flow and information in the flood defence document (National Rivers Authority 1994a) is restricted to vegetation. The invertebrate information in the New Rivers and Wildlife Handbook (RSPB, NRA and RSNC 1994) is mainly concerned with what is in the river there is only a little on the invertebrates of ERS. The only work on the potential and actual effects of river management practices on invertebrates has been carried out by Lott (1992, 1993).

The effects of river management practices on the distribution of ERS invertebrates is correlated with changes in the natural disturbance factors (Lott 1993). Impounded systems have less natural disturbance and consequently have invertebrates which prefer less disturbance. Species assemblages which prefer open substrates with larger particle sizes are replaced by those which prefer more vegetated silt structures. If water-level fluctuations such as flooding episodes continue as along the River Soar, then interesting wetland invertebrate assemblages can develop. If the impoundment is accompanied by smaller water-level fluctuations, then the extent of ERS is reduced and the riparian fauna becomes dominated by less specialist species, often those associated with damp grassland.

Channel regrading tends to remove ERS whilst initially providing open, bare river banks. The newly regraded surfaces provide a similar, but not identical, substrate to that produced by natural disturbance. Some invertebrate species will colonise both areas, some will not. Regrading can be carried out with the contents of natural ERS, as with pebble/gravel deposits on the Trent (Lott 1993). Where there is a change from pebbles/gravel to open clay, as on the Soar, the new substrate will be initially colonised by species preferring open, bare ground which will be pioneer species not restricted to ERS. Use of existing ERS material in regrading will limit damage to the system and recovery to a more 'natural' state will be possible.

The initial effects of channel regrading on the distribution of invertebrates appear to be limited to about five years after the engineering. Changes in the vegetation cover with time are accompanied by changes in the invertebrates, which after about five years usually settles into some kind of grassland fauna. There is evidence that if some of the ERS present before engineering is left or there is sufficient width in the new channel for ERS to form, then there can be a recovery to something like the situation before engineering.

The effects of organic enrichment of river water on aquatic invertebrates is well known, but there has been little research on the effects on ERS invertebrates. Green (1983) found a rich beetle assemblage on sewage sludge at treatment works in Birmingham. An exposed sediment assemblage downstream of a sewage outfall was found to be very species rich (D A Lott unpublished results) and it is likely that organic enrichment will benefit some, but not all ERS, species. It is likely that ERS specialist species will suffer from enrichment, especially if accompanied by widespread algae. The increased sediment load produced by such activities as riverside gravel workings is likely to lead to the silting of larger particle ERS. The precise effects are unknown but they are certain to be deleterious.

The effects of cattle trampling seem to persist for several years after cattle removal (Lott 1992). Intensive grazing by and on ERS are likely to eliminate hibernation sites as well as affecting ERS structure and both are likely to reduce invertebrate interest. The effects of the bare patches caused by anglers is to increase habitat diversity on ERS, especially if the bare ground persists to the following spring.

Another potential effect on important invertebrate habitats of extensive river management is to change the water table in adjacent habitats such as cut-offs. These sites in old channels of the river contain a variety of invertebrate habitats which differ in the extent of water permanency. There are different beetle assemblages in cut-offs which dry out or which remain wet (Lott 1993). There is likely to be increased drainage brought about by such activities as channel straightening and bank restructuring with the potential for the drying of cut-offs. Such changes will reduce habitat diversity with the replacing of specialised invertebrate assemblages preferring fluctuating water levels with an assemblage more associated with less specialised damp grassland. Even if not affected by changes in land use, embankments associated with flood alleviation reduce flooding, which is important in regulating vegetational succession in floodplain wetlands (Bravard, Amoros and Pautou 1986).

5.3 Information requirements

It is evident that little attention has been paid to the effects of river management on ERS and that ERS have probably been looked upon as a hinderance to engineering and other activities. Since they are likely to be of considerable wildlife and conservation importance, much more data is required on the effects of all river management and land use activities on the extent, composition and distribution of ERS.

There is a requirement for all aspects of river management to be investigated. Any survey of the effects of management and land use on ERS should probably be tied in with work on the invertebrates of ERS so that there can be an expansion of the preliminary results of Lott (1992, 1993). This would require the full variation in river systems in the lowland areas where management and land use to be surveyed, something which in any case is required in such region as Thames, Anglian and Southern where ERS information is relatively poor.

It should be understood that, given the obviously scant attention paid to ERS previously by river engineers and biologists, that the present knowledge base of the effects of river management and land use be classed as zero. This is one reason why the long list of environmental variables given in Appendix G are required. These can be used with knowledge of the history of management on a particular river stretch to ascertain effects on both ERS and on invertebrates. Carrying out such a survey will require considerable effort on the surveyors and a level of input on a much more conscientious plane than that shown by the effort in answering the questionnaire on ERS distribution.

6. CONCLUSIONS

6.1 Exposed riverine sediments

ERS are the product of the effects of river flow on the geology and drift in an area, with the major factors affecting the extent and type of ERS channel slope and the flow rate of the water. The nature of the bedrock does not appear to be especially important but drift, especially clay, is important in the formation of lowland ERS. The type and structure of ERS are related to altitude, topography and water flow. The rougher, larger particle ERS, with little or no vegetation, are generally found on the upper reaches of rivers with the steepest slope and the fastest flow in zones prone to spates. As the gradient flattens out flow rates reduce with the deposition of smaller particle ERS with more vegetation. In areas with little drift these ERS tend to be sandy, with sparse vegetation, whilst where rivers flow through clay, silt ERS with considerable vegetation are deposited.

The most knowledge of the distribution and extent of ERS (Figure 3.3, Appendix E) has been derived from invertebrate survey work. The knowledge of ERS in the NRA Regions is generally poor, probably because there has been little or no interest in these features by either engineers or biologists. There is an obvious need for accurate and systematic data on the extent, structure and distribution of ERS throughout England and Wales. The River Habitat Survey (RHS) (Appendix F) will give an idea of the potential distribution of ERS in catchments since it will provide a random, unbiased estimate of the distribution of ERS features. This information represents the first set of absolute records, subject to quality assurance and collected on such a large scale (over 5,000 sites by end of 1996). In contrast, the information gathered by entomologists tends to be skewed towards the best sites. However, RHS data will not provide a comprehensive account of ERS distribution or produce the precision in estimates of ERS structure that are desirable. The use of data from river corridor surveys and aerial photograph coverage for the determination of ERS distribution and structure is likely to be limited to indications of potential. There is too much inconsistency in corridor surveys and photographs both within and between NRA Regions for these to be relied upon.

The use of RHS, river corridor surveys, aerial photographs and remote-sensed data in estimating the distribution and structure of ERS is limited because these methods are point samples taken at only one time. Any method limited to this approach will only give an estimate of the potential distribution of features such as ERS, which are prone to change and to being hidden by such factors are high river water levels. Experienced geomorphologists working with the requisited large-scale and geological maps may also be able to predict the presence, and to some estent the structure, of ERS.

One obvious lack of knowledge is the effect of river management and land use on ERS distribution and structure. The only way sufficiently accurate data will be generated is by survey work by experienced personnel with access to the history of management and river engineering.

6.2 ERS invertebrates

The information about the invertebrates of ERS in England and Wales is a mixture *of data* generated by recorders especially interested in the distribution and biogeography of beetles, flies and spiders and the work carried out by A Fowles in Wales and by D Lott on the River Soar in Leicestershire on the distribution of beetles and other invertebrates by heavy-metal polluted and lowland rivers respectively, with some work on the effects of river management by D Lott. The work on the Soar is the most systematic work carried out on ERS invertebrates in Britain and the most comprehensive recording of all beetle species by rivers in Europe. There has been some work on specific groups of invertebrates, especially ground beetles, in Norway, Sweden, Finland, Germany, Italy and Belgium but it appears that the most information about the distribution of most ERS invertebrate species is British (see Appendix C).

Although the British data is probably the best in Europe, it is very patchy in terms of both the invertebrate groups and areas covered. By far the most information, especially on distribution, ecology and biogeography, is concerned with ground beetles (Carabidae) with other beetle groups, especially rove beetles (Staphylinidae), also relatively well researched. There are 230 species of beetle with high or total fidelity to ERS, including 44 and 123 species of ground and rove beetle respectively. However, it can be seen from Figures 4.1 and 4.2 that the coverage in England and Wales is concentrated on certain catchments and that ground beetle species assemblage data is restricted to only a few catchments. Only 25 fly and 5 spider species are known to have either high or total fidelity to ERS, a situation that is probably due to the relatively small effort put into investigations of these groups on ERS in England and Wales.

Table 4.3 and Appendix B lists a total of 369 invertebrate species which are known to occur on silt ERS. This is of interest as this indicates that there is likely to be most species on the ERS where knowledge of distribution and extent is least. These silt sediments are found in where rivers flow through highly managed landscapes and these ERS may constitute one of the most 'natural' habitats in that landscape. It is also likely that these ERS will contribute substantially to the biodiversity of any highly managed landscape area.

6.3 ERS and Conservation

The only data available from the national conservation bodies was a list of rare and notable species with localities received from the Joint Nature Conservation Committee (JNCC). This list contained 92 species which are supposed to be associated with 'shingle', the nearest category on the Invertebrate Site Register (ISR) for ERS. Not only was this number of species very inadequate as a list of rare and notable species found on ERS, it also contains species which are not found on 'shingle' or by rivers. The other major problem with ISR data is that it has been taken on trust from recorders, some of who may not be sufficiently competent. Species determinations have not been checked where this would be appropriate and, consequently, information from the ISR has to be treated with some suspicion.

In the list of ERS species (Appendix B) there are a total of 226 rare and notable species found on ERS. Most are beetle species (180) with the list of ground and rove beetles containing 36 and 84 rare and notable species respectively. 41 fly species are also rare or notable but it should be understood that the designation of conservation status to invertebrate species by JNCC is subject to considerable argument and change due to the generation of more distribution data. The conservation statuses of a number of ERS invertebrate species were probably out of date when the lists were published and a systematic survey of ERS invertebrates in England and Wales will help to rationalise the list of rare and notable species. A survey is also likely to increase the number of rare species found on ERS and it is undoubtedly true that as well as being important for biodiversity, ERS will be the habitats of a considerable number of rare invertebrate species.

The work on the ability to assess site quality using invertebrate records has been pioneered in Britain, mainly using two groups of invertebrates found commonly on ERS, ground and water beetles. Although the generation of ground beetle species assemblage has not been systematic, a sensible ERS habitat classification was produced for sites in Britain and Ireland (Appendix I). A more sophisticated classification was possible with the River Soar ground and rove beetle data, which had been generated in a standardised manner (Appendix I). These classification provided structures within which sites of similar type could be ranked using rarity indices based on distribution records (Appendix J). These classifications and site rankings are preliminary attempts designed to show the potential for using invertebrates for assessing ERS quality. Only classifications with more sites and incorporating more of the variation in data from the full range of ERS in England and Wales should be used for comparison purposes.

The use of ERS habitat classifications and rankings based on invertebrate species assemblage data is likely to be the way to assess not only individual ERS site quality but also the effects on ERS by the various river management and land use procedures. It has been shown by the work on the River Soar that ERS invertebrate species assemblages change with activities such as bank regrading and then with time. The conservation value of these ERS are also likely to change and the effects can be quantified using the ranking methods based on rarity indices. These indices would probably be based on regional distribution data to give the necessary fine tuning required to assess local ERS changes and temporal trends.

7. RECOMMENDATIONS

There is an obvious need for a structured, standardised field survey of ERS and ERS invertebrates so that the full potential for these habitats for biodiversity and conservation can be explored. There would be little point in carrying out a less than comprehensive survey as the problems of lack of basic knowledge, patchy coverage and ignorance of the effects of river management outlined in this report would not be addressed.

7.1 Survey work

A comprehensive survey would require

(a) Sampling by pitfall trapping of ERS in the all NRA regions such that the variation in the sediments of each region is covered (see section 4.7.1. and Appendix K). More sample sites will be needed in some regions than others.

(b) The recording of a number of environmental variables (Appendix G) from each ERS site sampled such that associations between invertebrate species and assemblage data and the size, structure and history of the sediment can be ascertained as well as the effects of river management and land use.

(c) Sorting should be carried out by an entomologist with sufficient experience (see section 4.7.2.). Catches should be sorted into major groups, usually insect orders and spiders, and preserved in tubes with 70% alcohol.

(d) Identification needs to be carried out by specialists, to species level, known to have the required ability in the relevant invertebrate groups and with a proven pedigree. This is not a job for inexperienced personnel and requires considerable expertise (see section 4.7.3.).

(e) The invertebrate and environmental data needs to be collated such that it can easily be converted into data sets for statistical analyses. These multivariate (e.g. DECORANA, TWINSPAN, fuzzy classification) methods (see section 4.3.1.) and such techniques as logistic regression should initially identify the environmental variables affecting the distribution of ERS invertebrates.

(f) The data should be used to quantify some conservation criteria, with an approach similar to that shown in this report. Sediments should be ranked within habitat classifications and ranking should be on both a national and regional basis.

(g) Assessments of the effects of river management and engineering and of land use should be carried out using a mixture of multivariate analyses and site ranking procedures.

7.2 Other objectives

There needs to be a concerted effort to emphasise and publicise the potential of ERS for wildlife conservation, in both river corridor and landscape contexts. A comprehensive survey of ERS for invertebrates would provide some publicity and more information should be made available to people further up the managerial hierarchy of relevant bodies who are in positions to make policy and decisions. Obviously, this NRA initiated project could be used as a tool for improving the knowledge and importance of ERS invertebrates. The use of NRA biologists in a standardised survey will also improve the knowledge base.

The carrying out of a survey of ERS invertebrates provides an opportunity for collaborative work with conservation bodies, especially English Nature and the Countryside Council for Wales. The product of any survey will be of considerable interest to these bodies as sites with conservation interest are bound to be identified.

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APPENDIX A

A.1 Overall Project Objective of Phase 1

To assess the habitat requirements, status and conservation value of riverine invertebrates associated with exposed sediments (shoals) to provide guidelines on river management practices which minimise impacts and maximise benefits.

A.2 Specific Objectives of Phase 1

(a) To examine in detail the distribution, variety and extent of exposed riverine sediment habitats in England and Wales.

(b) To describe the composition and variety of invertebrate assemblages associated with exposed riverine sediment habitats in England and Wales.

(c) To provide a UK and European context to (a) and (b) by reference to known habitat resources and assemblages in Scotland and Northern Ireland and key literature for mainland Europe.

(d) To assess the status and distributions of rare or endangered invertebrates (Red Data Book species) associated with exposed riverine sediments.

(e) To identify the ecological impacts of river management works and other activities (e.g. water abstraction, recreation, hydro-electric schemes) upon exposed riverine sediments and the specific invertebrate fauna associated with this habitat.

(f) To produce guidelines for the protection and conservation of exposed riverine sediment habitats and associated faunas.

(g) To recommend appropriate sampling methodologies for assessing the invertebrate fauna of exposed riverine sediments.

(h) To identify invertebrate species associated with exposed riverine sediments which are useful indicators of habitat or community type.

(i) To recommend species which could be used to determine the conservation value of different habitat types.

(j) To assess deficiencies in the geographic and taxonomic coverage of data associated with (b) and (c) above, and if appropriate to produce a project plan for phase 2 of the project recommending further work (including field surveys) to fill those deficiencies.

(k) To produce a R&D Project Record and R&D Note, including a draft handbook covering points (f) to (i) above, as an appendix to the R&D Note.

APPENDIX B

B.1 Invertebrate species found on ERS

A list of the invertebrates found on exposed riverine sediments (ERS) is given below. The conservation status (RDB1,2,3,I,K, Na, Nb) fidelity to ERS (low, moderate, high, total, ?) and the substrate preference for each species (silt, sand, shingle indicated by +, ?, other) are indicated (see section 4.1.) and the life stage (A=adult, L=larva, P=pupa) of each species on ERS shown. The species with high or total fidelity to ERS are enboldened.

	Conservation Status	Fidelity	Substrate Preference Silt	Sand	Shingle	Other	Life Stage
Coleoptera							
Carabidae							
Carabus granulatus Linnaeus	None	Moderate	+				A
Carabus violaceus Linnaeus	None	Low	+	+			A
Pelophila borealis (Paykull)	RDB3	Moderate	+	+			A
Nebria brevicollis (Fabricius)	None	Low	+	+	+		AL
Nebria gyllenhali (Schoenherr)	None	Moderate			+		AL
Nebria salina Fairmaire & Laboulbene	None	Low		+			AL
Notiophilus biguttatus (Fabricius)	None	Low	+	+	+		A
***Elaphrus cupreus* Duftschmid**	**None**	**High**	+				**AL**
***Elaphrus riparius* (Linnaeus)**	**None**	**High**	+	+			**AL**
Loricera pilicornis (Fabricius)	None	Low	+	+			AL
***Dyschirius aeneus* (Dejean)**	**None**	**High**	+				**AL**
***Dyschirius luedersi* Wagner**	**None**	**High**	+				**AL**
Dyschirius politus (Dejean)	None	Moderate	+	+			AL
***Clivina collaris* (Herbst)**	**None**	**High**	+	+	+		**AL**
Clivina fossor (Linnaeus)	None	Low	+				A
Patrobus atrorufus (Stroem)	None	Low	+				A
***Perileptus areolatus* (Creutzer)**	**Na**	**Total**			+		**AL**
***Thalassophilus longicornis* (Sturm)**	**Na**	**Total**			+		**AL**
Trechus discus (Fabricius)	Nb	Moderate	+	+	+		AL
Trechus micros (Herbst)	None	Low	+	+	+		A
Trechus obtusus Erichson	None	Low	+	+	+		A
Trechus quadristriatus (Schrank)	None	Low	+	+	+		A
Trechus rubens (Fabricius)	Nb	Low	+	+	+		A
***Asaphidion flavipes* (Linnaeus)**	**None**	**High**	+	+			**AL**
***Asaphidion pallipes* (Duftschmid)**	**Nb**	**High**	+	+			**AL**
Bembidion aeneum Germar	None	Moderate	+	+	+		A
***Bembidion andreae* (Fabricius)**	**None**	**Total**	+	+			**AL**
***Bembidion articulatum* (Panzer)**	**None**	**High**	+	+			**AL**
***Bembidion atrocoeruleum* Stephens**	**None**	**Total**			+		**AL**
Bembidion biguttatum (Fabricius)	None	Moderate	+				A
***Bembidion bipunctatum* (Linnaeus)**	**Nb**	**High**			+		**AL**
Bembidion bruxellense Wesmael	None	Moderate	+	+	+		A
***Bembidion clarki* (Dawson)**	**Nb**	**High**	+				**AL**
***Bembidion decorum* (Zenker)**	**None**	**Total**			+		**AL**
***Bembidion dentellum* (Thunberg)**	**None**	**High**	+				**AL**

Bembidion femoratum Sturm	None	Moderate			+	AL
***Bembidion fluviatile* Dejean**	**Nb**	**High**	+	+		**AL**
***Bembidion genei* Kuster**	**None**	**High**	+	+	+	**A**
***Bembidion geniculatum* Heer**	**None**	**Total**			+	**AL**
Bembidion gilvipes Sturm	Nb	Moderate	+			AL
Bembidion guttula (Fabricius)	None	Moderate	+	+		A
Bembidion lampros (Herbst)	None	Low	+	+	+	A
***Bembidion litorale* (Olivier)**	**Nb**	**Total**	+	+		**AL**
***Bembidion lunatum* (Duftschmid)**	**Nb**	**Total**		+		**AL**
Bembidion lunulatum (Fourcroy)	None	Moderate	+	+	+	AL
***Bembidion monticola* Sturm**	**Nb**	**High**			+	**AL**
Bembidion nitidulum (Marsham)	None	Moderate	+			A
Bembidion obtusum Serville	None	Moderate	+			A
Bembidion properans (Stephens)	None	Moderate	+	+		A
***Bembidion prasinum* (Duftschmid)**	**None**	**Total**			+	**AL**
***Bembidion punctulatum* Drapiez**	**None**	**High**			+	**AL**
Bembidion quadrimaculatum (Linnaeus)	None	Low	+	+	+	A
***Bembidion schueppeli* Dejean**	**Na**	**Total**	+	+		**AL**
***Bembidion semipunctatum* Donovan**	**Na**	**Total**	+	+	+	**AL**
***Bembidion stomoides* Dejean**	**Nb**	**Total**			+	**AL**
***Bembidion testaceum* (Duftschmid)**	**Nb**	**Total**		+	+	**AL**
***Bembidion tetracolum* Say**	**None**	**High**	+	+	+	**AL**
***Bembidion tibiale* (Duftschmid)**	**None**	**Total**			+	**AL**
Bembidion varium (Olivier)	None	Moderate	+			A
***Bembidion virens* Gyllenhal**	**RDB3**	**High**			+	**AL**
***Tachys bistriatus* (Duftschmid)**	**Nb**	**High**	+	+		**AL**
Tachys parvulus (Dejean)	Nb	Moderate	+	+	+	A
Pterostichus cupreus (Linnaeus)	None	Low	+			A
***Pterostichus gracilis* (Dejean)**	**Nb**	**High**	+			**AL**
Pterostichus minor (Gyllenhal)	None	Moderate	+			A
Pterostichus niger (Schaller)	None	Low	+	+	+	A
Pterostichus nigrita (Paykull)	None	Moderate	+			AL
Pterostichus rhaeticus Heer	None	Low	+			AL
Pterostichus strenuus (Panzer)	None	Moderate	+			AL
Pterostichus vernalis (Panzer)	None	Moderate	+			A
Pterostichus versicolor (Sturm)	None	Low	+			A
***Agonum albipes* (Fabricius)**	**None**	**High**	+	+	+	**AL**
Agonum assimile (Paykull)	None	Moderate	+	+	+	AL
Agonum dorsale (Pontoppidan)	None	Low	+	+		A
Agonum fuliginosum (Panzer)	None	Moderate	+			A
***Agonum livens* (Gyllenhal)**	**Na**	**High**	+			**AL**
Agonum marginatum (Linnaeus)	None	Moderate	+			A
***Agonum micans* Nicolai**	**None**	**High**	+			**AL**
Agonum muelleri (Herbst)	None	Low	+	+	+	A
Agonum obscurum (Herbst)	None	Moderate	+			A
***Agonum scitulum* Dejean**	**Na**	**High**	+			**AL**
Agonum thoreyi Dejean	None	Moderate	+			A
***Amara fulva* (Mueller)**	**Nb**	**High**		+		**AL**
Amara quenseli (Schoenherr)	Na	Moderate		+		A
Amara similata (Gyllenhal)	None	Low	+	+	+	A
Trichocellus placidus (Gyllenhal)	None	Moderate	+			A
***Stenolophus mixtus* (Herbst)**	**None**	**High**	+			**A**

Acupalpus flavicollis (Sturm)	Na	Moderate	+	+			A
Badister anomalus (Perris)	RDB1	Moderate	+				A
Badister dilatatus Chaudoir	Nb	Moderate	+				A
Badister unipustulatus Bonelli	Nb	Moderate	+				A
***Chlaenius nigricornis* (Fabricius)**	**Nb**	**High**	+				**A**
***Chlaenius vestitus* (Paykull)**	**None**	**High**	+	+			**A**
Demetrias atricapillus (Linnaeus)	None	Low	+				A
***Lionychus quadrillum* (Duftschmid)**	**RDB3**	**High**			+		**AL**
Polistichus connexus (Fourcroy)	RDB2	Low	+	+			A
Haliplidae							
***Brychius elevatus* (Panzer)**	**None**	**Total**	+	+	+		**P**
Haliplus flavicollis Sturm	None	Moderate	+	+			P
***Haliplus fluviatilis* Aube**	**None**	**High**	+	+			**P**
Haliplus fulvus (Fabricius)	None	Moderate			+		P
Haliplus immaculatus Gerhardt	None	Moderate	+	+			P
***Haliplus laminatus* (Schaller)**	**Nb**	**High**	+	+			**P**
Haliplus lineatocollis (Marsham)	None	Moderate	+	+			P
Haliplus ruficollis (DeGeer)	None	Low	+				P
Haliplus wehnckei Gerhardt	None	Low	+				P
Dytiscidae							
***Laccophilus hyalinus* (DeGeer)**	**None**	**High**	+				**P**
Laccophilus minutus (Linnaeus)	None	Low	+				P
Hydroglyphus geminus (Fabricius)	Nb	Low	+	+			P
***Bidessus minutissima* (Germar)**	**RDB3**	**High**	+	+			**P**
Hygrotus inaequalis (Fabricius)	None	Low	+				P
Hygrotus versicolor (Schaller)	None	Low	+				P
Hydroporus discretus Fairmaire	None	Moderate	+				P
Hydroporus erythrocephalus (Linnaeus)	None	Low	+				P
***Hydroporus ferrugineus* Stephens**	**Nb**	**High**				**Subterranean**	**P**
Hydroporus longulus Mulsant	Nb	Low	+				P
Hydroporus marginatus (Duftschmid)	Nb	Moderate				Chalk	P
Hydroporus memnonius Nicolai	None	Low	+				P
Hydroporus nigrita (Fabricius)	None	Low	+				P
Hydroporus obscurus Sturm	None	Low	+				P
Hydroporus obsoletus Aube	Nb	Moderate				Subterranean	P
Hydroporus palustris (Linnaeus)	None	Low	+	+			P
Hydroporus planus (Fabricius)	None	Low	+				P
Hydroporus pubescens (Gyllenhal)	None	Low	+				P
Hydroporus tessellatus Drapiez	None	Moderate	+				P
Stictonectes lepidus (Olivier)	Nb	Moderate	+				P
Graptodytes pictus (Fabricius)	None	Moderate	+				P
***Deronectes latus* (Stephens)**	**Nb**	**Total**			+		**P**
***Nebrioporus depressus elegans* (Panzer)**	**None**	**High**		+	+		**P**
***Oreodytes davisii* (Curtis)**	**Nb**	**Total**			+		**P**
***Oreodytes sanmarkii* (Sahlberg)**	**None**	**High**			+		**P**
***Oreodytes septentrionalis* (Sahlberg)**	**None**	**High**		+	+		**P**
Scarodytes halensis (Fabricius)	Nb	Moderate	+				P
***Platambus maculatus* (Linnaeus)**	**None**	**High**			+		**P**
Agabus bipustulatus (Linnaeus)	None	Low	+				P
***Agabus biguttatus* (Olivier)**	**Nb**	**High**			+		**P**

***Agabus brunneus* (Fabricius)**	**RDB2**	**Total**			+		**P**
***Agabus didymus* (Olivier)**	**None**	**Total**	+				**P**
***Agabus guttatus* (Paykull)**	**None**	**Total**	+		+		**P**
Agabus nebulosus (Forster)	None	Low	+				P
***Agabus paludosus* (Fabricius)**	**None**	**High**	+				**P**
Agabus sturmii (Gyllenhal)	None	Low	+				P
Ilybius fuliginosus (Fabricius)	None	Moderate	+				P
Colymbetes fuscus (Linnaeus)	None	Low	+				P
Dytiscus marginalis Linnaeus	None	Low	+				P
Dytiscus semisulcatus Mueller	None	Moderate	+				P
Gyrinidae							
Gyrinus aeratus Stephens	Nb	Low				Pools	AL
Gyrinus substriatus Stephens	None	Low	+				P
***Gyrinus urinator* Illiger**	**Nb**	**High**				**Shade**	**AL**
***Orectochilus villosus* (Mueller)**	**None**	**High**			+		**P**
Georissidae							
***Georissus crenulatus* (Rossi)**	**Na**	**High**	+	+			**ALP**
Hydrochidae							
***Hydrochus nitidicollis* Mulsant**	**RDB3**	**High**	+		+		**ALP**
Helophoridae							
Helophorus aequalis Thomson	None	Low	+				ALP
***Helophorus arvernicus* Mulsant**	**Nb**	**Total**	+	+			**ALP**
Helophorus brevipalpis Bedel	None	Low	+				ALP
Helophorus flavipes Fabricius	None	Low	+				ALP
Helophorus grandis Illiger	None	Low	+				ALP
Helophorus griseus Herbst	Nb	Low	+				ALP
Helophorus minutus Fabricius	None	Low	+				ALP
Helophorus obscurus Mulsant	None	Low	+				ALP
Helophorus strigifrons Thomson	Nb	Moderate	+				ALP
Hydrophilidae							
Hydrobius fuscipes (Linnaeus)	None	Low	+				ALP
***Anacaena bipustulata* (Marsham)**	**Nb**	**High**	+				**ALP**
Anacaena globulus (Paykull)	None	Moderate	+				ALP
Anacaena limbata (Fabricius)	None	Moderate	+				ALP
Anacaena lutescens Stephens	None	Low	+				ALP
***Laccobius atrocephalus* Reitter**	**Nb**	**High**	+				**ALP**
Laccobius bipunctatus (Fabricius)	None	Low	+				ALP
Laccobius sinuatus Motschulsky	Nb	Moderate	+				ALP
***Laccobius striatulus* (Fabricius)**	**None**	**High**	+				**ALP**
***Cercyon bifenestratus* Kuster**	**Na**	**High**		+			**ALP**
Cercyon convexiusculus Stephens	Nb	Moderate	+				ALP
Cercyon marinus Thomson	None	Moderate	+				ALP
Cercyon tristis (Illiger)	Nb	Moderate	+				ALP
Cercyon ustulatus (Preyssler)	Nb	Moderate	+				ALP
***Chaetarthria similis* Wollaston**	**RDBK**	**High**	+		+		**A**

Hydraenidae							
Ochthebius bicolon Germar	Nb	High	+				ALP
Ochthebius dilatatus Stephens	None	Low	+				ALP
Ochthebius exsculptus Germar	Nb	Total	+		+		ALP
Ochthebius minimus (Fabricius)	None	Low	+				ALP
Hydraena gracilis Germar	None	Total			+		ALP
Hydraena minutissimus Stephens	Nb	High				Moss	ALP
Hydraena nigrita Germar	Nb	Total	+				ALP
Hydraena pulchella Germar	RDB3	Total	+				ALP
Hydraena pygmaea Waterhouse	RDB3	Total	+		+		ALP
Hydraena riparia Kugelann	None	High	+				ALP
Hydraena rufipes Curtis	Nb	High	+		+		ALP
Hydraena testacea Curtis	Nb	Moderate	+				ALP
Limnebius nitidus (Marsham)	Nb	Moderate	+				ALP
Limnebius papposus Mulsant	Nb	Low	+				ALP
Limnebius truncatellus (Thunberg)	None	Low	+	+	+		ALP
Ptiliidae							
Acrotrichis henrici (Matthews)	None	Moderate	+				A
Acrotrichis sitkaensis (Motschulsky)	None	Moderate	+				A
Actidium aterrimum (Motschulsky)	RDBK	Total		+	+		A
Ptenidium brenskei Flach	Notable	Total			+		A
Ptenidium longicorne Fuss	None	Total?	+	+			A
Staphylinidae							
Lesteva hanseni Lohse	Notable	High				Moss	A
Lesteva heeri Fauvel	None	Moderate	+			Moss	A
Lesteva longoelytra (Goeze)	None	High	+	+	+		A
Lesteva monticola Kiesenwetter	None	Moderate				Moss	A
Lesteva pubescens Mannerheim	None	High	+				A
Lesteva punctata Erichson	None	High				Moss	A
Geodromicus nigrita (Mueller)	None	Total?			+		A
Deleaster dichrous (Gravenhorst)	Nb	High	+	+	+		A
Bledius annae Sharp	None	Total?		+			A
Bledius arcticus Sahlberg	RDB1	Total?	?	?	?		A
Bledius defensus Fauvel	RDBK	High		+			A
Bledius erraticus Erichson	RDBK	High	+	+			A
Bledius filipes Sharp	RDB1	High?		+			A
Bledius gallicus (Gravenhorst)	None	High	+	+			A
Bledius longulus Erichson	None	Moderate		+			A
Bledius pallipes (Gravenhorst)	None	High	+	+			A
Bledius subterraneus Erichson	None	Total?		+			A
Bledius terebrans (Schiodte)	RDBK	High		+			A
Ochthephilus andaluciacus (Fagel)	Notable	Total?	?	?	?		A
Ochthephilus aureus (Fauvel)	None	Total?			+		A
Ochthephilus omalinus (Erichson)	None	Total?			+		A
Ochthephilus venustulus (Rosenhauer)	Notable	Total?			+		A
Thinodromus arcuatus (Stephens)	None	Total	+	+	+		A
Carpelimus bilineatus Stephens	None	High	+				A
Carpelimus corticinus (Gravenhorst)	None	Moderate	+				A
Carpelimus fuliginosus (Gravenhorst)	Notable	?	?	?	?		A
Carpelimus gracilis (Mannerheim)	None	High	+	+	+		A

Capelimus impressus (Bois. & Lac.)	None	High	+				A
Carpelimus lindrothi Palm	Notable	High	+				A
Carpelimus obesus (Kiesenwetter)	Notable	Total?	+				A
Carpelimus rivularis (Motsculsky)	None	High	+	+			A
Carpelimus similis (Smetana)	Notable	High	+	+			A
Carpelimus subtilicornis (Roubal)	None	Total?	+	+			A
Carpelimus subtilis (Erichson)	Notable	High	+	+	+		A
Carpelimus zealandicus (Sharp)	None	High	+	+			A
Thinobius bicolor Joy	Na	Total			+		A
Thinobius brevipennis Kiesenwetter	RDBK	?	+	+			A
Thinobius crinifer Smetana	Notable	Total			+		A
Thinobius longipennis (Heer)	None	Total			+		A
Thinobius major Kraatz	RDBK	Total			+		A
Thinobius newberyi Scheerpeltz	RDBI	Total			+		A
Thinobius praetor Smetana	Notable	Total			+		A
Platystethus alutaceus Thomson	None	Moderate	+				A
Platystethus cornutus (Gravenhorst)	None	High	+				A
Platystethus degener Mulsant & Rey	None	High	+				A
Platystethus nitens (Sahlberg)	None	High	+				A
Platystethus nodifrons (Mannerheim)	Notable	High	+				A
Anotylus rugosus (Fabricius)	None	Moderate	+	+	+		A
Oxytelus fulvipes Erichson	Na	High	+				A
Stenus argus Gravenhorst	Nb	High	+				A
Stenus bifoveolatus Gyllenhal	None	Moderate	+				A
Stenus biguttatus (Linnaeus)	None	?	+				A
Stenus bimaculatus Gyllenhal	None	Moderate	+				A
Stenus boops Ljungh	None	Moderate	+				A
Stenus calcaratus Scriba	RDBK	High	+				A
Stenus canaliculatus Gyllenhal	None	High	+				A
Stenus carbonarius Gyllenhal	Nb	High	+				A
Stenus cicindeloides (Schaller)	None	Moderate	+				A
Stenus comma LeConte	None	High		+	+		A
Stenus guttula Mueller	None	High			+		A
Stenus guyemeri Jacquelin du Val	None	High			+	Moss	A
Stenus incanus Erichson	RDBK	High	+				A
Stenus juno (Paykull)	None	Moderate	+				A
Stenus latifrons Erichson	None	Moderate	+				A
Stenus melanopus (Marsham)	None	Moderate	+				A
Stenus pallitarsis Stephens	None	Moderate	+				A
Stenus pubescens Stephens	None	Moderate	+				A
Stenus pusillus Stephens	None	Moderate	+				A
Stenus solutus Erichson	None	Moderate	+				A
Stenus tarsalis Ljungh	None	High	+				A
Dianous coerulescens (Gyllenhal)	None	High			+	Moss	A
Paederus littoralis Gravenhorst	None	Moderate	+	+	+		A
Lathrobium angustatum Bois. & Lac.	Nb	High			+		A
Lathrobium angusticolle Bois. & Lac.	Nb	High			+		A
Lathrobium brunnipes (Fabricius)	None	Low	+				A
Lathrobium dilutum Erichson	RDB3	High			+		A
Lathrobium elongatum (Linnaeus)	None	Moderate	+				A
Lathrobium fulvipenne (Gravenhorst)	None	Moderate	+				A
Lathrobium geminum Kraatz	None	Moderate	+				A

Lathrobium multipunctum Gravenhorst	None	Moderate	+				A
Lathrobium pallidum **von Nordmann**	**RDBK**	**Total?**		**+**	**+**		**A**
Lathrobium quadratum (Paykull)	None	Moderate	+				A
Lathrobium ripicola Czwalina	Notable	Moderate	+				A
Achenium depressum (Gravenhorst)	None	?	?	?	?		A
Achenium humile (Nicolai)	Nb	?	?	?	?		A
Medon ripicola **(Kraatz)**	**Notable**	**High**		**+**			**A**
Sunius bicolor (Olivier)	RDBK	?	?	?	?		A
Scopaeus gracilis **(Sperk)**	**RDBK**	**Total?**			**+**		**A**
Scopaeus sulcicollis (Stephens)	None	Moderate	+	+	+		A
Rugilus fragilis (Gravenhorst)	Notable	?	?	?	?		A
Xantholinus linearis (Olivier)	None	Low	+	+	+		A
Xantholinus longiventris Heer	None	Moderate	+				A
Neobisnius procerulus (Gravenhorst)	RDBK	?	?	?	?		A
Neobisnius prolixus **(Erichson)**	**RDBK**	**Total?**			**+**		**A**
Neobisnius villosulus **(Stephens)**	**None**	**Total?**	**+**	**+**			**A**
Erichsonius signaticornis **(Mulsant & Rey)**	**Nb**	**Total?**		**+**	**+**		**A**
Philonthus atratus **(Gravenhorst)**	**Na**	**Total?**		**+**			**A**
Philonthus micantoides **Benick & Lohse**	**None**	**High**	**+**				**A**
Philonthus pullus von Nordmann	RDBI	?	?	?	?		A
Philonthus punctus **(Gravenhorst)**	**RDB3**	**High**	**+**				**A**
Philonthus quisquiliarius **(Gyllenhal)**	**None**	**High**	**+**	**+**	**+**		**A**
Philonthus rotundicollis **(Menetries)**	**None**	**High**	**+**				**A**
Philonthus rubripennis **Stephens**	**None**	**Total?**			**+**		**A**
Philonthus umbratilis (Gravenhorst)	None	Low	+				A
Gabrius astutoides **(Strand)**	**RDBI**	**High**	**?**	**?**	**?**		**A**
Gabrius bishopi **Sharp**	**Nb**	**High**	**+**	**+**			**A**
Gabrius nigritulus **(Gravenhorst)**	**None**	**High**		**+**			**A**
Gabrius pennatus **Sharp**	**None**	**High**	**+**				**A**
Gabrius subnigritulus (Reitter)	None	?	+				A
Gabrius velox **Sharp**	**Nb**	**High**	**+**				**A**
Quedius auricomus **Kiesenwetter**	**Nb**	**High**				**Moss**	**A**
Quedius maurorufus (Gravenhorst)	None	Low	+				A
Quedius plancus **Erichson**	**Na**	**Total?**	**+**				**A**
Quedius riparius **Kellner**	**RDBK**	**High**				**Moss**	**A**
Tachyporus chrysomelinus (Linnaeus)	None	Low	+	+	+		A
Tachyporus dispar (Paykull)	None	Low	+	+	+		A
Tachyporus hypnorum (Fabricius)	None	Low	+	+	+		A
Tachyporus nitidulus (Fabricius)	None	Low	+	+	+		A
Tachyporus obtusus (Linnaeus)	None	Moderate	+	+	+		A
Tachyporus pallidus Sharp	None	Moderate	+				A
Tachyporus solutus Erichson	None	Low	+				A
Tachinus signatus Gravenhorst	None	Low	+				A
Deinopsis erosa **(Stephens)**	**None**	**High**	**+**				**A**
Myllaena elongata **(Matthews)**	**Notable**	**High**	**+**	**+**	**+**		**A**
Hygronoma dimidiata (Gravenhorst)	None	Moderate	+				A
Falagria sulcatula (Gravenhorst)	Notable	?	+				A
Tachyusa atra **(Gravenhorst)**	**None**	**High**	**+**				**A**
Tachyusa coarctata **Erichson**	**Notable**	**High**	**+**				**A**
Tachyusa constricta **Erichson**	**None**	**High**	**+**	**+**			**A**
Tachyusa leucopus **(Marsham)**	**None**	**High**	**+**	**+**			**A**
Tachyusa scitula Erichson	RDBK	Total?	?	?	?		A

***Tachyusa umbratica* Erichson**	None	Total?	+	+		A
***Gnypeta caerulea* (Sahlberg)**	Notable	Total?	+			A
***Gnypeta carbonaria* (Mannerheim)**	None	High	+			A
***Gnypeta ripicola* (Kiesenwetter)**	Notable	High	+			A
***Gnypeta rubrior* Tottenham**	None	High	+			A
***Gnypeta velata* (Erichson)**	Notable	High	+	+		A
***Brachyusa concolor* (Erichson)**	Notable	High	+			A
***Hydrosmecta delicatula* (Sharp)**	RDBK	Total?			+	A
***Hydrosmecta eximia* (Sharp)**	None	Total?			+	A
***Hydrosmecta fragilis* (Kraatz)**	Notable	Total?			+	A
***Hydrosmecta thinibiodes* (Kraatz)**	Notable	High			+	A
***Hydrosmectina septentrionum* Benick**	Notable	Total?		+	+	A
***Aloconota cambrica* (Wollaston)**	None	Total?			+	A
***Aloconota currax* (Kraatz)**	None	Total?			+	A
***Aloconota eichoffi* (Scriba)**	Notable	Total?			+	A
Aloconota gregaria (Erichson)	None	Moderate	+	+	+	A
***Aloconota insecta* (Thomson)**	None	High	+	+	+	A
Aloconota mihoki Bernhauer	RDBI	?	?	?	?	A
***Aloconota planifrons* (Waterhouse)**	RDBK	High			+	A
Aloconota subgrandis (Brundin)	RDBK	?	?	?	?	A
***Aloconota sulcifrons* (Stephens)**	None	High	+	+	+	A
Amischa analis (Gravenhorst)	None	Low	+			A
***Dochmonota clancula* (Erichson)**	Notable	High	+			A
Liogluta nitidula (Kraatz)	None	Moderate	+			A
***Atheta autumnalis* (Erichson)**	RDBK	Total?	+			A
***Atheta basicornis* (Mulsant & Rey)**	Notable	High	+			A
Atheta debilis (Erichson)	None	?	?	?	?	A
Atheta deformis (Kraatz)	Notable	?	?	?	?	A
***Atheta elongatula* (Gravenhorst)**	None	High	+	+		A
Atheta fungi (Gravenhorst)	None	Low	+			A
Atheta graminicola (Gravenhorst)	None	Moderate	+	+		A
***Atheta gyllenhali* (Thomson)**	None	High	+			A
***Atheta hygrobia* (Thomson)**	Notable	High	+			A
***Atheta hygrotopora* (Kraatz)**	None	High	+	+	+	A
Atheta laticollis (Stephens)	None	Low	+			A
***Atheta luridipennis* (Mannerheim)**	None	High	+			A
***Atheta luteipes* (Erichson)**	None	High	+			A
***Atheta malleus* Joy**	None	High	+			A
***Atheta melanocera* (Thomson)**	None	High	+			A
Atheta nannion Joy	RDBK	?	?	?	?	A
***Atheta obfuscata* (Gravenhorst)**	Notable	High	+			A
***Atheta scotica* (Elliman)**	Notable	Total?			+	A
***Atheta vilis* (Erichson)**	None	High	+			A
***Atheta volans* (Scriba)**	None	High	+			A
Alianta incana (Erichson)	None	Moderate	+			A
Pachnida nigella (Erichson)	None	Moderate	+			A
Ilyobates propinquus (Aube)	Notable	?	+			A
Ilyobates subopacus Palm	Notable	?	+			A
***Calodera aethiops* (Gravenhorst)**	None	High	+			A
***Calodera nigrita* Mannerheim**	Notable	High	+			A
***Calodera riparia* Erichson**	Notable	High	+			A
Calodera uliginosa Erichson	RDBK	High	+			A

Chiloporata longitarsis (Erichson)	None	High	+	+	+	A
Chiloporata rubicunda (Erichson)	Notable	Total?	+	+	+	A
Ocalea latipennis Sharp	None	?	?	?	?	A
Ocalea rivularis Miller	None	?	+			A
Meotica anglica Benick	Notable	High	+	+	+	A
Oxypoda brachyptera (Stephens)	None	Low	+	+	+	A
Oxypoda elongatula Aube	None	Moderate	+			A
Oxypoda exoleta Erichson	Notable	High	+	+	+	A
Oxypoda lentula Erichson	None	High	+			A
Oxypoda nigrocincta Mulsant & Rey	RDBI	High	+			A
Oxypoda riparia Fairmaire	RDBK	?	?	?	?	A
Oxypoda soror Thomson	Notable	?	?	?	?	A
Aleochara brevipennis (Gravenhorst)	Notable	High	?	?	?	A
Pselaphidae						
Bibloplectus minutissimus Aube	RDBK	Total?			+	A
Brachygluta pandellei (Saulcy)	RDBK	Total?			+	A
Scarabaeidae						
Aegialia sabuleti (Panzer)	Nb	Moderate		+	+	A
Scirtidae						
Hydrocyphon deflexicollis (Mueller)	Nb	High			+	A
Heteroceridae						
Heterocerus fenestratus (Thunberg)	None	High	+			A
Heterocerus marginatus (Fabricius)	None	High	+			A
Limnichidae						
Limnichus pygmaeus (Sturm)	Na	High	+			A
Dryopidae						
Dryops ernesti des Gozis	None	Moderate	+			A
Dryops luridus (Erichson)	None	Low	+		+	A
Dryops nitidulus (Heer)	RDB3	Moderate		+	+	A
Elmidae						
Elmis aenea (Mueller)	None	Total		+	+	P
Esolus parallelepipedus (Mueller)	None	Total		+	+	P
Limnius volckmari (Panzer)	None	Total			+	P
Normandia nitens (Mueller)	RDB2	Total			+	P
Oulimnius major (Rey)	Na	High	+			P
Oulimnius rivularis (Rosenhauer)	Na	Total	+			P
Oulimnius troglodytes (Gyllenhal)	Nb	High	+	+		P
Oulimnius tuberculatus (Mueller)	None	High	+	+		P
Riolus cupreus (Mueller)	Nb	High	+	+		P
Riolus subviolaceus (Mueller)	Nb	Total	+	+		P
Stenelmis canaliculata (Gyllenhal)	RDB2	High			+	P

Elateridae							
***Fleutiauxellus maritimus* (Curtis)**	**Na**	**High**		**+**	**+**		**A**
Hypnoides riparius (Fabricius)	None	Moderate	+				A
***Negastrius pulchellus* (Linnaeus)**	**RDB2**	**High**		**+**	**+**		**A**
***Negastrius sabulicola* (Boheman)**	**RDB2**	**High**		**+**	**+**		**A**
***Zorochros minimus* (Bois. & Lac.)**	**None**	**High**		**+**	**+**		**A**
Rhizophagidae							
***Cyanostolus aeneus* (Richter)**	**Na**	**High**				**Bark**	**A**
Rhizophagus picipes (Olivier)	Na	Moderate				Bark	A
Cryptophagidae							
***Paramecosoma melanocephalum* (Herbst)**	**None**	**High**				**Refuse**	**A**
Coccinellidae							
Anisosticta novemdecimpunctata (Linn.)	None	Moderate	+				A
***Coccinella quinquepunctata* Linnaeus**	**RDB3**	**Total**			**+**		**A**
Coccidula rufa (Herbst)	None	Moderate	+				A
Coccidula scutellata (Herbst)	None	Moderate	+				A
Chrysomelidae							
Altica lythri Aube	None	Low	+				A
Donacia simplex Fabricius	None	Moderate	+				A
Galerucella calmariensis (Linnaeus)	None	?	?	?	?		A
Galerucella sagittariae (Gyllenhal)	None	Moderate	+				A
Gastrophysa viridula (DeGeer)	None	Low	+				A
Oulema melanopa (Linnaeus)	None	Low	+	+	+		A
Phaedon armoraciae (Linnaeus)	None	Moderate	+				A
Phaedon cochleariae (Fabricius)	None	Moderate	+				A
Prasocuris junci (Brahm)	None	Moderate	+				A
Psylliodes affinis (Paykull)	None	Low	+				A
Curculionidae							
***Baris lepidii* Germar**	**Na**	**High**	+				**A**
Notaris acridulus (Linnaeus)	None	Moderate	+				A
Notaris bimaculatus (Fabricius)	Nb	Moderate	+				A
Notaris scirpi (Fabricius)	Nb	Moderate	+				A
Poophagus sisymbrii (Fabricius)	None	Moderate	+				A
Thryogenes festucae (Herbst)	None	Moderate	+				A
Hemiptera							
Dipsocoridae							
***Cryptostemma alienum* Herrich-Schaeffer**	**None**	**Total?**			**+**		**A**
Saldidae							
***Saldula c-album* (Fieber)**	**None**	**Total?**			**+**		**AL**
Salda littoralis (Linnaeus)	None	Moderate	+				AL
***Saldula fucicola* (Sahlberg)**	**Notable**	**High**			**+**		**AL**
Saldula saltatoria (Linnaeus)	None	Moderate	+				AL
***Saldula scotica* (Curtis)**	**None**	**Total?**			**+**		**AL**

Hydrometridae						
Hydrometra stagnorum (Linnaeus)	None	High	+	+		A
Diptera						
Asilidae						
Rhadiurgus variabilis (Zetterstedt)	RDB3	High			+	A
Empididae						
Chersodromia cursitans (Zetterstedt)	Nb	?	?	?	?	A
Heleodromia irwini	pRDB1	?	?	?	?	A
Hemerodromia laudatoria Collin	Nb	?	?	?	?	A
Tachydromia acklandi Chvala	pRDB2	?	?	?	?	A
Tachydromia halidayi (Collin)	pRDB3	?	?	?	?	A
Tachydromia woodi (Collin)	pRDB2	?	?	?	?	A
Wiedemannia phantasma Mik	pRDB3	?	?	?	?	A
Dolichopodidae						
Rhaphium fractum Loew	Nb	?	?	?	?	A
Rhaphium gravipes Haliday	Nb	?	?	?	?	A
Rhaphium nasutum Fallen)	Nb	?	?	?	?	A
Rhaphium patulum (Raddatz)	Nb	?	?	?	?	A
Rhaphium rivale (Loew)	Nb	?	?	?	?	A
Lauxaniidae						
Homoneura limnea (Becker)	RDB2	?	?	?	?	A
Micropezidae						
Calobata stylifera Loew	pRDB3	?	?	?	?	A
Therevidae						
Psilocephala rustica (Panzer)	RDB3	High		+	+	A
Thereva handlirschi Krober	RDB3	High	+	+	+	A
Thereva inornata Verrall	RDB3	High	+	+	+	A
Thereva lunulata Zetterstedt	RDB3	High		+	+	A
Thereva valida Loew	RDB3	Moderate	+	+	+	A
Tipulidae						
Arctoconopa melampodia (Loew)	RDB2	High		+		A
Dicranota robusta Lundstroem	Notable	High		+	+	A
Dicranota simulans Lackschewitz	RDB3	High			+	A
Erioptera edwardsii (Lackschewitz)	RDBI	High			+	A
Erioptera limbata Loew	RDB2	High		+		A
Erioptera meigeni (Zetterstedt)	RDB3	High		+	+	A
Erioptera nigripalpis Goetghebuer	RDB3	High	+			A
Erioptera pusilla (Schiner)	RDB1	High		+	+	A
Gonomyia edwardsi	pRDBK	?	?	?	?	A
Gonomyia punctata Edwards	RDB2	High		+		A
Limnophila apicata (Loew)	Notable	High	+	+	+	A
Limnophila mundata (Loew)	Notable	High	+	+	+	A
Limonia omissinervis (de Meijere)	RDB2	High		+		A
Molophilus propinquus (Egger)	Notable	High		+		A

***Nephrotoma aculeata* (Loew)**	**RDB2**	**High**		**+**		**A**
***Nephrotoma dorsalis* (Fabricius)**	**Notable**	**High**		**+**		**A**
***Nephrotoma lunulicornis* (Schummel)**	**Notable**	**High**		**+**		**A**
Nephrotoma submaculosa Edwards	None	?	?	?	?	A
Rhabdomastix edwardsi Tjeder	None	?	?	?	?	A
***Rhabdomastix hilaris* Edwards**	**RDB3**	**High**		**+**		**A**
***Rhabdomastix inclinata* Edwards**	**RDB2**	**High**		**+**		**A**
***Tipula bistilata* Lundstroem**	**RDB2**	**High**		**+**		**A**
***Tipula dilatata* Schummel**	**RDB2**	**High**		**+**		**A**
Araneae						
Gnaphosidae						
Drassodes cupreus (Blackwall)	None	Low	+	+	+	A
Zelotes latreille (Simon)	None	Low	+	+	+	A
Micaria pulicaria (Sundevall)	None	Low	+	+	+	A
Clubionidae						
Clubiona phragmitis Koch	None	Low	+			A
Thomisidae						
Xysticus ulmi (Hahn)	None	Low	+			A
Lycosidae						
***Pardosa agricola* (Thorell)**	**None**	**High**	**+**	**+**	**+**	**A**
Pardosa amentata (Clerck)	None	Low	+	+	+	A
Pardosa nigriceps (Thorell)	None	Low	+	+	+	A
Pardosa palustris (Linnaeus)	None	Low	+	+	+	A
Trochosa ruricola (DeGeer)	None	Low	+	+	+	A
Trochosa terricola Thorell	None	Low	+	+	+	A
***Arctosa cinerea* (Fabricius)**	**Nb**	**High**			**+**	**A**
Arctosa perita (Latreille)	None	Low		+		A
Pirata piraticus (Clerck)	None	Low	+			A
Argyronetidae						
Argyroneta aquatica (Clerck)	None	Low	+			A
Hahniidae						
Antistea elegans (Blackwall)	None	Low	+			A
Tetragnathidae						
Pachygnatha clercki Sundevall	None	Low	+	+	+	A
Pachygnatha degeeri Sundevall	None	Low	+	+	+	A

Linyphiidae						
Walckenaeria acuminata Blackwall	None	Low	+	+	+	A
Walckenaeria alticeps (Denis)	None	Low	+			A
Walckenaeria cuspidata (Blackwall)	None	Low	+	+	+	A
Walckenaeria nudipalpis (Westring)	None	Low	+	+	+	A
Walckenaeria unicornis Cambridge	None	Low	+	+	+	A
Pocadicnemis pumila (Blackwall)	None	Low	+	+	+	A
Gnathonarium dentatum (Wider)	None	Moderate	+			A
Hypomma bituberculatum (Wider)	None	Moderate	+			A
Baryphyma pratense (Blackwall)	None	Low	+			A
Baryphyma trifrons (Cambridge)	None	Low	+			A
Oedothorax agrestis (Blackwall)	None	Low	+			A
Oedothorax apicatus (Blackwall)	None	Moderate			+	A
Oedothorax fuscus (Blackwall)	None	Low	+	+	+	A
Oedothorax gibbosus (Blackwall)	None	Low	+			A
Oedothorax retusus (Westring)	None	Low	+	+	+	A
Lophomma punctatum (Blackwall)	None	Moderate	+			A
Savignya frontata (Blackwall)	None	Low	+	+	+	A
***Diplocephalus connatus* Bertkau**	**RDB2**	**Total**			**+**	**A**
Diplocephalus cristatus (Blackwall)	None	Low	+	+	+	A
Diplocephalus picinus (Blackwall)	None	Low	+	+	+	A
***Diplocephalus protuberans* (Cambridge)**	**None**	**High**	**?**	**?**	**?**	**A**
Erigone atra (Blackwall)	None	Low	+	+	+	A
Erigone dentipalpis (Wider)	None	Low	+	+	+	A
Donacochara speciosa (Thorell)	None	Moderate	+			A
Leptorhoptrum robustum (Westring)	None	Moderate	+			A
Halorates distinctus (Simon)	None	Moderate	+			A
***Caviphantes saxetorum* (Hull)**	**Nb**	**Total**			**+**	**A**
Centromerus persimilis (Cambridge)	RDBK	Moderate			+	A
Centromerita bicolor (Blackwall)	None	Low	+	+	+	A
Tallusia experta (Cambridge)	None	Low	+			A
Bathyphantes approximatus (Cambridge)	None	Low	+	+	+	A
Bathyphantes gracilis (Blackwall)	None	Low	+	+	+	A
Kaestneria pullata (Cambridge)	None	Low	+			A
Lepthyphantes mengei Kulczynski	None	Low	+	+	+	A
Lepthyphantes pallidus (Cambridge)	None	Low	+	+	+	A
Lepthyphantes tenuis (Blackwall)	None	Low	+	+	+	A
Lepthyphantes zimmermanni Bertkau	None	Low	+	+	+	A
Allomengea scopigera (Grube)	None	Low	+			A
Allomengea vidua (Koch)	None	Low	+			A

APPENDIX C

This appendis contains a bibliography of references concerned with the distribution, ecology and conservation of ERS invertebrates.

To the right of each reference is a four letter abbreviation, in italics, of the invertebrate group and of the subject or subjects covered in the publication. These abbreviations are *Aran* = Araneae (spiders); *Cara* = Carabidae (ground beetles); *Cocc* = Coccinelidae (ladybirds); *Cole* = Coleoptera (beetles); *Cons* = Conservation; *Curc* = Curculionidae (weevils); *Dipt* = Diptera (flies); *Dist* = Distribution; *Dyti* = Dytiscidae (water beetles); *Ecol* = Ecology; *Elat* = Elateridae (click beetles); *Hali* = Haliplidae (water beetles); *Hetc* = Heteroceridae; *Hete* = Heteroptera (bugs); *Hydp* = Hydrophilidae (water beetles); *Hydr* = Hydraenidae (water beetles); *Larv* = Larvae; *Psel* = Pselaphidae; *Ptil* = Ptilidae; *Rhiz* = Rhizophagidae; *Scar* = Scarabaeidae; *Stap* = Staphylinidae (rove beetles).

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APPENDIX D

EXPOSED RIVERINE SEDIMENTS QUESTIONNAIRE

.. NRA

NATIONAL HYDROMETRIC AREA .... HYDROMETRIC REF.NO. ....

TABLE A

0 = No Information
1 = Absent/Rare
2 = Occasional
3 = Frequent
4 = Common/Widespread

1. Extent of Exposed Sediment Type:

Please estimate relative frequency using categories 0-4 in Table A

	Tributaries or streams	***Principal River channel/s***
Open/Vegetated Silt (<0.2mm)	....	....
Sand (0.2-2mm)	....	....
Shingle/Gravel/Pebbles (2mm-5cm)	....	....
Cobbles/Boulders (>5cm)	....	....

2. Water Management Influences:

Please estimate relative frequency using categories 0-4 in Table A

	Tributaries or streams	***Principal River channel/s***
Dams or reservoirs	....	....
Navigation	....	....
Channel straightening	....	....
Channel dredging/regrading	....	....
Impoundments (e.g. weirs/mills)	....	....
Intercatchment transfers	....	....
Water abstraction	....	....

3. Brief Description of Major Land Uses:

....

4. River Corridor Surveys/Aerial Photographs

Please estimate the percentage coverage of the Hydrometric Area by:

a. River Corridor Surveys ......% b. Aerial Photographs ......%

5. Further Information:

Please give details concerning any specific sub-catchments having the best examples of Exposed Riverine Sediments in the area (continue over and/or on separate sheet if necessary).

APPENDIX D, continued

Covering letter with the questionnaire.

Conservation Officer
NRA Region

Dear Conservation Officer

EMS is carrying out a NRA National R & D project (FO2(93)02) on the conservation importance of exposed riverine sediments. Some of the habitats produced by riverine sediments have a high conservation value because of the number of rare invertebrates present. A considerable number of nationally important invertebrate sites comprise sand, silt, shingle and boulder sediments by rivers.

In order to assess the extent of exposed riverine sediments in England and Wales, we are using a questionnaire for hydrometric area scale information. Please find enclosed enough questionnaires for each of these areas in your region. Could you please distribute these to conservation staff and water quality personnel with knowledge of these areas.

We are interested in all exposed sediments including the ones that are annually vegetated but not wooded. We require information about stretches of permanent riverine sediments but are not concerned with areas normally under water which show up in times of drought. If you have any other catchment information in the way of publicity materials etc., these would be of considerable use to us.

If it is possible please could we have these questionnaires filled in and returned by 10th July 1994.

With thanks for your cooperation in this survey

Yours sincerely

Dr M D Eyre

APPENDIX E

The type and extent of ERS in catchments in the NRA regions derived from the questionnaire and experience.

Appendix Table E.1 The types, and estimated quantity (1=absent/rare; 2=occasional; 3=frequent;4=common/widespread),of exposed riverine sediments (ERS) found in catchments in the Northumbriaregion derived from the ERS questionnaire and from EMS knowledge (as indicated by +).

River Catchment	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Tweed	+	3	4	3	1
Till	+	2	3	4	1
Breamish	+	3	4	2	1
Aln	+	3	3	2	2
Coquet	+	4	3	2	2
Wansbeck	+	3	3	1	1
Font	+	3	3	1	1
Blyth	+	2	3	1	2
Pont	+	1	3	1	1
Tyne	+	3	4	2	1
North Tyne	+	4	3	2	1
South Tyne	+	4	4	2	1
Rede	+	3	4	2	2
Allens	+	4	4	2	1
Wear	+	4	4	2	1
Browney	+	3	3	1	1
Tees	+	4	4	2	1
Skerne	+	1	2	2	2

Appendix Table E.2 The types, and estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread), of exposed riverine sediments (ERS) found in catchments in the Yorkshire region derived from the ERS questionnaire and from EMS knowledge (as indicated by +).

River Catchment	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Esk	+	3	3	1	1
Derwent	+	3	4	1	2
Hull		1	2	2	3
Swale	+	4	3	1	1
Wharfe	+	4	4	1	1
Ure	+	4	3	1	1
Nidd	+	3	3	1	2
Calder	+	4	3	1	2
Aire	+	3	3	1	2
Ouse	+	1	2	2	2
Don	+	3	3	2	2
Rother	+	1	1	1	1
Dearne	+	1	1	1	1

Appendix Table E.3 The types, and estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread), of exposed riverine sediments (ERS) found in catchments in the Anglian region derived from EMS knowledge (as indicated by +).

River Catchment	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Ancholme		1	1	1	1
Witham	+	1	2	2	2
Welland	+	1	2	2	2
Nene		1	2	2	3
Great Ouse		1	3	1	3
Little Ouse		1	3	3	2
Ely Ouse		1	1	1	4
Cam		1	3	2	2
Yare		1	2	2	4
Wensum		2	4	2	2
Bure		1	2	3	4
Waveney		1	3	2	4
Stour		2	4	2	3

Appendix Table E.4 The types, and estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread), of exposed riverine sediments (ERS) found in catchments in the North West region derived from EMS knowledge only (as indicated by +; nk=not known).

River Catchment	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Lyne		nk	nk	nk	nk
Eden	+	4	4	2	1
Irthing	+	4	4	2	1
Derwent	+	4	3	1	1
Leven	+	3	4	2	1
Kent	+	3	4	2	1
Lune	+	4	4	2	1
Wyre	+	4	4	1	1
Ribble	+	4	4	2	1
Hodder		nk	nk	nk	nk
Mersey		nk	nk	nk	nk
Irwell		nk	nk	nk	nk
Weaver		nk	nk	nk	nk

Appendix Table E.5 The types, and estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread), of exposed riverine sediments (ERS) found in catchments in the Severn-Trent region derived from EMS knowledge (as indicated by +).

River Catchment	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Trent u/s Sow		1	1	1	1
Sow/Penk		1	1	3	3
Trent (Sow-Dove)		2	2	2	2
Tame		3	3	2	3
Blythe/Cole		3	4	2	2
Anker		1	1	2	2
Dove/Churnet		4	4	4	4
Trent (Dove-Trent Falls)	+	1	2	2	2
Derwent		3	4	1	2
Soar	+	1	2	1	2
Erewash		1	2	1	1
Idle/Maun		1	2	2	2
Torne		1	1	1	1
Upper Severn		3	4	1	2
Lower Severn		1	1	1	2

Appendix Table E.6 The types, and estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread), of exposed riverine sediments (ERS) found in catchments in the Welsh region derived from EMS knowledge (as indicated by +).

River Catchment	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Dee		2	3	2	1
Clwyd		2	4	2	1
Conwy		2	4	2	1
Glaslyn		2	4	1	1
Dyfi		2	4	1	1
Mawddach	+	2	4	2	1
Wnion	+	2	4	2	1
Anglesey		1	3	2	1
Rheidol	+	4	4	1	1
Ystwyth	+	4	4	1	1
Aeron		4	4	1	1
Teifi	+	4	4	2	2
Cleddaus		4	3	1	2
Gwaun		4	3	1	2
Nevern		4	3	1	2
Twyi	+	4	4	2	2
Taf		4	3	1	2
Gwendraeths		4	3	1	2
Lougher		4	3	2	1
Tawe		4	3	2	1
Neath		4	3	2	1
Afan		4	3	2	1
Ogmore		4	3	2	1
Kenfig		4	3	2	1
Taff		3	2	1	1
Rhymney		3	2	1	1
Ely		3	2	1	1
Rhondda		4	3	1	1
Usk	+	4	4	2	2
Wye	+	4	4	2	2

Appendix Table E.7 The types, and estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread), of exposed riverine sediments (ERS) found in catchments in the Thames region derived from EMS knowledge (as indicated by +).

River Catchment or Area	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Thames		1	2	1	4
Thame		1	2	2	4
Ray		1	1	1	4
Kennet		1	2	1	2
Lambourne		1	2	1	2
Pang		1	2	1	2
Evenlode		1	2	1	1
Churn		1	2	1	1
Leach		1	2	1	1
Windrush		1	2	1	1
Wandle/Beverley/Hogsmire		1	2	2	1
Ravensbourne		1	2	2	1
Mole		1	2	2	2
Wey		1	1	3	1
Loddon		1	2	1	1
Blackwater		1	2	1	1
Brent/Crane		1	3	2	1
Colne		1	2	2	2
Gade		1	1	1	2
Ver		1	2	2	1
Chess		1	1	1	1
Misbourne		1	2	1	1
Roding		1	2	2	2
Ingrebourne/Rom		1	3	2	2
Lee (source-Rib)		1	3	2	1
Lee (Rib-Thames)		1	1	1	2
Lower Lee tributaries		1	3	2	1
Mimram		1	2	1	1
Ash		1	2	1	1
Stort		1	2	2	2
Rib		1	3	2	1
Beane		1	2	2	2

Appendix Table E.8 The types, and estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread), of exposed riverine sediments (ERS) found in catchments in the Southern region derived from EMS knowledge (as indicated by +).

River Catchment or Area	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Isle of Wight		1	2	1	1
New Forest		1	2	2	1
Test		1	1	1	1
Itchen		1	1	1	1
East Hampshire		1	1	1	1
Arun		1	2	2	1
Ouse		1	2	1	1
Eastern Rother		2	2	1	1
East Sussex		1	2	1	1
Great Stour		1	1	1	2
Medway		1	1	1	2
North Kent		1	1	1	1
Darent		2	2	1	1

Appendix Table E.9 The types, and estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread), of exposed riverine sediments (ERS) found in catchments in the Wessex region derived from EMS knowledge (as indicated by +).

River Catchment or Area	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
South Wessex		2	4	3	3
West Wessex		2	3	1	2

Appendix Table E.10 The types, and estimated quantity (1=absentrare; 2=occasional; 3=frequent; 4=common/widespread), of exposed riverine sediments (ERS) found in catchments in the South West region derived from EMS knowledge (as indicated by +).

River Catchment or Area	EMS knowledge	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Devon		3	2	1	1
Cornwall		3	4	2	1

APPENDIX F

Types and extent of ERS in catchments in NRA regions derived from the River Habitat Survey

Appendix Table F.1 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the Northumbria region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Tweed inc. Till Breamish	33	-	93	7	-
Aln	2	-	100	-	-
Coquet	26	62	27	-	12
Wansbeck inc. Font	6	50	50	-	-
Blyth inc. Pont	6	-	100	-	-
Tyne inc. North Tyne South Tyne Rede Allens	122	89	10	-	1
Wear inc. Browney	28	71	29	-	-
Tees inc. Skerne	54	30	60	-	10

Appendix Table F.2 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the Yorkshire region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Esk	11	73	27	-	-
Derwent inc. Rye	10	60	40	-	-
Hull	0	-	-	-	-
Swale	30	85	15	-	-
Wharfe	27	63	37	-	-
Ure	28	100	-	-	-
Nidd	1	100	-	-	-
Calder	6	17	83	-	-
Aire	6	67	17	-	17
Ouse	4	-	100	-	-
Don inc. Rother Dearne	23	87	13	-	-

Appendix Table F.3 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the Anglian region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Ancholme	5	-	100	-	-
Witham	48	-	60	-	40
Welland	21	-	76	-	24
Nene	10	-	30	-	70
Great Ouse inc. Little Ouse Ely Ouse Cam	28	-	79	-	21
Yare inc. Wensum	2	-	100	-	-
Bure	0	-	-	-	-
Waveney	6	-	83	-	17
Stour	14	-	72	7	21

Appendix Table F.4 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the North West region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Lyne	4	-	100	-	-
Eden	58	86	14	-	-
Irthing	1	100	-	-	-
Derwent	24	71	29	-	-
Leven	5	100	-	-	-
Kent	4	50	50	-	-
Lune	29	82	18	-	-
Wyre	30	83	-	17	-
Ribble	38	100	-	-	-
Hodder	13	100	-	-	-
Mersey	27	63	11	7	19
Irwell	8	87	-	-	13
Weaver	19	11	63	21	5

Appendix Table F.5 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the Severn-Trent region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Severn inc. Teme	125	43	42	2	13
Avon	25	16	56	-	28
Trent inc. Tame Soar Wreake Idle	132	17	48	5	30
Derwent	24	92	8	-	-
Dove	8	87	13	-	-

Appendix Table F.6 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the Welsh region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Dee	75	55	32	5	8
Clwyd	26	19	81	-	-
Conwy	26	54	46	-	-
Glaslyn	5	100	-	-	-
Mawddach inc. Wnion	6	100	-	-	-
Rheidol	3	100	-	-	-
Ystwyth	7	100	-	-	-
Teifi	34	56	44	-	-
Twyi inc. Cothi	36	78	22	-	-
Tawe	28	100	-	-	-
Neath	13	69	31	-	-
Taff	36	47	53	-	-
Rhondda	7	100	-	-	-
Usk	32	71	25	-	4
Wye inc. Monnow Lugg	149	24	71	-	5

Appendix Table F.7 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the Thames region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Thames inc. Wey Mole Loddon	17	-	82	-	17
Windrush	2	-	50	-	50
Cherwell	1	-	-	-	100
Thame	10	-	80	-	20
Kennet	0	-	-	-	-
Colne	9	-	100	-	-
Lee	8	-	87	-	13

Appendix Table F.8 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the Southern region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Stour	3	-	100	-	-
Medway	36	8	50	-	42
Rother	14	-	71	-	29
Ouse	3	-	33	-	67
Adur	8	-	100	-	-
Itchen	10	-	80	-	20
Test	32	-	100	-	-

Appendix Table F.9 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the Wessex region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Bristol Avon	43	-	81	14	5
Avon	26	-	77	23	-
Stour	24	-	13	21	66
Frome	12	-	100	-	-
Brue	7	43	43	-	14

Appendix Table F.10 Percentage of the types of exposed riverine sediments (ERS) found in catchments in the South West region derived from the River Habitat Survey.

River Catchment	Number of sediments	Boulders/ Cobbles	Pebbles/ Gravel	Sand	Silt/Clay
Axe	7	-	100	-	-
Exe	28	21	72	-	7
Teign	9	-	89	11	-
Dart	2	50	50	-	-
Taw	53	2	98	-	-
Torridge	27	100	-	-	-
Tamar	32	3	75	-	22
Tavy	7	-	100	-	-
Lynher	2	-	100	-	-
Fowey	20	-	100	-	-
Camel	29	-	100	-	-
Fal	6	-	-	100	-

APPENDIX G

The extent of river corridor and aerial photograph coverage and the number of Invertebrate Site Register records and EMS ground beetle assemblages in catchments of the NRA regions.

Appendix Table G.1 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the Northumbria region (from the questionnaire) and the number of invertebrate records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species; Several=4-10 species; Many=>10 species) and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment	River Corridor	Aerial Photographs	ISR Records	EMS lists
Tweed	100	-	Few	-
Till	100	-	Many	10
Breamish	100	-	Few	3
Aln	70	-	Few	1
Coquet	70	-	Few	3
Wansbeck	70	-	-	-
Blyth	70	-	Few	1
Tyne	100	-	Many	6
North Tyne	100	-	-	3
South Tyne	100	-	Several	5
Rede	100	-	Few	3
Allens	100	-	Several	11
Wear	70	-	-	-
Tees	nk	nk	Few	-

Appendix Table G.2 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the Yorkshire region (from the questionnaire) and the number of invertebrate records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species; Several=4-10 species; Many=>10 species)and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment	River Corridor	Aerial Photographs	ISR Records	EMS lists
Esk	nk	nk	-	-
Derwent	nk	nk	Few	-
Hull	15	30	-	-
Swale	nk	nk	-	1
Wharfe	nk	nk	Many	-
Ure	nk	nk	Several	-
Nidd	nk	nk	-	-
Calder	nk	nk	Few	-
Aire	15	30	-	-
Ouse	nk	nk	Few	-
Don	15	30	Few	-

Appendix Table G.3 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the Anglian region (from the questionnaire) and the number of invertebrate records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species; Several=4-10 species; Many=>10 species) and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment or Area	River Corridor	Aerial Photographs	ISR Records	EMS lists
Ancholme	100	-	-	-
Witham	100	-	-	-
Welland	100	100	Few	1
Nene	100	10	-	-
Great Ouse inc.	100	-	-	-
Little Ouse				
Ely Ouse				
Cam				
Norfolk inc.	100	-	-	-
Yare				
Wensum				
Bure				
Waveney				
Suffolk	100	-	-	-
Stour	100	-	-	-
Essex	100	100	-	-

Appendix Table G.4 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the North West region (from the questionnaire) and the number of invertebrate records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species; Several=4-10 species; Many=>10 species)and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment	River Corridor	Aerial Photographs	ISR Records	EMS lists
Lyne	nk	nk	-	-
Eden	nk	nk	Several	-
Irthing	nk	nk	Few	-
Derwent	nk	nk	-	-
Leven	nk	nk	Few	-
Kent	nk	nk	Few	-
Lune	nk	nk	Few	-
Wyre	nk	nk	Few	-
Ribble	nk	nk	Few	-
Hodder	nk	nk	-	-
Mersey	nk	nk	-	-
Irwell	nk	nk	-	-
Weaver	nk	nk	-	-

Appendix Table G.5 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the Severn-Trent region (from the questionnaire) and the number of invertebrate records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species, Several=4-10 species; Many=>10 species) and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment or Area	River Corridor	Aerial Photographs	ISR Records	EMS lists
Trent u/s Sow	100	100	-	-
Sow/Pen	70	100	-	-
Sow/Dove	90	100	-	-
Tame	100	100	Few	-
Blythe/Cole	100	100	Few	-
Anker	50	100	-	-
Dove/Churnet	70	100	Few	2
Dove/Trent Falls	50	90	Few	4
Derwent	100	80	Few	-
Soar	100	80	Several	74
Erewash	100	100	-	-
Idle/Maun	90	70	-	-
Torne	80	70	-	-
Upper Severn	66	30	Several	-
Teme			Few	1
Lower Severn	83	50	Several	-

Appendix Table G.6 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the Welsh region (from the questionnaire) and the *number of invertebrate* records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species; Several=4-10 species; Many=>10 species) and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment	River Corridor	Aerial Photographs	ISR Records	EMS lists
Dee	85	100	-	-
Clwyd	85	-	-	-
Conwy	85	-	Several	-
Glaslyn	25	-	Few	-
Dyfi	85	-	Few	-
Mawddach	85	-	Several	1
Wnion	85	-	Few	-
Anglesey	-	-	-	-
Rheidol	80	-	Many	5
Ystwyth	80	-	Many	27
Aeron	80	-	Few	-
Teifi	-	-	Many	3
Cleddaus	75	-	-	-
Gwaun	75	-	-	-
Nevern	75	-	-	-
Twyi	80	-	Many	3
Taf	80	-	-	-
Gwendraeths	80	-	-	-
Lougher	90	-	-	-
Tawe	90	-	-	-
Neath	90	-	Few	-
Afan	90	-	-	-
Ogmore	90	-	-	-
Kenfig	90	-	-	-
Taff	90	95	-	-
Rhymney	90	95	-	-
Ely	90	95	-	-
Rhondda	nk	nk	-	-
Ithon	nk	nk	Several	2
Usk	85	95	Several	-
Wye	90	15	Many	3

Appendix Table G.7 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the Thames region (from the questionnaire) and the number of invertebrate records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species; Several=4-10 species; Many=>10 species) and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment or Area	River Corridor	Aerial Photographs	ISR Records	EMS lists
Thames (west) inc.	60	nk	Few	-
Thame			-	
Ray			-	
Kennet			-	
Lambourne			-	
Pang			-	
Thames (west) inc.	nk	nk	-	-
Evenlode			-	
Churn			-	
Leach			-	
Windrush			Few	
Thames (s.east) inc.	80	nk	-	-
Mole			-	
Wey			-	
Loddon			-	
Blackwater			-	
Thames (n.east) inc.	nk	nk	-	-
Brent			-	
Colne			-	
Chess			-	
Misbourne			-	
Roding	70	nk	-	-
Lee	nk	nk	Few	-
Mimram	nk	nk	-	-
Ash	nk	nk	-	-

Appendix Table G.8 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the Southern region (from the questionnaire) and the number of invertebrate records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species; Several=4-10 species; Many=>10 species) and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment	River Corridor	Aerial Photographs	ISR Records	EMS lists
Isle of Wight	100	nk	-	-
New Forest	5	-	-	-
Test	50	-	-	-
Itchen	50	-	-	-
East Hampshire	15	-	-	-
Arun	70	nk	-	-
Ouse	nk	nk	-	-
Eastern Rother	nk	nk	-	-
East Sussex	nk	nk	-	-
Great Stour	nk	nk	Few	-
Medway	nk	nk	Few	-
North Kent	nk	nk	-	-
Darent	nk	nk	-	-

Appendix Table G.9 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the Wessex region (from the questionnaire) and the number of invertebrate records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species; Several=4-10 species; Many=>10 species) and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment or Area	River Corridor	Aerial Photographs	ISR Records	EMS lists
South Wessex	<10	100	-	-
West Wessex	nk	100	-	-
Avon	nk	100	Few	-
Parrett	nk	100	Few	-

Appendix Table G.10 The percentage coverage by river corridor surveys and aerial photographs of the catchments of the South West region (from the questionnaire) and the number of invertebrate records from the catchments derived from the Invertebrate Site Registar (ISR) (Few=1-3 species; Several=4-10; Many=>10 species) and the number of EMS-generated invertebrate site lists for individual catchments (- = none; nk = not known).

River Catchment or Area	River Corridor	Aerial Photographs	ISR Records	EMS lists
Devon	<5	100	-	-
Cornwall	<5	100	-	-
Axe	nk	100	Few	-
Exe	nk	100	Few	-
Torridge	nk	100	Few	-
Teign	nk	100	Few	-

APPENDIX H

Environmental variables for ERS survey. This list of variables is to be recorded when the 10 pitfall traps are installed for the sampling of ERS invertebrates and is based on the River Habitat Survey variables and will use the same abbreviations in the spot-check key.

A. Field Survey Details

Site name ....
River ....
Grid reference ....
Date set .... retrieved ....
Sampler name ....
Which bank next to ERS (tick one) Left [ ] Right [ ]
Number of traps retrieved ....
Cause of any disturbance ....

B. Impoundment for navigation (tick one)

No [ ] Yes [ ] Don't know [ ]

Impoundment for other purposes (tick one)
No [ ] Yes [ ] Don't know [ ]

C. ERS attributes

Substrate
estimated % of each substrate type on ERS
boulder (>256mm) ....
cobble (64-256mm) ....
pebble (16-64mm) ....
gravel (2-16mm) ....
sand (0.063-2mm) ....
silt (0.004-0.063mm) ....
undecayed organic matter (sludge) ....

Vegetation
vegetation structure (B=bare; S=Simple; C=complex) on ERS ....

estimated vegetation cover on ERS ....

D. ERS dimensions

Length of sampled ERS at time of trap installation .... metres

Maximum width of ERS at time of trap istallation .... metres

E. Land use next to ERS (E >33% or tick if present)

Broadleaf/mixed woodland [ ]
Coniferous plantation [ ]
Moorland/heath [ ]
Scrub/rough [ ]
Bog, marsh, fen [ ]
Grazed improved/semi-improved grass [ ]
Ungrazed improved/semi-improved grass [ ]
Tilled land (arable) [ ]
Suburban/urban development [ ]

Is land behind ERS grazed by cattle
No [ ] Yes [ ] Don't know [ ]

F. Bank Profile above ERS (tick one)

Natural/unmodified [ ]

Artificial/modified [ ]

G. ERS Profile

Profile types on ERS (tick if present)

F= nearly flat [ ]
G= gentle [ ]
S=steep (>10 degrees) [ ]

H. ERS Topographic Complexity (tick one)

Simple (no channels) [ ]
Humped (back channel next to bank) [ ]
Complex (a number of channels through sediment) [ ]

I. Extent of Shade

Percentage of ERS shaded by trees ....

J. Hibernation Potential

Presence of grass tussocks and dead wood high on ERS or on adjacent bank (0=none; 1=isolated; 2=in some quantity; 3=abundant)

Grass tussocks on ERS [ ]
Grass tussocks on bank [ ]
Dead wood on ERS [ ]
Dead wood on banks [ ]

K. Bank above ERS dimensions

Bankfull height (m) ....

Bank height if different (m) ....

Embanked height (m) ....

L. Evidence of Recent Management (obvious signs: tick box(es))

Banks

None	[ ]
Resectioning	[ ]
Bank mowing	[ ]
Enhancement	[ ]

Channel

None	[ ]
Dredging	[ ]
Weed-cutting	[ ]
Enhancement work	[ ]

M. Recreation (tick)

Evidence of fishing	[ ]
Presence of boats	[ ]

N. Brief Descriptive Sentence (indicate unusual features)

APPENDIX I

Frequency of occurrence of species in the groups derived from the classifications.

Appendix Table I.1 Frequency of occurrence (%) of species in the five groups interpreted from the fuzzy-set classification of the 194 sites in the UK data set (minimum 20% in one group). Species order is as in the first axis of DECORANA ordination.

Species	Group 1	Group 2	Group 3	Group 4	Group 5
Bembidion andreae	34	-	-	30	-
Lionychus quadrillum	21	-	-	-	-
Bembidion stomoides	-	11	-	26	-
Bembidion monticola	3	7	-	29	-
Bembidion atrocoeruleum	92	14	6	89	-
Bembidion tibiale	18	50	3	74	-
Bembidion decorum	74	21	19	44	-
Nebria gyllenhali	-	57	6	48	-
Bembidion schueppeli	-	25	6	11	-
Bembidion punctulatum	66	4	42	22	7
Agonum muelleri	13	11	23	11	1
Agonum assimile	5	36	6	19	6
Bembidion femoratum	13	11	26	11	3
Nebria brevicollis	5	43	23	26	9
Notiophilus biguttatus	-	11	13	26	11
Loricera pilicornis	5	46	23	7	19
Agonum albipes	66	86	84	74	91
Bembidion tetracolum	50	68	81	56	71
Bembidion lampros	13	18	42	19	21
Clivina fossor	34	7	19	11	26
Elaphrus cupreus	-	50	-	4	23
Pterostichus nigrita	3	46	29	7	47
Pterostichus strenuus	5	18	39	4	37
Bembidion guttula	3	39	42	7	71
Pterostichus vernalis	3	-	10	4	24
Elaphrus riparius	3	11	48	-	51
Bembidion aeneum	-	18	29	-	67
Agonum marginatum	3	-	19	-	31
Bembidion biguttatum	-	4	29	-	69
Bembidion lunulatum	-	4	16	-	67
Bembidion dentellum	3	-	19	-	74
Bembidion gilvipes	-	-	10	-	53
Agonum micans	-	-	3	-	46
Bembidion properans	-	-	3	-	24

Appendix Table I.2 Frequency of occurrence (%) of species in the three groups interpreted from the fuzzy-set classification of the 56 sites of the *Soar* data set (minimum 20% in one group). Species order is as in the first axis of DECORANA ordination.

Species	Group 1	Group 2	Group 3
Bembidion punctulatum	5	38	6
Stenus comma	14	25	-
Elaphrus riparius	55	81	39
Dyschirius aeneus	32	6	-
Bembidion articulatum	45	50	17
Notiophilus biguttatus	9	13	22
Gnypeta velata	41	6	17
Bembidion lampros	23	44	33
Chiloporata longitarsis	91	44	50
Bembidion properans	23	31	17
Carpelimus similis	27	38	6
Lathrobium fulvipenne	50	44	33
Dyschirius leudersi	32	-	17
Philonthus quisquiliarius	55	25	28
Platystethus cornutus	50	25	50
Xantholinus longiventris	68	38	44
Trechus quadristriatus	9	13	33
Amara similata	9	13	22
Bembidion tetracolum	73	94	78
Dilacra luteipes	23	6	6
Carpelimus rivularis	86	63	100
Carpelimus subtilicornis	41	50	61
Neobisnius villosulus	18	6	22
Tachyporus hypnorum	18	81	61
Tachyporus chrysomelinus	5	13	22
Stenus boops	86	63	83
Clivina fossor	9	6	33
Anotylus rugosus	41	31	61
Pterostichus nigrita	64	31	67
Gnypeta carbonaria	45	25	50
Agonum albipes	91	100	100
Stenolophus mixtus	41	-	22
Aloconota gregaria	14	25	33
Carpelimus bilineatus	59	25	56
Bembidion obtusum	18	19	33

Appendix Table I.2, continued

Species	Group 1	Group 2	Group 3
Philhygra volans	36	13	44
Tachyporus obtusus	36	38	89
Tachyporus nitidulus	-	6	28
Philhygra malleus	82	38	83
Lesteva longoelytra	55	75	78
Bembidion lunulatum	68	63	91
Clivina collaris	32	19	33
Agonum marginatum	32	13	50
Elaphrus cupreus	32	-	44
Bembidion dentellum	77	44	100
Gabrius bishopi	14	6	39
Tachyporus solutus	5	13	33
Tachyporus pallidus	41	31	61
Philhygra elongatula	68	44	83
Tachyusa atra	23	13	61
Bembidion gilvipes	45	44	83
Stenus juno	64	13	67
Bembidion aeneum	55	69	94
Tachinus signatus	27	-	56
Bembidion guttula	68	56	100
Loricera pilicornis	9	13	39
Deinopsis erosa	41	6	17
Tachyporus dispar	5	19	39
Lathrobium brunnipes	23	-	33
Patrobus atrorufus	9	-	28
Lesteva heeri	23	-	28
Agonum dorsale	-	13	22
Gnypeta rubrior	18	6	39
Pterostichus vernalis	27	6	56
Agonum obscurum	9	6	22
Bembidion biguttatum	73	38	100
Asaphidion curtum	-	6	22
Hygronoma dimidiata	18	-	28
Lathrobium geminum	9	-	22
Stenus bimaculatus	14	-	33
Atheta laticollis	-	6	22
Pterostichus strenuus	27	19	83

Appendix Table I.2, continued

Species	Group 1	Group 2	Group 3
Philonthus fimetarius	-	-	28
Mocyta fungi	32	13	78
Gnypeta ripicola	5	6	33
Agonum micans	41	19	78
Stenus tarsalis	23	-	56
Agonum fuliginosum	-	-	56
Atheta graminicola	32	25	83
Amischa analis	5	-	22

APPENDIX J

The Species and Rarity Quality Factors and the Quantified Species and Rarity Quality Factors of the sites in the two classifications.

Appendix Table J.1 The Species Quality Factors (SQF) and Rarity Quality Factors (RQF) for sites in the five groups derived from the classification of the 194 ground beetle sites.

Group 1			Group 2			Group 3		
River	SQF	RQF	River	SQF	RQF	River	SQF	RQF
Rheidol	29.78	52.00	Rede	11.50	17.00	Wye	6.55	11.05
Rheidol	29.85	50.43	Till	4.62	8.15	Teifi	7.55	9.18
Rheidol	35.00	38.00	S.Tyne	4.50	7.75	Soar	6.83	8.50
Ystwyth	29.00	33.80	S.Tyne	3.30	6.00	Ithon	5.63	7.13
Wye	17.00	33.77	Coquet	3.67	5.89	Trent	4.60	5.80
Ystwyth	21.43	25.43	S.Tyne	3.55	5.71	Aln	4.56	5.00
Twyi	18.00	21.00	Breamish	3.53	4.60	Blyth	4.56	5.00
Ystwyth	9.88	11.63	Rede	4.00	4.55	Till	2.50	4.13
Teifi	9.33	11.56	Devils Water	2.43	4.29	Dove	2.50	4.10
Rheidol	9.24	10.76	Till	2.78	4.16	Till	2.18	3.82
Rheidol	7.82	9.64	Tyne	2.74	4.00	Ystwyth	2.20	3.80
Ystwyth	5.00	9.00	Rede	3.36	3.79	Trent	2.00	3.50
Ystwyth	5.00	9.00	Druid	2.00	3.20	Trent	2.00	3.50
Teme	6.43	8.43	Wooler W.	2.29	3.14	Till	2.05	3.42
Ystwyth	4.17	7.50	Allen	2.00	2.67	Dove	1.90	3.30
Mawddach	4.20	7.40	Ess	1.43	2.29	Soar	1.89	3.22
Ystwyth	4.25	7.25	Coquet	1.42	2.25	Soar	1.89	3.22
Ystwyth	3.75	6.25	N.Tyne	1.50	2.10	Breamish	2.11	3.00
Ystwyth	3.25	6.25	Cargen	1.33	2.00	Rother	1.71	2.57
Twyi	3.17	6.17	Ciliau	1.80	1.80	Till	1.70	2.59
Ystwyth	3.60	6.00	Breamish	1.60	1.60	Soar	1.90	2.50
Ystwyth	3.60	6.00	Coquet	1.20	1.60	Soar	1.67	2.33
Ystwyth	3.00	5.80	Boho	1.25	1.25	Soar	2.17	2.17
Swale	3.22	5.67	N.Tyne	1.20	1.20	Soar	1.57	2.14
Wye	3.50	5.50	Ystwyth	1.20	1.20	Till	1.50	2.00
Ithon	2.83	5.50	Loughan	1.14	1.14	Manifold	1.50	2.00
Teifi	2.75	5.25	Alurlow	1.00	1.00	Bush	1.44	1.89
Ystwyth	2.80	5.25	Barnhills	1.00	1.00	Soar	1.25	1.75
Ystwyth	2.75	5.25				Soar	1.33	1.67
Ystwyth	3.20	5.20	Group 1, cont			Soar	1.17	1.17
Ystwyth	2.80	5.20	Ystwyth	2.50	4.50	Soar	1.14	1.14
S.Tyne	2.67	5.00	Ystwyth	2.50	4.50	Suck	1.00	1.00
Ystwyth	2.67	5.00	Twyi	2.25	4.00			
Ystwyth	2.60	5.00	Failmore	2.20	3.80			

Appendix Table J.1, continued

Group 4 River	SQF	RQF	Group 5 River	SQF	RQF	Group 5 continued River	SQF	RQF
Tyne	16.33	29.00	Soar	4.50	6.93	Chater	1.73	2.82
Allen	10.71	16.63	Soar	4.82	6.64	Crane	1.60	2.80
Allen	6.67	12.00	Soar	3.88	5.88	Soar	1.71	2.79
Tyne	7.00	9.15	Soar	2.68	4.86	Soar	1.71	2.76
Northouse B.	6.57	8.86	Soar	2.50	4.50	Soar	1.57	2.71
Tyne	7.00	8.85	Soar	2.45	4.45	Trent	1.80	2.60
Allen	5.00	8.43	Eye	2.67	4.44	Soar	1.72	2.60
Allen	4.67	8.00	Soar	2.48	4.39	Soar	1.71	2.57
Allen	4.40	7.60	Soar	2.29	3.86	Soar	1.62	2.54
Allen	5.00	7.40	Soar	2.14	3.86	Soar	1.62	2.53
Allen	3.92	6.79	Soar	2.14	3.86	Soar	1.61	2.50
Tyne	4.37	6.23	Soar	2.31	3.85	Dunkellin	1.50	2.50
Allen	3.00	5.00	Soar	2.21	3.79	Soar	1.50	2.50
S.Tyne	2.88	4.88	Soar	2.25	3.75	Soar	1.54	2.45
Water of Ae	2.88	4.88	Soar	2.27	3.73	Soar	1.67	2.43
Allen	2.67	4.44	Soar	2.00	3.57	Eye	1.57	2.43
Ystwyth	2.40	4.40	Soar	2.32	3.50	Soar	1.60	2.40
Ystwyth	2.40	4.40	Soar	2.09	3.45	Soar	1.63	2.38
Allen	2.57	4.00	Soar	3.20	3.40	Soar	1.55	2.27
Ystwyth	2.29	4.00	Soar	2.00	3.33	Soar	1.56	2.22
Wark Burn	2.14	3.86	Soar	1.88	3.29	Soar	1.50	2.17
Ystwyth	2.20	3.80	Soar	1.89	3.22	Soar	1.47	2.13
Wooler W.	2.22	3.33	Soar	2.00	3.20	Soar	1.38	2.13
Devils Water	2.09	3.18	Soar	2.09	3.18	Soar	1.38	2.13
Ystwyth	1.80	2.60	Soar	1.94	3.17	Soar	1.50	2.00
Lilburn Burn	1.50	2.17	Soar	2.10	3.10	Eye	1.33	2.00
Dawros	1.60	1.60	Soar	1.95	3.10	Soar	1.33	2.00
			Soar	1.82	3.09	Lin	1.29	1.86
			Soar	2.00	3.06	Soar	1.36	1.79
			Soar	1.94	3.06	Welland	1.22	1.67
			Eye	1.80	3.00	Soar	1.18	1.55
			Soar	1.93	3.00	Eye	1.25	1.25
			Soar	1.76	3.00	Soar	1.20	1.20
			Eye	1.93	2.93			
			Soar	1.85	2.92			
			Soar	1.78	2.88			

Appendix Table J.2 The Species Quality Factors (SQF), the Quantified Species Quality Factors (QSRF), the Rarity Quality Factors (RQF), the Quantified Rarity Quality Factors and the ranking of sites by RQF and QRQF for sites in the three groups derived from the classification of the 56 Soar sites.

Group 1

Site	SQF	QSQF	RQF	QRQF	Rank 1	Rank 2
19	4.66	5.35	8.95	10.34	1	3
24	5.75	11.22	7.62	14.95	2	1
32	4.00	5.50	7.56	10.57	3	2
41	4.83	4.87	7.00	7.09	4	10
56	4.58	4.93	6.42	7.12	5	9
45	3.18	3.86	5.92	7.36	6	7
30	3.11	4.11	5.91	7.90	7	5
34	3.19	4.67	5.88	8.84	8	4
22	3.20	4.09	5.73	7.51	9	6
26	3.03	3.95	5.31	7.14	10	8
27	2.73	3.19	5.07	5.99	11	12
23	2.63	3.25	4.92	6.17	12	11
55	2.41	3.20	4.42	5.98	13	13
28	2.41	2.68	4.33	4.88	14	16
48	2.36	2.85	4.25	5.23	15	15
38	2.69	2.89	4.19	4.58	16	18
40	2.19	2.58	3.94	4.73	17	17
42	2.27	2.41	3.73	4.03	18	19
47	2.07	2.20	3.72	3.90	19	20
33	2.07	3.05	3.50	5.45	20	14
37	1.79	1.86	2.86	3.00	21	21
31	1.29	1.29	1.86	1.86	22	22

Appendix Table J.2, continued

Group 2

Site	SQF	QSQF	RQF	QRQF	Rank 1	Rank 2
21	7.07	8.73	11.47	14.78	1	1
46	5.96	6.44	10.19	11.15	2	2
35	3.44	4.19	6.48	7.98	3	5
51	3.11	3.50	5.78	6.55	4	6
44	4.94	5.54	5.18	9.31	5	3
16	3.57	4.73	4.48	9.06	6	4
1	2.37	2.60	4.26	4.71	7	8
50	2.41	3.38	4.18	6.12	8	7
29	2.39	2.47	4.17	4.32	9	10
43	2.23	2.28	3.86	3.97	10	11
39	2.11	2.17	3.67	3.78	11	13
4	2.22	2.23	3.65	3.67	12	14
52	2.07	2.35	3.36	3.91	13	12
49	2.06	2.74	3.28	4.65	14	9
54	1.86	1.94	2.71	2.89	15	15
53	1.13	1.22	1.13	1.22	16	16

Group 3

Site	SQF	QSQF	RQF	QRQF	Rank 1	Rank 2
2	4.74	5.32	8.52	9.61	1	1
7	4.07	4.85	6.98	8.55	2	2
5	3.27	4.16	6.05	7.82	3	3
12	3.69	4.06	5.69	6.28	4	5
13	3.00	4.06	5.57	7.70	5	4
10	2.80	3.37	5.02	6.16	6	6
6	2.57	3.19	4.64	5.87	7	9
9	2.45	3.04	4.46	5.64	8	12
36	2.39	2.85	4.39	5.32	9	13
14	2.37	3.21	4.23	5.90	10	8
15	2.29	3.09	4.16	5.76	11	11
25	2.23	2.81	4.03	5.17	12	14
18	2.16	2.42	3.84	4.37	13	16
3	2.12	2.59	3.69	4.64	14	15
11	2.56	4.76	3.22	6.07	15	7
8	2.35	4.24	3.17	5.87	16	9
20	1.67	1.96	2.76	3.25	17	17
17	1.52	1.64	2.33	2.57	18	18

APPENDIX K

The standardised pitfall trapping method developed in the Department of Agricultural & Environmental Science, University of Newcastle upon Tyne by M D Eyre and M L Luff is here adapted for the sampling of ERS.

K.1 Equipment

a) Pitfall traps (10 per site), 7.5cm diameter, 10cm deep.
b) Commercial anti-freeze (usually blue) from somewhere like Halfords. About 0.75 litre per 10 traps.
c) Potting trowel and strong gloves.
d) Brightly coloured cloth tape and/or sticks.
e) A sieve with a minimum mesh of about 1mm, usually from the nearest cookery utensil shop.
f) Polythene bags (approx 30 x 45cm).
g) Labels made of greaseproof paper, a notebook (preferably waterproof), pencils (2B) and a penknife.

K.2 Site selection

a) An ERS is defined as sediment deposited in a river channel below the main riverbank. Established ERS may be extensive and have trees. ERS are prone to both active erosion and deposition.
b) Walk up or downstream from parking place and find the first ERS with a length of at least 50 metres. On rivers of stream order 3 or less, select two sites of 20 metres or more. Ignore soft sediment ERS heavily poached and trampled by cattle. Make sure that the bridge near the parking space is not the cause of the sediment and walk far enough downstream to ensure no interference.
c) On ERS of 50m and above, select 10 pitfall trap sites (two sets of five in the two 20m ERS) which cover a variety of substrate and/or vegetation types.

K.3 Setting the traps

a) On soft sediments (silt or clay) push two beakers together (usually with a foot) into the sediment until the bottom beaker is flush or just below the sediment surface. Remove the top beaker and put in 3-5cm of anti-freeze.
b) On the more solid, harder sediments, including sand, dig a hole with the trowel just deeper than a beaker. Place two beakers together in the whole and backfill the sediment so that the top of the bottom beaker is just below consolidated sediment. Remove the top beaker and put in 3-5cm of anti-freeze.
c) A marker in the form of a stick or a piece of tape may be employed to avoid difficulties in finding the traps later. Tape is usually tied to a bush or tree to indicate the area of trapping whilst a stick can be placed in the sediment to indicate the position of one of the traps, which one to be recorded.

d) Sampling should be carried out in two two-week periods, one in spring, the other in summer. The spring sample should be taken in two weeks between mid-April and June 16th. The summer sample should be from two weeks in July to mid-September.

K.4 Recording environmental variables

At the same time the traps are set, the environmental variables on the relevant forms should be recorded. These are necessary for the data analyses required to explain invertebrate species and assemblage distribution.

K.5 Collecting the samples

a) The traps should be emptied by the same workers who set the traps because they will then be found quickly and time will not be wasted and confusion avoided.
b) The samples in the traps should be collected two weeks after the traps were set.
c) The contents of the traps need to be sieved and the anti-freeze and accumulated water discarded. The sieve and sample should be placed as a whole into a polythene bag. The sample should be knocked out into the bag with nothing remaining on the sieve. The contents of all 10 traps in one site should be knocked out into one bag but two may be necessary if there is a lot of detritus.
d) Sufficient virgin anti-freeze should be decanted into the bag with the sample so that all contents are wetted with the anti-freeze.
e) A label, pencil on greaseproof paper, with the grid reference, location, site number (the same as on the environmental variables form) and sample collection date, should be placed inside the bag with the sample.
f) The sample bag should be tied and this bag put in another which should also be tied. This limits the amount of anti-freeze weepage in transit.

K.6 Problems

Problems with flooding or human disturbance should be noted and reported to the project co-ordinator for guidance.

APPENDIX L

A list of references for use in the identification of ERS invertebrates.

To the right of each reference is a four letter abbreviation, in italics, of the group to which is covered. These abbreviations are *Aran* = Araneae (spiders); *Cara* = Carabidae (ground beetles); *Cole* = Coleoptera (beetles); *Dipt* = Diptera (flies); *Dyti* = Dytiscidae (water beetles); *Hali* = Haliplidae (water beetles); *Hetc* = Heteroceridae; *Hete* = Heteroptera (bugs); *Hydp* = Hydrophilidae (water beetles); *Hydr* = Hydraenidae (water beetles); *Larv* = Larvae; *Psel* = Pselaphidae; *Ptil* = Ptilidae; *Rhiz* = Rhizophagidae; *Stap* = Staphylinidae (rove beetles).

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APPENDIX M

The type and extent of river management practices and land use in catchments in the NRA regions as derived from the questionnaire.

Appendix Table M.1 The estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread) of dams and reservoirs (Dams), navigation (Nav), channel engineering (ChEn), channel straightening and regrading (StRe), impoundments (Imp), intercatchment transfers (InTr) and water abstraction (WaAb), together with the main land uses in the catchments of the Northumbria region (A=agriculture; M=moorland; F=forestry; W=woodland; U=urban/industrial).

River Catchment	Dams	Nav	ChEn	StRe	Imp	InTr	WaAb	Land Uses
Tweed inc.	1	2	2	2	3	1	1	AMW
Till								
Breamish								
Aln	1	1	1	1	1	1	1	AMWF
Coquet	1	1	1	1	1	1	1	AMWF
Wansbeck inc.								
Font	1	1	1	1	1	1	1	AWFU
Blyth	1	1	1	1	1	1	1	AWU
Tyne inc.	2	2	2	1	1	1	1	AMWFU
North Tyne								
South Tyne								
Rede								
Allens								
Wear inc.	1	1	1	1	1	1	1	AMWU
Browney								

Appendix Table M.2 The estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread; nk=not known) of dams and reservoirs (Dams), navigation (Nav), channel engineering (ChEn), channel straightening and regrading (StRe), impoundments (Imp), intercatchment transfers (InTr) and water abstraction (WaAb), together with the main land uses in the catchments of the Yorkshire region (A=agriculture; M=moorland; F=forestry; W=woodland; U=urban/industrial).

River Catchment	Dams	Nav	ChEn	StRe	Imp	InTr	WaAb	Land Uses
Esk	1	1	1	1	nk	nk	nk	MAF
Derwent inc.	2	2	2	2	2	nk	nk	MAF
Rye								
Hull	1	2	4	4	2	1	3	AU
Swale	1	1	1	1	nk	nk	nk	MA
Wharfe	1	1	1	1	nk	nk	nk	MA
Ure	1	1	1	1	nk	nk	nk	MA
Nidd	1	1	2	1	nk	nk	nk	MAU
Calder	2	2	2	1	nk	nk	nk	MAU
Aire	2	2	2	1	3	1	3	MAU
Ouse	2	3	3	2	nk	nk	nk	AU
Don	2	2	2	1	3	1	3	MAU

Appendix Table M.3 The estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread) of dams and reservoirs (Dams), navigation (Nav), channel engineering (ChEn), channel straightening and regrading (StRe), impoundments (Imp), intercatchment transfers (InTr) and water abstraction (WaAb), together with the main land uses in the catchments of the Anglian region (A=agriculture; W=woodland; U=urban/industrial).

River Catchment or Area	Dams	Nav	ChEn	StRe	Imp	InTr	WaAb	Land Uses
Ancholme	2	3	4	4	3	2	4	AU
Witham	2	4	4	4	4	4	4	AU
Welland	3	2	3	4	3	3	4	AU
Nene	3	4	4	4	4	3	4	AU
Great Ouse inc. Little Ouse Ely Ouse Cam	4	4	4	4	4	4	4	AUW
Norfolk inc. Yare Wensum Bure Waveney	1	4	4	4	4	1	4	AU
Suffolk	2	1	2	3	4	1	4	AU
Stour	2	3	3	4	4	4	4	AU
Essex	4	4	4	4	4	4	4	AU

Appendix Table M.5 The estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread) of dams and reservoirs (Dams), navigation (Nav), channel engineering (ChEn), channel straightening and regrading (StRe), impoundments (Imp), intercatchment transfers (InTr) and water abstraction (WaAb), together with the main land uses in the catchments of the Severn-Trent region (A=agriculture; M=moorland; F=forestry; U=urban/industrial).

River Catchment	Dams	Nav	ChEn	StRe	Imp	InTr	WaAb	Land Uses
Trent u/s Sow	1	1	2	4	2	1	2	A
Sow/Penk	1	1	2	4	2	1	2	A
Trent (Sow-Dove)	2	2	2	4	2	1	2	A
Tame	1	1	4	4	2	3	1	AU
Blythe/Cole	2	1	1	2	3	1	4	AU
Anker	1	1	2	2	1	1	2	A
Dove/Churnet	4	2	2	2	4	2	4	A
Trent (Dove-Trent Falls)	1	4	1	2	2	2	3	AU
Derwent	2	1	1	1	3	2	2	AU
Soar	1	4	3	3	2	1	2	AU
Erewash	1	1	3	3	1	1	2	AU
Idle/Maun	2	1	3	3	2	1	4	AU
Torne	2	1	4	4	1	1	4	A
Upper Severn	1	3	2	2	3	2	3	AFMU
Lower Severn	1	4	1	2	2	2	2	AU

Appendix Table M.6 The estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread) of dams and reservoirs (Dams), navigation (Nav), channel engineering (ChEn), channel straightening and regrading (StRe), impoundments (Imp), intercatchment transfers (InTr) and water abstraction (WaAb), together with the main land uses in the catchments of the Welsh region (A=agriculture, M=moorland, F=forestry, W=woodland, U=urban/industrial).

River Catchment	Dams	Nav	ChEn	StRe	Imp	InTr	WaAb	Land Uses
Dee	1	2	2	1	1	1	1	AFM
Clwyd	1	1	1	1	1	1	1	AFM
Conwy	1	1	1	1	1	1	1	AFM
Glaslyn	1	1	1	1	1	1	1	AFM
Dyfi	1	1	1	1	1	1	1	AFM
Mawddach	1	1	1	1	1	1	1	AFM
Wnion	1	1	2	2	1	1	1	AFM
Anglesey	2	1	1	1	1	1	1	AU
Rheidol	2	1	2	2	1	1	1	MA
Ystwyth	2	1	2	2	1	1	1	MA
Aeron	2	1	2	2	1	1	1	MA
Teifi	1	1	1	1	2	1	1	MA
Cleddaus	2	1	3	3	2	1	2	A
Gwaun	2	1	3	3	2	1	2	A
Nevern	2	1	3	3	2	1	2	A
Twyi	2	1	1	3	2	1	2	AF
Taf	2	1	1	3	2	1	1	A
Gwendraeths	2	1	1	3	2	1	1	A
Lougher	1	1	2	3	2	1	1	A
Tawe	1	1	2	3	2	1	1	AU
Neath	1	1	2	2	2	1	1	AMU
Afan	1	1	2	2	2	1	1	AMU
Ogmore	1	1	2	2	2	1	1	AMU
Kenfig	1	1	2	2	2	1	1	AMU
Taff	2	1	1	1	1	1	2	AU
Rhymney	2	1	1	1	1	1	2	AU
Ely	2	1	1	1	1	1	2	AU
Rhondda	2	1	1	1	1	1	1	AU
Usk	1	2	1	1	1	1	2	A
Wye	1	1	1	1	1	2	3	AU

Appendix Table M.7 The estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread; nk=not known) of dams and reservoirs (Dams), navigation (Nav), channel engineering (ChEn), channel straightening and regrading (StRe), impoundments (Imp), intercatchment transfers (InTr) and water abstraction (WaAb), together with the main land uses in the catchments of the Thames region (A=agriculture, U=urban/industrial).

River Catchment or Area	Dams	Nav	ChEn	StRe	Imp	InTr	WaAb	Land Uses
Thames (west) inc. Thame/Ray Kennet	1	3	2	4	3	1	2	AU
Lambourne	1	1	1	1	1	1	1	A
Pang	1	1	1	1	1	1	3	A
Thames (west) inc. Evenlode Churn/Leach Windrush	1	2	2	2	3	1	2	AU
Mole	1	1	3	3	2	1	1	AU
Wey	1	3	2	2	2	1	3	AU
Loddon	1	2	3	3	3	1	3	AU
Blackwater	1	2	3	3	3	1	3	AU
Wandle/Beverley/ Hogsmire	1	1	4	4	3	1	2	U
Ravensborne	1	1	4	4	3	1	1	AU
Brent/Crane	1	1	4	2	2	1	1	U
Colne	1	2	2	2	3	2	3	AU
Gade	1	4	4	3	3	1	3	AU
Ver	1	1	2	1	2	1	4	AU
Chess	1	1	1	1	2	1	1	A
Misbourne	1	1	1	1	2	1	4	A
Roding	1	1	3	4	2	1	nk	AU
Ingrebourne/Rom	1	1	3	2	2	1	1	AU
Lee (source-Rib)	1	2	3	2	3	2	2	AU
Lee (Rib-Thames)	1	4	4	4	4	1	1	AU
Lower Lee tributs	1	1	3	2	3	1	1	AU
Mimram	1	1	1	1	3	1	3	AU
Ash	1	1	2	2	2	1	3	AU
Stort	1	3	3	3	3	1	3	AU
Rib	1	1	2	2	2	1	2	AU
Beane	1	1	3	3	3	1	2	AU

Appendix Table M.8 The estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread; nk=not known) of dams and reservoirs (Dams), navigation (Nav), channel engineering (ChEn), channel straightening and regrading (StRe), impoundments (Imp), intercatchment transfers (InTr) and water abstraction (WaAb) (nk=not known), together with the main land uses in the catchments of the Southern region (A=agriculture; F=forestry; M=moorland; U=urban; W=woodland).

River Catchment or Area	Dams	Nav	ChEn	StRe	Imp	InTr	WaAb	Land Uses
Ise of Wight	1	1	2	2	2	1	2	AU
New Forest	1	1	1	1	1	1	1	FM
Test	1	1	1	1	2	1	4	AU
Itchen	1	1	2	1	2	1	4	AU
East Hampshire	1	1	2	3	2	1	3	AU
Arun	1	2	3	3	3	1	2	AU
Ouse	nk	nk	2	3	1	nk	2	AWU
Eastern Rother	nk	1	1	1	1	1	1	AWU
East Sussex	1	1	1	1	1	1	1	AWU
Great Stour	nk	nk	1	3	2	nk	2	AU
Medway	2	2	2	3	3	nk	3	AU
North Kent	1	1	3	4	3	nk	nk	AU
Darent	nk	1	1	1	2	1	3	AU

Appendix Table M.9 The estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread) of dams and reservoirs (Dams), navigation (Nav), channel engineering (ChEn), channel straightening and regrading (StRe), impoundments (Imp), intercatchment transfers (InTr) and water abstraction (WaAb), together with the main land uses in the catchments of the Wessex region (A=agriculture).

River Catchment or Area	Dams	Nav	ChEn	StRe	Imp	InTr	WaAb	Land Uses
South Wessex	1	1	1	2	3	1	4	A
West Wessex	2	3	3	4	3	2	4	A

Appendix Table M.10 The estimated quantity (1=absent/rare; 2=occasional; 3=frequent; 4=common/widespread) of dams and reservoirs (Dams), navigation (Nav), channel engineering (ChEn), channel straightening and regrading (StRe), impoundments (Imp), intercatchment transfers (InTr) and water abstraction (WaAb), together with the main land uses in the catchments of the South West region (A=agriculture; U=urban/industrial).

River Catchment or Area	Dams	Nav	ChEn	StRe	Imp	InTr	WaAb	Land Uses
Devon	2	1	1	2	2	1	2	A U
Cornwall	1	2	2	2	2	1	3	A U