Joint Nature Conservation Committee

Species Status

No. 1

A review of the scarce and threatened Coleoptera of Great Britain

Part 3: Water beetles of Great Britain

by

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Further information on the JNCC Species Status project can be obtained from the Joint Nature Conservation Committee website at
http://www.jncc.gov.uk/

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Contents

1. Introduction to the series

1.1 The Species Status Assessment series

This publication is one of a series produced under the auspices of the Species Status Assessment project initiated by JNCC in 1999. The project established the means by which the statutory conservation agencies, in partnership with voluntary conservation organisations and leading specialists, assign conservation statuses to British species. It aims to work towards assessing the status of all native species against standard criteria based on the internationally accepted guidelines developed by the International Union for Conservation of Nature and Natural Resources (IUCN) (see IUCN, 2001, 2003).

Comparisons are facilitated by assessing all taxa to the same standards. This is not without difficulty because species have a variety of life and reproductive strategies. Status assessments are prepared on the basis of the best available information for the group concerned, recognising that this will vary according to the intensity of recording and study, the majority of which is carried out by volunteer naturalists.

Assessments are produced as Red Lists or as broader National Reviews of taxonomic groups of species. Both types of publication provide an audit trail of the assessment. To enable assessments to reach as many practitioners as possible, the texts are made freely available via the JNCC web site (http://www.jncc.gov.uk/) as well as hard copy publications.

1.2 The Red List system

The Red List system was initiated by IUCN in 1966 with the publication of the first Mammal Red Data Book. Since then Red Lists, and more detailed Red Data Books, have been published that deal with many plants, fungi and animals at global, regional, country, and even local scales. The aim has been to identify those species at greatest risk from extinction and to identify the critical factors responsible, so that action may be taken to improve the chances of these species surviving in the long term.

In Britain the first published Red Data Book endorsed by a statutory conservation agency was by Perring and Farrell (1977, 2nd edition published 1983), dealing with vascular plants. The Red Data Book for insects, edited by Shirt, was published in 1987, with volumes dealing with other animal and plant groups appearing thereafter. The geographic range is normally Great Britain, and hence excludes Northern Ireland as well as the Isle of Man and the Channel Isles. Only one volume has a combined treatment for Britain and Ireland, that by Stewart and Church (1992) for stoneworts, although separate statuses were provided.

The British Red List of vascular plants has had a full update twice (Wigginton, ed. 1999, Cheffings and Farrell, 2005) following the production by the IUCN of a new, quantitative approach to threat assessment (IUCN, 1994, 2001, 2003). The recent Red List of British Odonata (Daguet *et al,* eds., 2008) and reviews of Diptera (Falk and Crossley, 2005, Falk and Chandler, 2005) have continued to follow the revised IUCN guidelines.

1.3 Status assessments other than Red Lists for species in Britain

Conservation assessments that are broader in scope than the traditional Red Data Books and Red Lists have been produced. These assessments add GB-specific categories based on restricted distribution rather than risk. The term Nationally Scarce, originally coined for plants, is applied to species that are known to occur in 16 to 100 ten-km squares (or hectads). Early assessments of invertebrate taxa used the term Nationally Notable and, for some taxa this category was further split into Notable A (Na) for

species occurring in 16 to 30 hectads and Notable B (Nb) for those occurring in 31 to 100 hectads.

A further category that has a very specific application is that of 'Nationally Rare'. This category is only used for plant and lichen species that occur in 15 or fewer hectads in Britain and is used in SSSI designation and Common Standards Monitoring.

The restricted distribution categories have now been standardised to Nationally Rare (used only for plants and lichens) and Nationally Scarce (used for all taxa including plants and lichens), without further subdivision. The GB system of assessing **rarity** based solely on distribution is used alongside the IUCN criteria which, although they also use measures of geographical extent, are concerned with assessing **threat**.

Publications that compile information about Red List species are known as Red Data Books and usually cover broad taxonomic groups (e.g. insects). Publications that include information about both Red Listed and Nationally Scarce species are known as National Reviews. The latter are usually produced for a more restricted taxon group (e.g. dragonflies or water beetles). Both types of publication contain individual species accounts that include information about their biology, distribution and status as well as threats to the species and their conservation needs.

1.4 Species Status Assessment and conservation action

Making good decisions to conserve species should primarily be based upon an objective process of determining the degree of threat to the survival of a species, in the present exercise by assigning the species to one of the IUCN threat categories. This assessment of threats to survival should be separate and distinct from the subsequent process of deciding which species require action and what activities and resources should be allocated.

When making decisions as to which species should be treated as priorities for conservation action, factors to be considered other than IUCN threat category include: the likely chances of recovery being achieved; the cost of achieving recovery (and whether sources of funding are available or likely to be available); the benefits to other threatened species of a recovery programme; the fit of a recovery programme with other conservation activities (including conservation actions to be taken for habitats); the likely gains for the profile of conservation; and the relationship and fit between national and international obligations. Under the UK Biodiversity Action Pan (see www.ukbap.org.uk) a list of priority species has been identified as a focus for conservation effort. In addition, certain species are legally protected in Great Britain under legislation such as the Wildlife and Countryside Act 1981, and British wildlife legislation is overlaid by international directives such as the Habitats Directive (Directive 92/42/EEC). For some species groups, threat assessments and rarity assessments also underlie the criteria used for protected site selection, and these species can then constitute protected interest features on the site.

1.5 References

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2. Introduction to this Review

2.1 World water beetles

Jäch & Balke (2008) estimate that there are currently about 18,000 species of water beetle of which 70% have been described. About thirty families have aquatic representatives, with 25 of them having at least half of them aquatic. The estimates for the dominant families are, from October 2005, Dytiscidae with 3,908 species, 5,000 being estimated, Hydraenidae (1,380/2,500), Hydrophilidae (1,800/2,320), Elmidae (1,330/1,850), Scirtidae (900/1,700) and Gyrinidae (750/1,000). The Palaearctic (3,350 named as opposed to 3,900 estimated), the Neotropical (2,510/3,900) and the Afrotropical (2,700/3,750) regions have the most species, followed by the Oriental (2,200/3,580) and the Australasian (1,300/2,100), the Nearctic (1,420/1,550) being by far the poorest in terms of diversity.

2.2 Taxa considered in this Review

The first step is to identify what is included in the term "water beetle" for the purposes of this review. Many species of beetle are obligately associated with water with a continuum from those that are found throughout their life-cycle under water (reed beetles in the genus *Macroplea* and a few weevils), through the majority, i.e. those that pupate out of the water but are aquatic as both larvae and adults, and on to those that live in the water as larvae but are found above and away from the water as adults. The latter include the Scirtidae, many plant-feeding species, in particularly most of the reed beetles or Donaciinae. The current review is concerned with the Hydradephaga (that is the aquatic members of the suborder Adephaga, the Gyrinidae, Haliplidae, Noteridae, Paelobiidae and Dytiscidae), with our sole representative of the suborder Myxophaga (*Sphaerius acaroides*), and with several families of Polyphaga (the Hydrochidae, Helophoridae, Georissidae, Spercheidae, the aquatic Hydrophilidae, Hydraenidae, Heteroceridae, Dryopidae, Elmidae, Psephenidae, Limnichidae and the Scirtidae).

The status of leaf beetles and weevils will not be considered further here, being best addressed for these as part of an overall review of Chrysomeloidea and Curculionoidea. Further, the many moisture-loving ground and rove beetles should also be reviewed as part of their major phylogenetic groups. There will always be inconsistencies in combining the ecological and phylogenetic approaches, but the groups covered here have the virtue of being part covered by a single national recording scheme. Another peculiar exception is the exotic and largely aquatic family Ptilodactylidae, represented in Britain by a species confined to moist soils in greenhouses (Mann 2006).

Three hundred and eleven taxa were assessed for this Review, four of them regarded as subspecies (*Nebrioporus depressus depressus* and *N. depressus elegans*, and *Ochthebius viridis viridis* and *O. viridis fallaciosus*), the rest as species.

The area covered in this Review is Great Britain (i.e. England, Scotland and Wales, excluding the Isle of Man and the Channel Isles). Northern Ireland and the Republic of Ireland have produced a joint Red List of water beetles for the whole of Ireland (Foster, Nelson & O Connor 2009).

Beetle names follow Foster (2004, 2005) and plant names Stace (1997).

2.3 Previous reviews

The first account of threatened British Coleoptera, including water beetles, was in the *British Red Data Books: 2. Insects* (Shirt 1987), prefaced by a listing of all species with conservation status by Ball (1986). Shirt (1987) listed 60 species of aquatic Coleoptera: 9 Endangered, 12 Vulnerable and 39 Rare water beetle species, plus several leaf beetles and many weevils, particularly in the Bagoinae. Data sheets were

given for the Endangered and Vulnerable species. This was followed by publication in two parts of *A review of the scarce and threatened beetles of Great Britain* (Hyman & Parsons 1992, 1994) in which a reassessment of water beetle status resulted in a revised list in Appendix 1 of Hyman and Parsons (1992). JNCC subsequently adopted revised IUCN Guidelines (IUCN 1994, 2001, 2003) making it necessary to revise the status of all species.

3. The IUCN threat categories and selection criteria

3.1 The evolution of threat assessment methods

The first, provisional, outline of a new system was published in Mace & Lande (1991). This was followed by a series of revisions, and the first version of the new Red List categories was adopted as the global standard by the IUCN Council in December 1994. The guidelines were recommended for use also at the national level. In 1995, JNCC endorsed their use as the new national standard for Great Britain, and subsequent British Red Data Books have used these revised IUCN criteria. Following further minor revisions to the IUCN guidelines, the 2001 IUCN Red List Categories and Criteria are now used as the GB standard (IUCN 2001).

Newly established categories were *Extinct in the wild* (EW), and *Critically Endangered* (CR). Whilst the names *Endangered* (EN) and *Vulnerable* (VU) were maintained, they were defined differently from in the original guidelines, and species in one of these threat categories in the old system will not necessarily be in the same category in the new. Most species deemed to be *'Rare'* in the old system have been assigned to the *Near Threatened* (NT) category in the new system, although on the basis of the new criteria, some are now regarded as *Vulnerable*. The *Least Concern* (LC) category represents most other species, but some species are regarded as *Nationally Scarce* (ns), a status peculiar to Great Britain (see Sections 3.4 and 4.5).

In addition, IUCN (2003) has published regional guidelines (applicable to individual countries) particularly concerned with developing a two-step process, the first with taxa evaluated purely on their status within the region under assessment, the second with how that status might be amended to take into account interaction with populations of the taxon in neighbouring regions.

3.2 Summary of the 2001 categories and criteria

A brief outline of the revised IUCN criteria and their application is given below, a full explanation being available (IUCN 2001) and on the IUCN web site (http://www.iucnredlist.org/; www.iucn.org/). The definitions of the categories are given in Figure 1 and the hierarchical relationship of the categories in Figure 2 (see Appendix 1). The category Extinct in the Wild has not been applied in this review.

REGIONALLY EXTINCT (RE)
A taxon is Extinct when there is no reasonable doubt that the last individual has died. In this review the last date for a record is set at fifty years before publication.
CRITICALLY ENDANGERED (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered.
ENDANGERED (EN)
A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered.
VULNERABLE (VU)
A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable.
NEAR THREATENED (NT)
A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future.
LEAST CONCERN (LC)
A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category.
DATA DEFICIENT (DD)
A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate.
NOT EVALUATED (NE)
A taxon is Not Evaluated when it is has not yet been evaluated against the criteria.

Figure 1. Definitions of IUCN threat categories (from IUCN 2001 with a more specific definition for regional extinction).

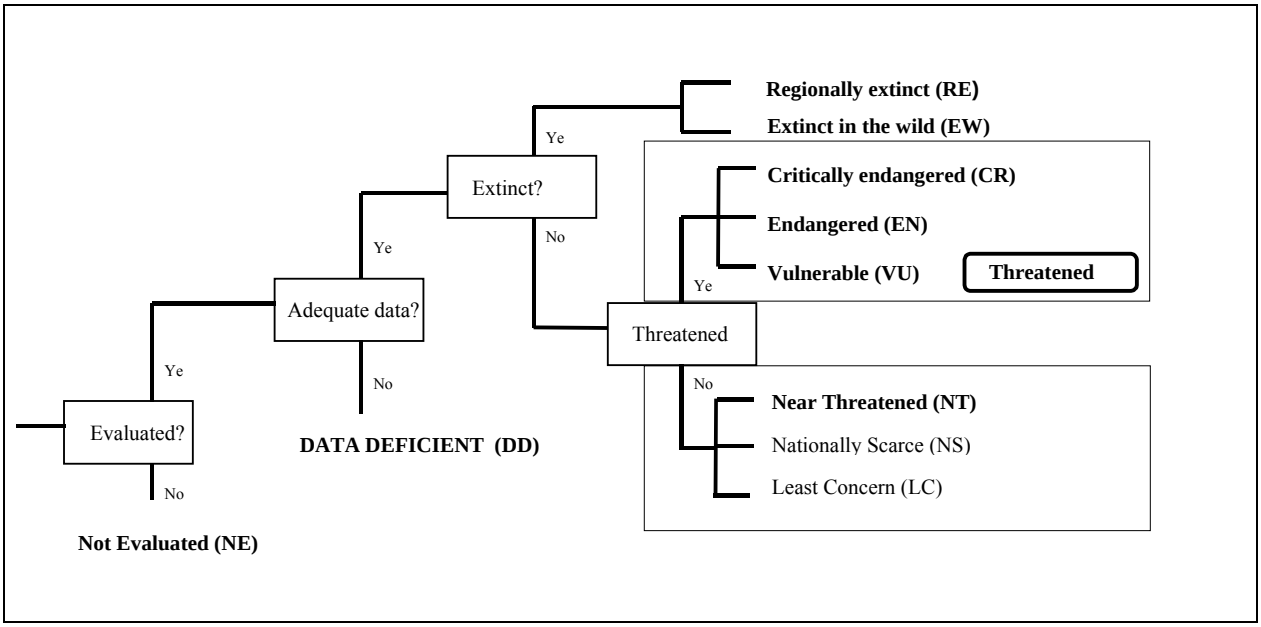

Figure 2. Hierarchical relationships of the categories . Figure adapted from IUCN (2001)

Taxa listed as *Critically Endangered, Endangered* or *Vulnerable* are defined as Threatened (Red List) species. For each of these threat categories there is a set of five main criteria A-E, with a number of sub-criteria within A, B and C (and an additional sub-criterion in D for the *Vulnerable* category), any one of

which qualifies a taxon for listing at that level of threat. The qualifying thresholds within the criteria A-E differ between threat categories. They are summarised in Table 1, and given in full in Appendix 1.

Table 1. Summary of the thresholds for the IUCN Criteria

Criterion	Main thresholds *Critically Endangered*	*Endangered*	*Vulnerable*
A. Rapid decline	>80% over 10 years or 3 generations in past or future	>50% over 10 years or 3 generations in past or future	>30% over 10 years or 3 generations in past or future
B. Small range + fragmented, declining or fluctuating	Extent of occurrence <100 km^2 or area of occupancy <10 km^2 + two of the following: - severely fragmented or only a single location - continuing decline - extreme fluctuations	Extent of occurrence <5,000 km^2 or area of occupancy <500 km^2 + two of the following: - severely fragmented or no more than 5 locations - continuing decline - extreme fluctuations	Extent of occurrence 20,000 km^2 or area of occupancy <2,000 km^2 + two of the following: - severely fragmented or no more than 10 locations - continuing decline - extreme fluctuations
C. Small population and declining	<250 mature individuals, population declining	<2,500 mature individuals, population declining	<10,000 mature individuals, population declining
D. Very small population	<50 mature individuals	<250 mature individuals	D1. <1,000 mature individuals
D2. Very small area of occupancy			D2. <20 km^2 or 5 or fewer locations
E. Quantifiable probability of extinction	>50% within 10 years or three generations	>20% within 20 years or five generations	>10% within 100 years

In this Review, Area of occupancy is indicated thus:

- for Critically Endangered, <10 km^2 is equivalent to being recorded at a single location from 1980 onwards or from a later specified date if the species has been subject to a special survey of its status since 1980
- for Endangered, <500 km^2 is equivalent to being recorded in at least two locations and up to five hectads from 1980 onwards or from a later specified date if the species has been subject to a special survey of its status since 1980
- for Vulnerable, <2,000 km^2 is equivalent to being present in five to ten hectads from 1980 onwards or from a later specified date if the species has been subject to a special survey of its status since 1980.

The revised IUCN criteria have more quantitative elements than the previous criteria, although these can be difficult to apply where there are limited data on abundance and distribution for the group concerned. However, subjective assessments are still required as, for example, in predicting future trends and judging the quality of the habitat. Since the criteria have been designed for global application and for a wide range of organisms, it is hardly to be expected that each will be appropriate to every taxonomic group or taxon. Thus, a taxon need not meet all the criteria A-E, but is allowed to qualify for a particular threat category on any single criterion. The criteria A, C, D1 and E are in rarely appropriate for beetles.

The guidelines emphasise that a precautionary principle should be adopted when assigning a taxon to a threat category, and this should be the arbiter in borderline cases. The threat assessment should be made on the basis of reasonable judgement, and it should be particularly noted that it is not the worst-case scenario which will determine the threat category to which the taxon will be assigned.

3.3 The two-stage process in relation in relation to developing a Red List

The IUCN regional guidelines (IUCN 2003) indicate that if a given taxon is known to migrate into or out of the region it should be assessed using a two stage process. Populations in the region under review should firstly be assessed as if they were isolated taxa. They should then be reassessed and can be assigned a higher or a lower category if their status with in the region is likely to be affected by emigration or immigration. The extent to which populations of water beetles under threat are interdependent within Britain and between Ireland, Britain, and the Continent is uncertain and controversial. Recruitment from abroad has clearly accounted for the establishment of some newcomers to the British fauna, e.g. *Hydrovatus cuspidatus* (Kunze) (Drake 2006) and *Nebrioporus canaliculatus* (Lacordaire) (Carr 1999). Northward movement is evident for a suite of species responding to climate change (e.g. Eyre, Woodward & Luff 2005; Foster 2007b). Newly established subpopulations of *Hydrochara caraboides* (L.) in Cheshire and *Hydrochus crenatus* (Fab.) at Dungeness may owe little to existing populations in Somerset and the Brecks respectively. This evidence, by definition based on the more mobile species rather than those generally regarded as of relict status and most at risk, is regarded as insufficient to justify downgrading the statuses of any British species of water beetle.

3.4 The Near Threatened and Nationally Scarce categories

IUCN (2001) recognised the value of a *Near Threatened* category to identify species that need to be kept under review to ensure that they have not become vulnerable to extinction. This category is used for species where a potential threat, natural habitat dependency or range change demand frequent review of status.

At the national level, countries are permitted to refine the definitions for the non-threatened categories and to define additional ones of their own. The *Nationally Scarce* category is defined as species recorded from 16 to 100 hectads of the Ordnance Survey national grid in Great Britain since 1980, and which neither have a threat status nor are considered *Near Threatened.* The Nationally Scarce category was formerly known as Nationally Notable for invertebrates, and was divided into Lists A and B.

4. Methods and sources of information in this review

4.1 Introduction

The most recent published list of scarce and threatened water beetles (Hyman & Parsons 1992) was based on the Red Data Book criteria used in the British Insect Red Data Book (Shirt 1987) with the addition of the category RDB K (Insufficiently Known) after Wells, Pyle & Collins (1983). The original IUCN criteria for assigning threat status used in these publications had the categories *Endangered, Vulnerable,* and *Rare*, which were defined rather loosely and without quantitative thresholds. The application of these categories was largely a matter of judgement, and it was not easy to apply them consistently within a taxonomic group or to make comparisons between groups of different organisms.

4.2 Data sources

The author of this Review assessed the status of all the species using the information sources described in this section and the system explained in Sections 3 and 6. During the process he sought the views of a large number of other specialists (see Acknowledgements).

The data used in this review have been compiled over the thirty years since the inception of a recording scheme for the British Isles, based on the National Grid and under the auspices of the Biological Records Centre of the (then) Institute of Terrestrial Ecology. There was a gap of about 16 years between Balfour-Browne's vice-county recording and the present recording activity. Much recording went on during this hiatus, most of which has been published and incorporated into the data sheets. In 1976, the Balfour-Browne Club was founded as a group for the promotion of the study of water beetles. The Club's newsletters maintained interest in the recording scheme, and maps of most water beetles species have been published in a "preliminary" atlas (Foster, G.N. 1981b, 1983b, 1984b, 1985b, 1987a, 1990d, 1995b), which concentrated on mapping modern records, rather than on reworking the records earlier collated by Balfour-Browne. The discovery of cryptic species pairs has meant that the starting point for the search for records of certain species, e.g. *Hydrochus brevis*., some *Enochrus* spp., and *Chaetarthria* spp. is much later than 1979, when the scheme began for most species. A separate mapping scheme was operated for the Elmidae by David Holland until the mid 1980s, and he too produced maps in a Club newsletter (Holland 1980). The survey of *Dryops* species (Foster 1995b) became a "recording scheme within a recording scheme", where a requirement to check voucher material severely restricted acceptance of records. Later Jonty Denton took on the Scirtidae and greatly improved our knowledge of that group (Denton & Foster 2000).

These recording activities have provided a firm base for the selection of rare and threatened species. It must, however, be borne in mind that the intensity of recording can never be as great as within some groups such as Odonata and the larger Lepidoptera. Coverage of the British Isles is at any one time patchy, the focus shifting from one area to another with the changes in distribution of a few enthusiasts. On the other hand, water beetles are frequently recorded by limnologists as part of their professional duties, including, for example, routine monitoring of water quality. These records, where made available and supported by voucher material, have greatly improved our knowledge of the distribution of the species in running water.

The first Countryside Survey (Barr *et al*. 1993), carried out by the Institute of Terrestrial Ecology (now part of the Centre for Ecology & Hydrology) in 1990, provided data for independent assessment of the statuses assigned to beetles living in stagnant water. This involved twice-replicated sampling of 508 one km squares taken at random from a stratification of Great Britain. It resulted in 750 samples of stagnant water sites, of which 387 had water beetles (Eyre, Foster & Carr 1992). The occurrence of species in these samples is recorded in the Status section of the data sheets, no mention indicating no record. Subsequent surveys in the same series have proved less useful owing to uncertainty about the identification of some species and location of vouchers. Another source of data for independent assessment of statuses was the survey associated with RIVPACS III (Wright *et al.* 1996). This involved 614 samples of running water across Great Britain, during which 99 species of water beetle were identified to a level useful for assessment of the status of individual species.

4.3 Amateur and professional entomologists

The majority of those who have contributed to the recording scheme are listed in the References and in the Acknowledgements, which are largely based on those with whom the author has corresponded since the recording scheme began.

People record water beetles for many reasons and with varying degrees of accuracy (Foster 1994b). Dedicated amateur entomologists have provided the bulk of records. The most valuable contributions concerning the rarer species in Britain undoubtedly come from the long-term enthusiasts, but natural historians who take a short-term interest in a particular group have made excellent contributions to coverage. In recent years, several dedicated field entomologists have been able to develop their interest on a professional basis, and their contributions are particularly effective with regard to "critical species", i.e. those that prove most difficult to identify within species complexes. The contribution of professional limnologists is largely confined to species associated with the main flow of the larger running water bodies though there is increasing professional interest in the stagnant water fauna.

4.4 Collections

Professor Balfour-Browne catalogued all of the major collections of water beetles available in public museums. Additional catalogues have been prepared by the author as one of the activities of the national recording scheme, as well as re-examination of museum collections for taxa recognised "post Balfour-Browne". A free identification service has been operated since the mid 1970s, particularly targeted at those with a spasmodic interest in water beetles. This has generated the majority of the modern database over and above the survey work of the author and a few other active recorders.

4.5 Near Threatened and Nationally Scarce categories

It must be emphasised that the selection of Nationally Scarce species is separate from evaluation of the species under threat in that many of the latter, particularly the species with action plans under the UK Biodiversity Action Plan, have been studied more intensively, with significant changes detected in their status since 1980.

With the removal of those species considered to be under threat or Near Threatened there are 84 taxa that meet the current criteria for National Scarce species. These are listed in section 9.1.

The following 35 species were included in the most recent review (Hyman & Parsons 1992) as Nationally Notable List B, but they have been reassessed and cannot now be given Nationally Scarce, Near Threatened or Red List status because they are known to occur in more than 100 hectads and no case can be made for current threat or decline (Table 2). Nevertheless many of these species have a conservation value as indicators of good quality sites. Development of a new system of scoring sites, or upgrade of existing systems such as Chadd & Extence (2004) or Foster & Eyre (1992), is desirable to take advantage of the intensive recording of such species.

Table 2. Species that are too widespread to qualify as Nationally Scarce, formerly classified as Nationally Notable List B

Species	No. vice-counties since 1980	No. hectads since 1980	No. hectads since 2000
Agabus unguicularis (Thomson)	47	159	79
Anacaena bipustulata (Marsham)	46	254	122
Berosus affinis Brullé	28	105	66
Berosus signaticollis (Charpentier)	36	109	74
Cercyon convexiusculus Stephens	54	324	184
Cercyon sternalis Sharp	36	108	58
Cercyon tristis (Illiger)	61	221	117
Cercyon ustulatus (Preyssler)	63	256	115
Dytiscus circumflexus Fab.	44	127	58
Enochrus affinis (Thunberg)	50	154	70
Enochrus melanocephalus (Olivier)	51	178	85
Enochrus ochropterus (Marsham)	56	148	64
Graptodytes granularis (L.)	36	122	69
Gyrinus urinator Illiger	41	134	76
Haliplus heydeni Wehncke	44	142	65
Haliplus laminatus (Schaller)	31	128	56
Helochares lividus (Forster)	60	429	269
Helophorus arvernicus Mulsant	58	189	64
Helophorus griseus Herbst	47	221	135
Hydraena nigrita Germar	44	144	86
Hydraena testacea Curtis	53	227	124
Hydroglyphus geminus (Fab.)	55	299	188
Hydroporus longulus Mulsant	63	171	71

Species	No. vice-counties since 1980	No. hectads since 1980	No. hectads since 2000
Ilybius aenescens Thomson	54	127	44
Ilybius chalconatus (Panzer)	51	196	81
Ilybius fenestratus (Fab.)	42	169	72
Ilybius guttiger (Gyllenhal)	44	163	87
Laccobius sinuatus Motschulsky	45	207	121
Laccobius ytenensis Sharp	36	110	37
Limnebius nitidus (Marsham)	46	150	73
Ochthebius bicolon Germar	56	145	51
Ochthebius marinus (Paykull)	41	110	37
Prionocyphon serricornis (Müller)	48	220	184
Rhantus grapii (Gyllenhal)	35	128	73
Rhantus suturalis (Macleay)	54	285	188

5. Format of the data sheets

5.1 Information on the data sheets

Data sheets have been prepared for each of the Regionally Extinct, Threatened, Near Threatened and Data Deficient taxa (see Section 9 for the list). Information on each species is given in a standard form. The data sheets are designed to be self-contained in order to enable site managers to compile species-related information on site files; this is the reason for the repetition that occurs between the species accounts. This section provides context for the eight items of information on each of the data sheets. The completed data sheets are given in Section 10.

5.2 The species' name

Nomenclature is intended to be as up to date as possible and follow Foster (2004, 2005). The species accounts explain changes in the names used in previous reviews.

5.3 Identification

This subsection suggests reference works for the determination of the adult of the species, and the larval stage, if described. These suggestions go beyond the British literature. Anyone studying British water beetles should take advantage of the intense interest in water beetles in Europe as a whole, which has resulted in many identification manuals, of which those not written in English may still have useful illustrations. Tachet, Richoux, Bournand & Usseglio-Polatera (2000) provided a pictorial key to the French genera and this is applicable to the British fauna. British coleopterists would be well advised to master some basic German in order to take advantage of the rich Central European literature, in particular the publications in the series, *Die Käfer Mitteleuropas* (Freude, Harde & Lohse 1971, and its revisions) and *Süßwasserfauna von Mitteleuropa.* The latter cover the Helophoridae (Angus 1992), the Haliplidae, Noteridae and Hygrobiidae (van Vondel & Dettner 1997), both in English, and, in German, the Hydrophiloidea other than Helophoridae (Hebauer & Klausnitzer 1998) and the Scirtidae (Klausnitzer 2009). British species are a mixture of those with Fennoscandian, Central European and Atlantic Coast distributions. Keys intended for use, say, in Scandinavia, may omit a few British species, and should be used with caution, but works in the *Fauna Entomologica Scandinavica* series will prove most helpful (Hansen 1987, Holmen 1987a, Nilsson & Holmen 1995), especially as they are written in English. The illustrations for the Dutch keys (Drost *et al*. 1992) are also worth consulting.

Balfour-Browne's works (1940, 1950, 1953, 1958) of the British fauna continue to provide invaluable guidance on most British species, largely because the discursive treatment of each species covers their variations and how they might be confused with similar species. Friday's treatment (1988a), in lacking this discursive element, can lead one astray because the simple keys favoured in the AIDGAP series do not take into account the difficulties associated with identifying beetles, particularly those of a streamlined body form. Nevertheless Friday's work is invaluable in covering more aquatic families than Balfour-Browne's works, in using a relatively modern checklist, and in signifying the most straightforward identification features. A recent publication by Sutton (2008) covers some of Britain's larger water beetles in detail.

Though not cited in the species accounts there is increasing scope for use of images accessible on the worldwide web as a means to identification. Caution is again advisable in that species may have been misidentified just as they often are in popular, generalist treatments.

Keys to larvae are incomplete because certain larvae have yet to be described, and such keys should be treated with even more caution. A publication on European aquatic insects (Nilsson 1996) is recommended for its coverage of all British genera except *Stictonectes*. Nilsson (1990) provided a critical review of some earlier works.

5.4 Distribution

The vice-county recording system is strongly associated with the study of water beetles as Professor Frank Balfour-Browne pioneered and promoted its use (Balfour-Browne 1962) for over fifty years, resulting in a comprehensive series of species distribution maps in the Ray Society publications *British Water Beetles* (Balfour-Browne 1940, 1950, 1958). The current literature search goes back to 1963, the year when Balfour-Browne ceased to maintain his recording scheme. In this review distribution is given as a list of Watsonian vice-counties (Table 2), using a mixture of names, sometimes abbreviated, derived from Dandy (1969), Heath & Scott (1974) and modern Welsh equivalents where available. It should be noted that Balfour-Browne used other names for some vice-counties, e.g. North and South Sutherland for East and West Sutherland respectively (Balfour-Browne 1962). An exception to the vice-county system is provided by islands. Given the continuing interest in island faunas, individual islands are named at the ends of vice-county listings. It should be noted that the vice-counties are used here primarily to portray distributions, whereas assessments of the scarcity or decline are largely based on counts of hectads (10 x 10 km squares; Table 4).

Table 3. Names and numbers of Watsonian vice-counties and islands used in this review.

No.	Usage in this review, including islands	Other names
1	West Cornwall	West Cornwall (with Scilly)
2	East Cornwall	
3	South Devon	
4	North Devon, Lundy	
5	South Somerset	
6	North Somerset	
7	North Wilts	North Wiltshire
8	South Wilts	South Wiltshire
9	Dorset, Brownsea Island	
10	Isle of Wight	
11	South Hants	South Hampshire
12	North Hants	North Hampshire
13	West Sussex	
14	East Sussex	
15	East Kent	

No.	Usage in this review, including islands	Other names
16	West Kent	
17	Surrey	
18	South Essex	
19	North Essex	
20	Herts	Hertfordshire
21	Middlesex	
22	Berks	Berkshire
23	Oxon	Oxfordshire
24	Bucks	Buckinghamshire
25	East Suffolk	
26	West Suffolk	
27	East Norfolk	
28	West Norfolk	
29	Cambs	Cambridgeshire
30	Beds	Bedfordshire
31	Hunts	Huntingdonshire
32	Northants	Northamptonshire
33	East Gloucester	East Gloucestershire
34	West Gloucester	West Gloucestershire
35	Monmouth	Monmouthshire
36	Hereford	Herefordshire
37	Worcester	Worcestershire
38	Warks	Warwickshire
39	Staffs	Staffordshire
40	Salop	Shropshire or Salop
41	Glamorgan, Sully	
42	Brecon	Breconshire
43	Radnor	Radnorshire
44	Caerfyrddyn	Carmarthenshire
45	Pembroke	Pembrokeshire
46	Ceredigion	Cardiganshire
47	Montgomery	Montgomeryshire
48	Meirionydd	Merionethshire
49	Caernarfon	Caernarvonshire
50	Denbigh	Denbighshire
51	Flint	Flintshire
52	Anglesey	
53	South Lincs	South Lincolnshire or Lincoln, South
54	North Lincs	North Lincolnshire or Lincoln, North
55	Leics	Leicestershire (with Rutland)
56	Notts	Nottinghamshire
57	Derbyshire	
58	Cheshire	
59	South Lancs	South Lancashire
60	West Lancs	West Lancashire
61	South-east Yorks	South-east Yorkshire
62	North-east Yorks	North-east Yorkshire
63	South-west Yorks	South-west Yorkshire
64	Mid-west Yorks	Mid-west Yorkshire
65	North-west Yorks	North-west Yorkshire
66	Durham	
67	South Northumberland	
68	North Northumberland, Holy Island	North Northumberland (Cheviot)

No.	Usage in this review, including islands	Other names
69	Westmorland	Westmorland with North Lancashire
70	Cumberland	
72	Dumfries	Dumfriesshire
73	Kirkcudbright	Kirkcudbrightshire
74	Wigtown	Wigtownshire
75	Ayrshire	
76	Renfrew	Renfrewshire
77	Lanark	Lanarkshire
78	Peebles	Peeblesshire
79	Selkirk	Selkirkshire
80	Roxburgh	Roxburghshire
81	Berwick	Berwickshire
82	East Lothian	East Lothian or Haddington
83	Edinburgh	Midlothian or Edinburgh
84	Linlithgow	West Lothian or Linlithgow
85	Fife	Fifeshire (with Kinross)
86	Stirling	Stirlingshire
87	West Perth	West Perthshire (with Clackmannan)
88	Mid Perth	Mid Perthshire
89	East Perth	East Perthshire
90	Angus	Angus or Forfar
91	Kincardine	Kincardineshire
92	South Aberdeenshire	
93	North Aberdeenshire	
94	Banff	Banffshire
95	Moray	Moray or Elgin
96	East Inverness	East Inverness-shire (with Nairn), Easterness
97	West Inverness	West Inverness-shire, Westerness
98	Argyll	Argyll Main, Main Argyll – also Argyle
99	Dumbarton	Dunbartonshire
100	Arran, Bute, Cumbrae, Holy Isle	Clyde Isles
101	Kintyre	Cantire
102	Islay, Jura	South Ebudes
103	Coll, Mull, Ulva	Mid Ebudes
104	Eigg, Raasay, Rum, Skye, Soay	North Ebudes
105	West Ross	West Ross
106	East Ross	East Ross
107	East Sutherland	South Sutherland
108	West Sutherland	North Sutherland
109	Caithness	
110	Harris, Lewis, North Uist, South Uist	Outer Hebrides or simply Hebrides
111	Hoy, Orkney Mainland	Orkney Islands
112	Shetland Mainland	Shetland Islands or Zetland

Balfour-Browne excluded the Dryopidae, Elmidae and the aquatic members of the Sphaeridiinae from his recording scheme. Also, his approach to the taxonomy and systematics of much of the Hydrochidae, Helophoridae and Hydrophilidae *s. str.* does not follow the modern system, and his assessments of the distributions of species (Balfour-Browne 1958) in these families should be quoted with caution. In some cases qualifying remarks are given after the vice-county, for instance when a species is known from just a single example or locality.

Water beetles lend themselves to preservation as sub-fossils by virtue of their habitat as well as their hard body parts. Many studies of organic deposits that can be reliably dated to postglacial times generate

records of water beetles. The majority of records have been summarised in the BUGS Coleopteran Ecology Package (currently at www.bugscep.com in an edition provided by Philip Buckland: see also Buckland & Coope 1992, Sadler *et al*. 1992). In this review the finds are usually summarised by a list of vice-counties at the end of the British distributions, though sometimes elsewhere in the account where such finds can be linked to perceived threats. Just as there are biases in recording living beetles there are potential biases, rather different ones, in use of sub-fossil records. Firstly many of these records emanated from the University of Birmingham, with most from the English Midlands. Secondly, some species cannot be identified with safety by reference to humified material but thirdly and conversely others are more likely to be detected as sub-fossils than they are in life. Finally finds are limited by local geology. However, the sub-fossil record often emphasises how boreal species that were once widespread in Britain and the copious records from the Somerset Levels, both sub-fossil and extant, illustrate how the fenland fauna of south-west England has changed, the sub-fossil fauna being nearer to that of the modern fens of East Anglia. No preglacial or interglacial records have been included in this review, and reference to the Late Glacial Interstadial and the period of the Loch Lomond Readvance (the Younger Dryas) is largely confined to the long profile provided by the Gransmoor kettlehole (Walker *et al.* 1993). It is unlikely that species dying out before the Loch Lomond Readvance (e.g. *Ochthebius* cf. *pedicularius* Kuwert), or immediately after it (e.g. *Agabus serricornis* (Paykull), *Colymbetes dolabratus* (Paykull) and *C. paykulli* Erichson) will be rediscovered alive in Britain. *Bidessus grossepunctatus* Vorbringer was present in the Somerset levels from the Neolithic until the Bronze Age (Foster & Carr 2008). *Gyrinus colymbus* Erichson, appears to have survived until the Little Ice Age (Girling 1984a), and *Oreodytes alpinus* and *Ilybius wasastjernae* were detected as sub-fossils in Britain before being discovered alive (Coope 1981 and Osborne 1972 respectively).

Distributions outside Britain are largely based on a series of Palaearctic catalogues edited by Ivan Löbl and Aleš Šmetana (2003, 2004, 2006).

Records held in the database of the Water Beetle Recording Scheme form the basis for determining the modern distributions of species, both as maps and as detailed data on occurrence by vice-county and hectads. Some of these data can be accessed through the NBN Gateway (www.searchnbn.net), currently about 370,000 records held for the UK, and operated in joint stewardship between the Aquatic Coleoptera Conservation Trust, the Balfour-Browne Club and the Biological Records Centre. However, for those who prefer to cite hard copy publications, the most recently published maps are noted in the data sheets.

5.5 Habitat and ecology

Information is provided on habitats, larval and adult ecology, behaviour, including flight capacity, and on phenology. Coleopterists should be wary when applying the ecological descriptions ("acidophil", "silicophil", "rheophil", *etc*.) popular in mainland Europe. These descriptions often fail when applied to the ecological niches occupied by species in Britain, with its wide range of climatic and geological conditions, and with its isolated and rather impoverished island fauna. In particular, readers are urged to keep an open mind concerning claimed associations of water beetles with a restricted range of pH. Experimental evidence (Juliano 1991; Foster 1995a) indicates that associations with pH are indirect. Some beetles are confined to peaty or sandy substrata, even though they are typically associated with acid water; and some are confined to exposed shores, such as occur in both acidic hill lochs and in marl lakes. Fish, major predators of beetles, are absent from the most acidic sites as they are from temporary habitats. This almost certainly explains the fact that *Agabus labiatus* tolerates highly alkaline conditions in temporary turlough and turlough-like pools, whilst also being found in permanent, dystrophic waters.

Considerable emphasis is placed in this Review on the importance of relict sites in supporting rare species. This indicates either that such species have poor dispersal capacity or that they require a special set of conditions provided only by such sites, or perhaps a combination of the two. The relative importance of these factors has been discussed in a study of one of these species, *Hydroporus glabriusculus* Aubé (Bilton 1993b, 1994a, 1994b). It should be noted that although the term “pingo fen"

has entered the conservation literature (Foster 1993, Anonymous 1997) this term is unfortunately inappropriate. Such fens originated from cryogenic mounds more correctly referred to as "palsa scars", the remains of mineral palsas (Worsley, Gurney and Collins 1995). Burmeister (1980), Claassen (1987) and Bameul (1994, 1997) have identified rare water beetles associated with such periglacial features in Germany, the Netherlands and France respectively.

There was considerable controversy in the past about the extent to which water beetles were capable of flight (Jackson 1956a and 1956b), with strong opinions expressed about whether some species were capable of flight at all. A generally accepted modern view is that, in addition to those species that retain flight capability throughout adult life, and those that possess it for a variable period after adult emergence, there are species that produce specimens capable of flight only rarely. Flight musculature may be lacking, the skeletal structure may be weak or the wings may be severely reduced. The final extreme, the fusion of the elytra, as in some ground beetles, is not known among British water beetles. Even those species generally regarded as micropterous or otherwise incapable of flight may yet be found to produce the occasional flighted specimen. This has proved the case for heteropteran bugs where it is easier to detect the presence of functional wings (Andersen 1982). Distributional data strongly support the idea that many species are largely sedentary, living in relict sites, and rarely use flight to disperse, irrespective of whether the majority of individuals have intact flight structures or not. Species living in running water are more likely to have reduced flight capacity that those associated with stagnant water (Ribera, Foster & Vogler 2003). However, among the stagnant water species associated with temporary waters two contrasting strategies have developed. Some species have strong flight capability enabling them to escape from habitats when they dry out, whereas others stay put and may have flight capability wanting or confined to the teneral period in adult life (Ribera 1992).

5.6 Status

Status is largely based on range size and both short and long term trends, but association of a species with particular habitats under threat is also taken into account. Counts of hectads known to be occupied since 1980 were used to establish whether or not a species might be considered scarce. The IUCN guidelines (see Section 5 and Appendix 1) were then used to decide whether such species might also be considered under threat, and to assign a category, often using detailed survey data acquired well after 1980.

The water beetle recording scheme has generated an *ad hoc* collation of observations from many recorders using a variety of methods. It is subject to year on year variations in the amount of recording effort and its geographical extent, and rarely includes observations on numbers. Nevertheless the sheer quantity of data received largely eliminates these biases and trends can be detected. Stuart Ball has developed a suite of robust non-parametric tests to identify trends from general biological recording schemes for JNCC's Wildlife Statistics project (www.jncc.gov.uk\WildlifeStatistics). Three statistics were used to identify water beetle species with declining ranges:

(a) the percentage change in hectads recorded before 1990 and after 1989 (50% of all records are post 1989), a 25% reduction being used as a threshold for Species of Conservation Concern;
(b) significant value (P <0.05) for the Spearman Rank Correlation Coefficient for the correlation between year order and the proportion for the species of all records received in each year;
(c) a significant value (P <0.05) for the Spearman Rank Correlation Coefficient for the correlation between year order and the proportion of hectads recorded for the species in each year.

Very few species showed a significant decline using all the tests available even though there were, year-on-year, sufficient data to detect trends for about half of the fauna, 200 species having been recorded more than 100 times within the 27 years to 2008. They include: six Gyrinidae; fifteen Haliplidae; the sole representative of the Hygrobiidae, *Hygrobia hermanni* (Fabricius); both British members of the Noteridae; 84 Dytiscidae; thirteen Helophoridae; three Hydrochidae; 35 Hydrophilidae; fourteen Hydraenidae; five Elmidae; two Dryopidae; one Heteroceridae, *Heterocerus fenestratus* (Thunberg); and eleven Scirtidae, plus eight leaf beetles and weevils not considered as part of the present review. Only seven species of water beetle in the database showed significant decline using all three statistics. Five of

these were running water species, these being *Brychius elevatus* (Panzer), *Oreodytes davisii* (Curtis), *Oreodytes sanmarkii* (Sahlberg), *O. septentrionalis* (Gyllenhal) and *Stictotarsus duodecimpustulatus* (Fabricius), all free-swimming species of running water margins as opposed to the common riffle beetles that normally occupy the main river channel and did not show any significant decline. This is taken to indicate the importance of loss of riparian structure as opposed to pollution. *O. davisii* is selected for the Near Threatened status as the least common of this suite of running water species.

Of the other two species the hydraenid *Limnebius papposus* is associated with lowland peat and can be assigned a threat category with some confidence. The other species is a distinctive small diving beetle, *Porhydrus lineatus* (Fabricius), a lowland species of rich fen habitats in ponds and drainage ditches on grazing fen. Although *P. lineatus* appears to have undergone a 40% decline since 1980 it continues to occupy much of its known range. Thus there is a fourth test:

(d) reduction in the known range.

On the basis of *P. lineatus* retaining its known range it is not currently given a threat or Near Threatened status but it must be kept under review.

The majority of species included in this review are too scarce to generate sufficient data from which to quantify trends statistically. Quite appropriately, many of these scarce species are listed as threatened in this review. The evidence in support of this is often based on a restricted number of sites and consequent small Extent of Occurrence or Area of Occupancy, habitat quality and, because sample sizes are small, decline is indicated simply by reference to the numbers of hectads formerly and currently occupied.

5.7 Threats

Threats to the species' habitat and microhabitat are described. Known threats to individual populations, or examples of activities that have led to the destruction of populations of the species, are given where appropriate. Otherwise the statement summarises those activities perceived to be most likely to put individual populations at risk. Examples of such activities, not necessarily in order of importance, are:

- drainage and infill of ponds and other water bodies
- land drainage - this may severely modify aquatic systems but also created habitat such as the biodiverse grazing marshes
- urban development, including road construction
- abstraction of water, resulting in lowering of water tables in fens and temporary Breckland pools
- inundation through impoundment or pumping, resulting in loss of temporary aquatic habitats
- introduction of fish, resulting in predation and loss of vegetation structure
- spread of predatory crayfish (see, for example, Pederzani & Fabbri 2007)
- afforestation, resulting in increased run-off and siltation, loss of marginal habitats and natural springlines
- degradation of fen ditch systems when grazing fens are converted to arable use
- enrichment from loss of nutrients from farmland and disposal of water from sewage outfalls
- pollution and loss of bank structure in lakes used for pleasure craft
- loss or natural vegetation and bank structure through spread of alien plants, e.g. New Zealand Pigmyweed (*Crassula helmsii* (Kirk.)) and Himalayan balsam (*Impatiens balfourii* Hook.)
- insensitive river management techniques, in particular steepened banks and canalisation
- fencing off watercourses to prevent access by livestock
- effects of climate change, such as loss of coastal marshes, reduced persistence of temporary waters, low flows in rivers
- acidification, resulting in loss of mesotrophic fen structures
- loss of peatlands through mechanised peat cutting, deep drainage and oxidation
- loss of insecticides from treated farm crops, forests and disposal of spent sheep-dip

- enrichment of water bodies through excessive use by waterfowl, including use of waste seed as bait
- increased stocking densities resulting in intensified disturbance and localised enrichment of grazing fen and lake edges.

Climate change has potentially profound implications for wetland habitats. Water beetles vary considerably in their ability to respond to changes (Calosi *et al*. 2007a, 2007b). Relatively predictable response to rising summer temperatures might be offset by the largely unknown impact of increasingly erratic winter conditions. At one extreme the near threatened category might be applied to montane species and, at the other, to those of temporary pools and intermittent streams staying dry for several years in succession.

Species of running water have special problems. It is rarely possible to provide statutory protection for an entire drainage system except perhaps under the changes needed to implement catchment management plans developed under the Water Framework Directive to achieve "Good Ecological Status". The sustained concern over nitrification through agricultural applications causing diffuse pollution of watercourses and groundwater is possibly less important to water beetles than siltation and loss of structure through excessive river management. However, abstraction, with resultant low flows, will exacerbate diffuse and point source pollution.

5.8 Management and conservation

Some of the oldest nature reserves in Britain were created to protect their invertebrate interest but beetles are rarely the prime movers in site designation and protection. Nevertheless the value of beetles as indicators of site condition has been recognised when many fen and bogs in SSSIs have been re-evaluated. Beetles also feature in designations for some Special Areas of Conservation (SAC) and Ramsar sites.

Where known sites have the benefit of statutory protection (e.g. they occur on National Nature Reserves NNRs) this is noted. Sites designations as Special Areas of Conservation (SAC) under the European Habitats Directive, Sites of Special Scientific Interest (SSSI), Special Protection Areas (SPA) under the Birds Directive or Ramsar Sites protect water beetles as long as any conservation interest associated with them is adequately expressed in the citation and as long as that interest is effectively translated into site conservation objectives. Loss of suitable habitat continues in undesignated sites. The populations of many water beetle species with fragmented distributions are relicts of previously widespread populations, surviving in small patches of relatively undisturbed habitats after loss of the intervening habitats. For these species it is critical to maintain a chain of protected sites. Other species are more mobile and often rely on dynamic ecological processes operating over areas larger than those normally covered by individual designated sites. Some of these species have benefited from recent changes in the modern landscape, for example the pioneer community that colonises gravel pits and other newly created static water bodies such as trunk road balancing lagoons. Others, such as the water beetle communities associated with brackish/freshwater transition marsh and running water, have probably not benefited from rigid approaches to flood control and land management.

Preventative measures and positive action designed to maintain populations are suggested where these are known or can reasonably be inferred. Inevitably, in many cases this section tends to be generalised, identifying practices that have been found to favour those aspects of the habitat with which the species may be associated. Kirby (2001) provides further, more detailed, information on the management of habitats for the conservation of invertebrates. Pond creation is a popular management practice, and is generally good for water beetles, especially if the ponds occasionally dry out – and therefore do not support many fish. However too much new habitat in relic areas may encourage invasive species at the expense of the sedentary – and almost by definition more valued – species. Clearance of old ponds is also popular and generally effective for beetles if done piecemeal: the same applies to ditch management. One

specific management practice, translocation and reintroduction, is in its infancy for water beetles and may become more frequent if it proves successful for some endangered species and does not impact on others. Conservation can be informed by DNA analysis, in particular through recognising subpopulations: the analysis of about 800 base-pairs of the mitochondrial DNA for a cytochrome oxidase has become a standard and relatively cheap practice. This can identify differences between races and the extent to which a population may have been "bottlenecked" before expansion back into western Europe following the last glaciation. Properly preserved voucher material is essential for this exercise, just as it is for the recording of many species.

5.9 Published sources

Literature references that refer to the previous conservation status of the species in Britain, or that have contributed information to the Data Sheet, are cited here. The literature survey is intended to be complete from 1963, though a few publications that duplicate records are omitted. Many general accounts of beetles that include sections devoted to water beetles (e.g. Cooter & Barclay 2006) are not cited in the species accounts. Similarly, reference to the most comprehensive review of water beetle biology by Klausnitzer (1996) is also omitted from species accounts: it is in German but is nevertheless of great value for treatment of the lesser groups.

6. The UK Biodiversity Action Plan

Ten water beetles evaluated in this review are UK Biodiversity Action Plan (UK BAP) priority species. These include nine threatened species: *Agabus brunneus*, *Bidessus minutissimus*, *Bidessus unistriatus*, *Graphoderus zonatus*, *Helophorus laticollis*, *Hydrochus nitidicollis*, *Hydroporus necopinatus*, *Hydroporus rufifrons* and *Laccophilus poecilus*. The tenth is *Ochthebius poweri*, classified as Near Threatened on the basis of recent survey work. *Hydrochara caraboides* was removed from the priority list in the most recent review of UK BAP species and is here rated as Near Threatened. *Donacia aquatica* and *D. bicolora*, also water beetles, but not evaluated here, also have their own Species Action Plan under the UK BAP. The UK BAP species and a few others have been subject to special survey since 2000, and therefore it is more appropriate to use these data for evaluation rather than the recording scheme hectad counts.

7. The Future

The IUCN criteria for threat categories concentrate on imminent danger of local extinction which hopefully applies to very few species, whilst the criterion for Nationally Scarce species relates to a small geographic distribution within Great Britain, without taking any account of trends, whether for increase or decline. However, in relation to the Convention on Biological Diversity and the processes of Biodiversity Action Planning that have stemmed from it, more attention has been focussed in recent years on species (and habitats) which are declining even if they are not currently scarce or rare. This focuses attention on species that are potentially in trouble whilst they are still widespread, so that remedial action might stop them from becoming rare enough to figure in a review such as this. However, at the risk of being bifocal, the main allocation of resources must always rest with the species most at immediate threat of extinction.

8. Acknowledgements

This review is based upon data accumulated since the days of Darwin, an enthusiastic water beetler in his youth, with the modern database built upon the sustained effort of Professor Frank Balfour-Browne, who ran a vice-county recording scheme over much of the first half of the 20th Century.

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9. Summary of the results of this Review

9.1 Taxa listed by status category

The following list shows taxa listed by threat category. Five species are Regionally Extinct, 34 are threatened, 37 taxa are Near Threatened, 84 taxa are Nationally Scarce and one is Data Deficient. The taxa are given in alphabetical order within status categories.

Regionally Extinct
Graphoderus bilineatus (De Geer)
Gyrinus natator (L.)
Ochthebius aeneus (Stephens)
Rhantus bistriatus (Bergsträsser)
Spercheus emarginatus (Schaller)
Critically Endangered
Bidessus unistriatus (Goeze)
Graphoderus zonatus (Hoppe)
Haliplus furcatus (Seidlitz)
Haliplus varius (Nicolai)
Laccophilus poecilus (Klug)
Endangered
Helophorus laticollis (Thomson)
Hydroporus necopinatus (Fery)
Hydroporus rufifrons (Müller)
Ilybius wasastjernae (Sahlberg)
Limnebius crinifer (Rey)
Normandia nitens (Müller)
Ochthebius lenensis (Poppius)
Paracymus aeneus (Germar)
Vulnerable
Agabus brunneus (Fab.)
Agabus striolatus (Gyllenhal)
Berosus fulvus (Kuwert)
Bidessus minutissimus (Germar)
Dryops griseus (Erichson)
Elodes tricuspis (Nyholm)
Graphoderus cinereus (L.)
Gyrinus suffriani (Scriba)
Haliplus variegatus (Sturm)

Helochares obscurus (Müller)
Helophorus tuberculatus (Gyllenhal)
Heterocerus fusculus (Kiesenwetter)
Hydraena pulchella (Germar)
Hydraena pygmaea (Waterhouse
Hydrochus megaphallus (van Berge Henegouwen)
Hydrochus nitidicollis (Mulsant)
Hydroporus elongatulus (Sturm)
Hydroporus glabriusculus (Aubé)
Hydroporus scalesianus (Stephens)
Oreodytes alpinus (Paykull)
Pomatinus substriatus (Müller)
Stenelmis canaliculata (Gyllenhal)

Near Threatened

Agabus labiatus (Brahm)
Agabus uliginosus (L.)
Agabus undulatus (Schrank)
Augyles hispidulus (Kiesenwetter)
Augyles maritimu (Guérin-Méneville)
Aulacochthebius exaratus (Mulsant)
Berosus luridus (L.)
Dryops anglicanus (Edwards)
Dryops auriculatus (Fourcroy)
Dryops nitidulus (Heer)
Dytiscus dimidiatus (Bergsträsser)
Dytiscus lapponicu (Gyllenhal)
Enochrus nigritus (Sharp)
Eubria palustris Germar)
Graptodytes flavipes (Olivier)
Hydraena minutissima (Stephens)
Hydraena palustris (Erichson)
Hydrochara caraboides (L.)
Hydrochus brevis (Herbst)
Hydrochus crenatus (Fab.)
Hydrochus elongatu (Schaller)
Hydrochus ignicollis (Motschulsky)
Hydrocyphon deflexicollis (Müller)
Hydrophilus piceus (L.)
Hydroporus longicornis (Sharp)
Hygrotus novemlineatus (Stephens)
Laccornis oblongus (Stephens)
Limnebius aluta (Bedel)
Limnebius papposus Mulsant)
Limnoxenus niger (Zschach)
Macronychus quadrituberculatus Müller)
Nebrioporus depressus depressus (Fab.)
Ochthebius poweri (Rye)
Oreodytes davisii (Curtis)
Sphaerius acaroides (Waltl)
Stictonectes lepidus (Olivier)

Nationally Scarce (neither Red List nor Near Threatened)

Acilius canaliculatus (Nicolai)
Agabus biguttatus (Olivier)
Agabus conspersus (Marsham)
Agabus melanarius (Aubé)
Cercyon bifenestratus (Küster)
Cercyon depressus (Stephens)
Cercyon granarius (Erichson)
Cercyon littoralis (Gyllenhal)
Chaetarthria seminulum (Herbst)
Chaetarthria simillima (Vorst & Cuppen)
Cyphon kongsbergensis (Munster
Cyphon pubescens (Fab.)
Cyphon punctipennis (Sharp)
Deronectes latus (Stephens)
Dryops similaris (Bollow)
Dryops striatellus (Fairmaire & Brisout)
Dytiscus circumcinctus (Ahrens)
Elodes elongata (Tournier)
Elodes minuta (L.)
Elodes pseudominuta (Klausnitzer)
Enicocerus exsculptus (Germar)
Enochrus bicolor (Fab.)
Enochrus halophilus (Bedel)
Enochrus quadripunctatus (Herbst)
Georissus crenulatus (Rossi)
Graptodytes bilineatus (Sturm)
Gyrinus aeratus (Stephens)
Gyrinus distinctus (Aubé)
Gyrinus minutus (Fab.)
Gyrinus opacus (Sahlberg)
Gyrinus paykulli (Ochs)
Haliplus apicalis (Thomson)
Haliplus mucronatus (Stephens)
Helochares punctatus (Sharp)
Helophorus alternan (Gené)
Helophorus dorsalis (Marsham)
Helophorus fulgidicollis (Motschulsky)
Helophorus granularis (L.)
Helophorus longitarsis (Wollaston)
Helophorus nanus (Sturm)
Helophorus nubilus Fab.)
Helophorus strigifrons (Thomson)
Heterocerus flexuosus (Stephens)
Heterocerus fossor (Kiesenwetter)
Heterocerus marginatus (Fab.)
Heterocerus obsoletus (Curtis)
Hydaticus seminiger (De Geer)
Hydaticus transversalis (Pontoppidan)
Hydraena rufipes (Curtis)
Hydrochus angustatus (Germar)
Hydroporus ferrugineus (Stephens)
Hydroporus marginatus (Duftschmid)
Hydroporus neglectus (Schaum)

Hydroporus obsoletus (Aubé)
Hydrovatus clypealis (Sharp)
Hydrovatus cuspidatus (Kunze)
Hygrotus decoratus (Gyllenhal)
Hygrotus nigrolineatus (von Steven)
Hygrotus parallellogrammus (Ahrens)
Hygrotus quinquelineatus (Zetterstedt)
Ilybius subaeneus (Erichson)
Laccobius atratus (Rottenberg)
Laccobius simulatrix (d'Orchymont
Limnichus pygmaeus (Sturm)
Nebrioporus canaliculatus (Lacordaire)
Noterus crassicornis (Müller)
Ochthebius auriculatus (Rey)
Ochthebius lejolisii (Mulsant & Rey)
Ochthebius nanus (Stephens)
Ochthebius punctatus (Stephens)
Ochthebius pusillus (Stephens)
Ochthebius viridis fallaciosus (Ganglbauer)
Ochthebius viridis viridis (Peyron)
Oulimnius major (Rey)
Oulimnius rivularis (Rosenhauer)
Oulimnius troglodytes (Gyllenhal)
Paracymus scutellaris (Rosenhauer)
Peltodytes caesus (Duftschmid)
Rhantus frontalis (Marsham)
Riolus cupreus (Müller)
Riolus subviolaceus (Müller)
Scarodytes halensis (Fab.)
Scirtes orbicularis (Panzer)
Stictotarsus multilineatus (Falkenström)

Data Deficient

Cybister lateralimarginalis (De Geer)

9.2 Criteria used for assigning species to threat categories

The following list gives the 2001 IUCN criteria and sub-criteria (see Appendix 1) that were satisfied by each of the red listed species. The species are listed in taxonomic order within status categories

Scientific name	Status	Criteria used
Bidessus unistriatus (Goeze)	CRITICALLY ENDANGERED	B2ab(ii, iv)c (ii-iv)
Graphoderus zonatus (Hoppe)	CRITICALLY ENDANGERED	B1ac(i-iv) B2ac(i-iv)
Haliplus furcatus Seidlitz	CRITICALLY ENDANGERED	B1ac(i-iii) B2ac(i-iii)
Haliplus variegatus	VULNERABLE	
Haliplus varius Nicolai	CRITICALLY ENDANGERED	B1ab(ii,iv)
Laccophilus poecilus Klug	CRITICALLY ENDANGERED	A2(c) B1ab(i-v) B2ab(i-v) C2a D
Helophorus laticollis Thomson	ENDANGERED	B1ab(i-iv) B2ab(i-iv)
Hydroporus necopinatus Fery	ENDANGERED	B1ab(i-iv) B2ab(i-iv)
Hydroporus rufifrons (Müller)	ENDANGERED	A2c B1b(I ,iii, iv) B2b(i, iii, iv)
Ilybius wasastjernae (Sahlberg)	ENDANGERED	B1ab(i-v)c(iv) B2ab(i-v)c(iv)
Limnebius crinifer Rey	ENDANGERED	B1ab(i-iv) B2ab(i-iv)
Normandia nitens (Müller)	ENDANGERED	B1ab(i-iv) B2ab(i-iv)
Ochthebius lenensis Poppius	ENDANGERED	B1ab(i-iv) B2ab(i-iv)
Paracymus aeneus (Germar)	ENDANGERED	B2ab(ii-iv)c(ii, iii)
Sphaerius acaroides Waltl	ENDANGERED	B2ab(ii, iv)
Agabus brunneus (Fab.)	VULNERABLE	B1ab(i-iv) B2ab(i-iv) D2
Agabus striolatus (Gyllenhal)	VULNERABLE	B1ab(ii-iv) B2ab(i-iv)
Berosus fulvus Kuwert	VULNERABLE	B1ab(i, iii, iv) B2ab(i, iii, iv)
Bidessus minutissimus (Germar)	VULNERABLE	B1ab(i-iv) B2ab(i-iv)
Elodes tricuspis Nyholm	VULNERABLE	D2
Dryops griseus (Erichson)	VULNERABLE	B1ab(i, ii) B2ab(i, ii)
Graphoderus cinereus (L.)	VULNERABLE	B2ab(i, ii, iv)
Graptodytes flavipes (Olivier)	VULNERABLE	B1ab(i, ii) B2ab(i, ii)
Gyrinus suffriani Scriba	VULNERABLE	B2ab(ii-iv)
Helochares obscurus (Müller)	VULNERABLE	B1ab(ii-iv) B2a(ii-iv)
Helophorus tuberculatus Gyllenhal	VULNERABLE	B1ab(i-iv) B2ab(i-iv)
Heterocerus fusculus Kiesenwetter	VULNERABLE	B2ab(i-iv)
Hydraena pulchella Germar	VULNERABLE	B2ab(i-iv)
Hydraena pygmaea Waterhouse	VULNERABLE	B2ab(i-iv)
Hydrochus megaphallus van Berge Henegouwen	VULNERABLE	B1ab(i-iv) B2ab(i-iv) D2
Hydrochus nitidicollis Mulsant	VULNERABLE	B1ab(i-iv) B2ab(i-iv) D2
Hydroporus elongatulus Sturm	VULNERABLE	B2b(i, ii, iv)
Hydroporus glabriusculus Aubé	VULNERABLE	B1ab(i-iv) B2ab(i-iv)
Hydroporus scalesianus Stephens	VULNERABLE	B2ab(ii-iv)
Oreodytes alpinus (Paykull)	VULNERABLE	B1ab(i-iii) B2ab(i-iii)
Pomatinus substriatus (Müller)	VULNERABLE	B2ab(ii-iv)
Stenelmis canaliculata (Gyllenhal)	VULNERABLE	B2ab(ii-iv)

10. The data sheets

Data sheets for the 77 species assessed as Regionally Extinct, Red List, Near Threatened and Data Deficient are given in this section. The data sheets are in alphabetical order by scientific name. Individual species can be found by looking up the generic or specific names (including synonyms) in the index.

AGABUS BRUNNEUS VULNERABLE
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Agabus brunneus (Fabricius, 1798).

Identification The adult is keyed by Balfour-Browne (1950) and Friday (1988a). The first and second instars are described by de Marzo (1974) and the third instar by de Marzo (1973).

Distribution The most recent map is provided by the UK Biodiversity Group (1999). There are recent published records for West Cornwall, Dorset and South Hants, and an earlier one from South Wiltshire. The species is confined to two areas, one in the extreme south-west and another centred on the New Forest, but recent records for Dorset in the Frome catchment raise the possibility that the distribution is more continuous. *A. brunneus* is centred on the Mediterranean, reaching northern Europe in southern England and Belgium. It has been recognised as part of a cryptic species complex (Millán *et al*. 1997, Millán & Ribera 2001).

Habitat and ecology *A. brunneus* occurs in shallow, intermittent, lowland streams, often occurring deep in the gravel. Balfour-Browne (1950) noted third instar larvae in March, and took this to indicate that eggs are laid in the autumn, with the larvae overwintering. Early spring breeding of adults is, however, possible in these climatically favoured, southern coastal sites. Larvae have been found in late August in the New Forest. Flight tests have proved negative.

A. brunneus is the most widespread of the three species in its group, and Calosi *et al*. (2007b) have demonstrated that it has a wider thermal tolerance than the others. However the lower temperature tolerance is quite high compared with other mid-temperate-latitude insects. Under laboratory conditions *A. brunneus* did not acclimatise well to either high or low temperatures, emphasising the problems that it might face in a time of climate change.

Status *A. brunneus* has been recorded from eight hectads from 1980 onwards, and from 5 since 2000 in surveys of known sites, mainly in 2001. IUCN criteria satisfied are based on the geographic range restricted both in extent of occurrence (2,600 km²) and in area of occupancy (probably less than 20 km² overall) with severely fragmented populations in five locations, further losses likely as a result of human activity.

Threats Disturbance of catchments associated with development of former heathland sites will damage the habitat for this species, in particular through contamination of gravel beds with silt. Coastal developments may impact particularly on the Cornish sites.

Management and conservation A Biodiversity Action Plan has been prepared for this species. The Lizard and at least one of the New Forest sites fall within SSSI. The status of other sites is unclear. The conservation of this species in particular has been dogged by secrecy and a consequent lack of precise information about its breeding localities, even though it is extremely unlikely that collecting activity could affect its abundance. The genetics of the British subpopulations should be investigated in relation to each other (i.e. south-west England and that of the New Forest and adjacent areas) and in relation to subpopulations abroad.

Published sources Appleton (2004), Armitage & Blackburn (2001), Balfour-Browne (1950), Bilton (1997), Calosi *et al*. (2007b), Darby (2009), Department of the Environment (1995b), Foster, G.N. (1983b, 2000a, 2000b, 2002), Friday (1988a), Key (1998), de Marzo (1973, 1974), Millán & Ribera (2001), Millán *et al*. (1997), Nash (1977, 1979), Shirt (1987), UK Biodiversity Group (1999).

AGABUS LABIATUS Near Threatened
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Agabus labiatus (Brahm, 1790)

Identification The adult is keyed by Balfour-Browne (1950) and Friday (1988a). The larva is illustrated and keyed by Nilsson (1982a, 1982c).

Distribution The map provided by Foster (1983b) should be used with the vice-county map of Balfour-Browne (1950, map 12). Records since 1980 are for North Somerset, South Wilts, South and North Hants, East Sussex, West Kent, Surrey, South Essex, Oxon, Bucks, West Suffolk, East and West Norfolk, Hereford, Salop, Brecon, Radnor, South and North Lincs, Notts, South-east, Mid-west and North-west Yorks, Westmorland, Fife, Angus, South Aberdeenshire, Moray, East Inverness, and East Ross. *A. labiatus* is a western Palaearctic species, ranging from northern Spain to Ireland, and east to Siberia.

Habitat and ecology Carr (1989) found that this species overwintered as adults in Kent, with larvae early in the summer. Jackson (1958) concluded that oviposition occurred from November to April in Scotland. Galewski (1971) noted it as one of the earliest breeding species in the spring, with oviposition resumed in late summer or autumn in the event of drought. Most authors (e.g. Nilsson 1986b) agree that larvae occur early in the season and pupation has been observed in July (Schlick 1894). The larvae have swimming hairs and are adapted to forage over the open bottom of temporary ponds, preying mainly upon water fleas, whereas most other *Agabus* larvae crawl in amongst litter. The association with temporary water and with some more permanent acid pools suggests an avoidance of fish predation. Jackson (1956a, 1956b, 1973) described *A. labiatus* as incapable of flight on the basis of large numbers of individuals that she had dissected, plus its very local distribution, but Holmen (1987b) has noted several specimens in flight from a dried-out pond in Denmark. The egg-parasitoid *Caraphractus cinctus* Walker is recorded from this species and *A. labiatus* is prone to nematode infection (Jackson 1951).

Status *A. labiatus* has been recorded from 54 hectads in Britain from 1980 onwards. It has become extinct in sites in northern England, e.g. Prestwick Carr (Eyre & Luff 2005), and southern Scotland, and it has not been recorded recently from many well surveyed sites on the Dorset and southern English heathland and the Cambridgeshire Fens. Although it has clearly declined in the Home Counties, it persists in a few sites in the London area. *A. labiatus* is known from a Bronze Age deposit in the Somerset Levels but is not extant on the Levels themselves, although being known from Priddy in Somerset. This species, once lost from a natural or seminatural site, does not return. A general pattern of decline indicates that it should be considered as Near Threatened.

Threats Loss of heathland habitats in southern England accounts for the major losses in this species, and Hammond & Merritt (2008) have noted that its survival in Yorkshire is mainly on former commons. Water extraction in areas with temporary ponds, particularly in the Breckland, will cause loss of habitat, but *A. labiatus* appears to be capable of persisting in quite severely disturbed sites. However, temporary ponds are easily lost in the wider countryside following upon agricultural improvement. The larval habitat opens them up to fish predation, so fish introduction and rendering a site permanent, thus permitting fish survival, are considered to be detrimental.

Management and conservation *A. labiatus* is found on many sites receiving protection, e.g. the New Forest SAC, the palsa scar ("pingo") fen reserves of the Norfolk Wildlife Trust, Ministry of Defence property in Woolmer Forest and on the Stanford Training Area in Norfolk, Morton Lochs NNR, and Rossie Muir SSSI. Fluctuating water levels should be maintained in pools occupied by this species, and fish introduction must be discouraged.

Published sources Angus (1964a, 1964b), Balfour-Browne (1950), Bilton (1987), Bratton (1990b), Carr (1989), Carr & Philp (1988), Darby (2009), Denton (1996, 1997, 2001, 2005, 2007a), Duff (1993), Eyre (1985), Eyre & Luff (2005), Foster, A.P. & Foster, G.N. (1984), Foster, G.N. (1977c, 1981a, 1983b, 1983c, 1988a, 1993), Foster & Eyre (1992), Friday (1988a), Fursov (2000), Galewski (1971), Girling (1982a, 1984a), Hammond (2004),

Hammond & Merritt (2008), Holmen (1987b), Jackson (1951, 1956a, 1956b, 1973), Nilsson (1982a, 1982c, 1986b), Palmer (1981a), Peters (1972), Philp (1969), Ratcliffe (1977), Sanderson & Wilkinson (1989), Schlick (1894), Sinclair (1976b), van Vondel (1989), Warne (1987), Watson & Foster (2006), Young (1982).

AGABUS STRIOLATUS VULNERABLE
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Agabus striolatus (Gyllenhal, 1808).

Identification The adult is keyed by Balfour-Browne (1950) and Friday (1988a). The aedeagus and body shape are compared with those of *A. affinis* (Paykull) and *A. unguicularis* (Thomson) by Foster (1982b). The larva is illustrated and keyed by Nilsson (1982a, 1982c) and Nilsson & Cuppen (1983).

Distribution *A. striolatus* is confined to East Norfolk and South-west Yorks. Abroad, *A. striolatus* appears to be confined to northern Europe, being known from France, the Netherlands, Denmark, Sweden, Finland, the Baltic States, Poland, and Russia, but doubtful in Bohemia.

Habitat and ecology This species lives in temporary, shaded pools in fen carr, and is also known from tussock fens on commons to the west of the Broads. It is capable of running when out of the water, and crawls rather than swims when submerged. Flight tests have failed and six specimens dissected were found to have vestigial flight muscles and poorly sclerotised subalar discs (Foster 1982b). In recognising five life-cycle patterns in Agabini, Nilsson (1986b) consigned *A. striolatus* to the large group, which are univoltine spring breeders on the basis of larvae being found in spring and early summer, and adults being active during the winter.

Status *A. striolatus* is known from eight hectads in East Norfolk and South-west Yorks. The Yorkshire site is about a kilometre from where sub-fossil remains have been found by Whitehouse (1997). The relict status of this species is indisputable but it appears to have benefited from 20th Century development of fen carr in the Broads. Since 2000 *A. striolatus* has been found in nine sites in eight hectads. The IUCN criteria for Vulnerable status that are satisfied in the restricted extent of occurrence (9,600 km²) and area of occupancy, with severely fragmented populations in habitats the quality of the major proportion of which is projected to deteriorate. This is a population confined to a small number of sites assumed to represent the last remains of a formerly widespread tract of occupied fenland. The inference is that the factors causing this reduction continue to operate.

Threats *A. striolatus* is largely confined to the Broads and fen carr nearby. Its survival chances in Broadland itself, a "paramaritime zone" (Boorman *et al*. 1989), must be low in the event of salinification associated with sea level changes following climatic change. The relatively recent discovery of *A. striolatus* in Norfolk away from the Broads (Nobes 2001) and at Inkle Moor, South-west Yorks (Hammond & Merritt 2008) significantly raise its survival prospects. Cuppen & Cuppen (1983) identified lowering of groundwater level as the main threat in the Netherlands, to which might be added salinification as far as the Norfolk Broads sites are concerned.

Management and conservation Most of the sites at which this species occurs are either National Nature Reserves or are managed by the Norfolk Wildlife Trust and the Broads Authority. Whilst the development of fen carr must be considered beneficial to this species, succession to drier woodland would be detrimental so water levels must be kept high. *A. striolatus* has survived piecemeal destruction of carr at Mrs. Myhill's Marsh in Hickling Broad NNR and, conversely, appeared to flourish when grazing and access pressures were reduced in tussocky areas at Whitwell Common during the outbreak of Foot & Mouth Disease in 2001.

Published sources Balfour-Browne (1950), Boorman *et al.* (1989), Boukal *et al.* (2007), Collier & Foster (1986), Cuppen & Cuppen (1983), Department of the Environment (1995b), Foster, G.N. (1977c, 1982b, 1983c), Foster *et al.* (2007), Friday (1988a), Hájek & Šťastný (2005), Hammond & Merritt (2008), Hodge (1978c), Jackson & Howlett (2000), Lohez (2007), Nilsson (1982a, 1982c, 1986b), Nilsson & Cuppen (1983), Nobes (2001), Shirt (1987), Whitehouse (1997).

AGABUS ULIGINOSUS Near Threatened
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Agabus uliginosus (Linnaeus 1761). Nilsson & Petrov (2005) resolved longstanding concerns about the identity of Linnaeus' *Dytiscus uliginosus.*

Identification The adult is keyed by Balfour-Browne (1950) and Friday (1988a). The larva is keyed by Nilsson (1982a, 1982c).

Distribution Records since 1980 are for South and North Somerset, North and South Wilts, Berks, Oxon, East and West Suffolk, East and West Norfolk, Cambs, Hunts, Monmouth, Shropshire, North Lincs, Notts, South-east, North-east, Mid-west and North-west Yorks, Durham, South and North Northumberland, Berwick, East Ross, and East Sutherland. Earlier records add North Wilts, Dorset, North Hants, South Essex, Glamorgan only on Sully Island, Cumberland, Dumfries, and Kirkcudbright. The most recent published map (Foster 1983b) should be used in conjunction with the vice-county map of Balfour-Browne (1950, map 9). An intensive survey of Derbyshire, Notts and South Yorks (Merritt 2006) has shown *A. uliginosus* to be confined to east of the areas on the Humberhead Levels and the lower Trent Valley. A recent record for the Wood of Cree, Kirkcudbright, has proved incorrect. *A. uliginosus* is a European species ranging to longitude 52º E, not into Siberia as previously supposed, where it is replaced by the vicariant *A. uralensis* Nilsson & Petrov, but recently found to extend to central Spain by David Bilton, and to be very rare in the Gironde (Bameul 2002). It is one of four diving beetle species known from Iceland.

Habitat and ecology *A. uliginosus* is primarily confined to highly temporary still waters on low ground, sometimes on marshes subject to tidal influence, and in the south-west in association with puddles around springs in otherwise dry terrain. It often appears very early in the spring, and in central Europe can be found in ponds formed by snow melt. Galewski (1971) noted that its larvae could not swim to the surface and could therefore only survive in shallow water. *A. uliginosus* is, however, also found in some primary fen sites which have permanent water, and its distribution is largely relict. Braasch (1989b) suggested that occurrence of larvae in Germany in March to May and again in July indicated bivoltinism. Whilst this clearly indicates the possibility of two broods, it is more likely, as Nilsson (1986b) suggested, in consigning *A. uliginosus* to the large agabine group of univoltine spring breeders, that it can lay eggs over a long period within a season. Galewski (1968) found second instar larvae from early May to late July, and third instars from late April to mid September. Larvae were most common in May and pupation and teneral adults were observed in the same month. Galewski (1968) connected the presence of larvae in late summer with prolonged oviposition in permanent ponds but this species is highly responsive to the availability of water in the extremely temporary habitats, the ability to oviposit over a prolonged period being an adaptation to the highly variable duration of water in the temporary sites that it can occupy. Some sites in England rarely have water and have no aquatic vegetation. Jackson (1956a) noted this as a species in which flight capacity was reduced. However, a highly teneral male was noted in flight on a warm, humid afternoon at Woodwalton Fen (Kirby & Foster 1991) since when further specimens have been detected in flight at Wicken Fen and in Sweden. An interesting feature of the British distribution is that both forms of female occur, the shining, male-like form, confined to the south-west of England and to Wales, and the dull form *dispar* Bold, found from East Anglia northwards.

Status *A. uliginosus* has been recorded from 53 hectads from 1980 onwards. The modern records are widely distributed through the known range, but there would appear to have been some contraction in range from the coast, particularly in East Anglia and the Solway area. This is possibly the most resilient of the water beetles occupying temporary waters in relict sites. It continues to occur, for example, on Boldon Flats, Durham, from where Bold (1849) originally described *dispar*; the type form occurs in temporary pools associated with springs on Salisbury Plain, and such habitats must be considered fragile, offsetting the potential persistence of this species. Whitehouse (1997) recorded it from Bronze Age peat deposits on Thorne Moors, the immediate area still being occupied by this species.

Threats Loss of temporary habitats in fenland may come about through inappropriate maintenance of high water levels, whereas drainage was the most likely cause of habitat loss in the past. Temporary ponds are often lost from the wider countryside as a result of agricultural improvement.

Management and conservation *A. uliginosus* occurs in several NNR, e.g. Woodwalton, in palsa scar ("pingo") fens managed as reserves by the Norfolk Wildlife Trust, in Magor Marsh, an SSSI and reserve of the Gwent Wildlife Trust, and in pools on Ministry of Defence land in the Stanford Training Area in Breckland, designated as SSSI. A northern Scottish site lies within the Dornoch Firth and Morrich More SAC.

Artificial management of water supplies to increase pool flooding may be detrimental to the survival of this species, but spring flooding from ground-water is probably desirable to guarantee breeding success.
The genetic basis of dimorphism in the females should be investigated and the Continental distribution of var. *dispar* established in order to assess the importance of the British population. The possibility that the males can also be differentiated, as has recently been done for *Hydroporus memnonius* Nicolai (Bilton, Thompson & Foster 2008), should also be investigated as it may be necessary to treat the two forms as separate breeding entities.

Published sources Balfour-Browne (1950), Bameul (2002), Bilton (1987), Bilton, Thompson & Foster (2008), Bold (1849), Braasch (1989b), Cadbury & Telfer (2005), Carr (1997), Collinson *et al.* (1995), Darby (2009), Duff (1993), Dunn (1987), Eyre (1985), Eyre & Foster (1984), Fitter & Smith (1979), Foster, A.P. (1984b), Foster, A.P. *et al*. (1986), Foster, G.N. (1977c, 1980b, 1983b, 1983c, 1984d, 1987b, 1988a, 1993), Foster & Eyre (1992), Foster & Sinclair (1982), Friday (1988a, 1990, 1997), Galewski (1968, 1971), Gregory (1987), Hammond (2002, 2004, 2009), Jackson (1956a), Kirby & Foster (1991), Larson & Gígja (1959), Lohez (2007), Lott (2002), Lundkvist, Landin & Karlsson (2000), Merritt (1987, 2006), Nilsson (1982a, 1982c, 1986b), Nilsson & Petrov (2005), Painter (1999), Palmer (1981a), Pope (1969), Queney (2002a), Sinclair (1982), Whitehouse (1997).

AGABUS UNDULATUS Near Threatened

A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Agabus undulatus (Schrank 1776).

Identification The adult is keyed by Balfour-Browne (1950) and Friday (1988a). The larva is illustrated and keyed by Nilsson (1982a, 1982c).

Distribution The map provided by Foster (1983b) should be used in conjunction with the vice-county map of Balfour-Browne (1950, map 13). Records since 1980 are for West Suffolk, West Norfolk, Cambs, Hunts, Northamptonshire, South Lincs, South-east and Mid-west Yorks. The species is not known from Scotland and Wales. *A. undulatus* is a northern and central European species, ranging to France and Kyrgyzstan.

Habitat and ecology *A. undulatus* lives in lowland fens, in ponds and ditches with rich vegetation. It breeds in the summer, overwintering as adults. Mating has been observed in late March and April in northern Germany (Blunck 1913). Oviposition has been recorded in the axils of the leaves of Canadian pondweed (*Elodea canadensis* Michx). The larvae, which are of the free swimming type, have been frequently reported from April to June. Bertrand (1928) described emergence from the pupa in France in May and June. Gut contents analysed by Deding (1988) were dominated by chironomid larvae but also included copepods and plant remains. This species is considered to be flightless on the basis of observations by Jackson (1956a).

Status *A. undulatus* has been recorded from 14 hectads in England from 1980 onwards. It appears to have become extinct in southern England and in the Midlands, being now confined to the fens draining into the Wash and on the Breckland. It may have become extinct recently in the Severn valley where it was once known from the Coombe Hill SSSI, an area of flood pasture that appears to have dried out (J. H. Bratton, pers. comm.). In Yorkshire it could now be restricted to a small area near York. This distinctive species has only been noted once in a fossil deposit, from the Late Devensian and the Flandrian in Shropshire (Osborne 1972).

Threats Despite clear evidence of contraction in range, *A. undulatus* appears to be able to withstand disturbance and some pollution. For example, it occurs in regularly cleaned ditches in the Wash fens. Site development appears to have been the main cause of habitat loss in the past.

Management and conservation This distinctive species is a suitable candidate for regular field monitoring by non-coleopterists; it is also a potential "flagship" species. Its apparent decline should be monitored systematically. Many of the sites in which it occurs receive protection, e.g. Askham Bog, a reserve of the Yorkshire Wildlife Trust, Naburn Marsh SSSI, Wicken Fen, a reserve of the National Trust, Holme Fen NNR and Woodwalton NNR, the Cross Drain SSSI in Lincolnshire, Thurlby Fen Slipe, a reserve of the Lincolnshire Wildlife Trust, the palsa scar ("pingo") fen reserves of the Norfolk Wildlife Trust and ponds on the Stanford Training Area of the Ministry of Defence in Norfolk. Other sites might also receive protection by sympathetic management, e.g. ditches in the ADAS Arthur Rickwood farm. Balfour-Browne (1906) noted an apparently unsuccessful attempt to establish a Broadland population with 50-60 teneral specimens from Askham Bog being transferred to the "Hickling clayholes".

Published sources Atty (1983), Balfour-Browne (1950), Bertrand (1928), Bilton (1987), Blunck (1913), Deding (1988), Fitter & Smith (1979), Foster, A.P. *et al*. (1986), Foster, G.N. (1977c, 1980b, 1983b, 1983c, 1993), Foster, G.N. *et al*. (1989), Friday (1988a, 1997), Hoare (1998), Jackson (1956a), Key (1994), Nilsson (1982a, 1982c), Osborne (1972), Painter (1994), Palmer (1977, 1981a), Perry (1998), Shirt (1987), Sinclair (1982).

AUGYLES HISPIDULUS Near Threatened

Order COLEOPTERA Family HETEROCERIDAE

Augyles hispidulus (Kiesenwetter). The genus *Augyles* was created by Pacheco (1964) as distinct from *Heterocerus* but not recognized until recently.

Identification The most recent key is by Clarke (1973).

Distribution Records since 1980 are for East Sussex, East Kent, East Suffolk and West Norfolk. *H. hispidulus* was originally found at Rye Harbour in 1969. *A. hispidulus* is a western Palaearctic species, widespread across southern and central Europe and extending to Iraq, Israel, Turkey, Turkmenistan and Uzbekistan.

Habitat and ecology The original site was described by a small water-filled sand pit at the edge of which the beetles were found burrowing in association with a band of detritus buried below the surface. Further sites have been very similar. Adults have been recorded from March to June and from August to October.

Status *A. hispidulus* is known from five hectads since its discovery. This species was classified as Rare in the previous review (Hyman & Parsons 1992) but the manmade origin of its typical habitat makes it necessary to reduce its status, whilst still reflecting the temporary and fragile nature of the habitat.

Threats Landfill of gravel and sand, and vegetation succession, must pose the main threats.

Management and conservation This species is mainly associated with manmade sites such as sand and gravel pits, and thus might benefit from the activities of extractive industries so long as the resulting pits are kept free of vegetation. This species occurs in the shingle pits at Dungeness including the RSPB Reserve.

Published sources Allen (1970), Boukal *et al*. (2007), Clarke (1973), Collier (1987, 1988), Hodge (1990), Hyman & Parsons (1992), Löbl & Šmetana (2006), Lohez (2007), Pacheco (1964).

AUGYLES MARITIMUS Near Threatened

Order COLEOPTERA Family HETEROCERIDAE

Augyles maritimus (Guérin-Méneville). The genus *Augyles* was created by Pacheco (1964) but not recognized until recently.

Identification The most recent key is by Clarke (1973).

Distribution Records since 1980 are for North Devon, East and West Sussex, East Kent, West

Norfolk, Caernarfon, Leics, South-east Yorks, Cumberland, and East Lothian. Earlier records add South Northumberland and Dumfries. This is a western European and Mediterranean species, known from Ireland, France, Germany, Italy, Greece, Italy, Romania, Spain, Malta, Morocco, Algeria, Tunisia, and Turkey.

Habitat and ecology This species lives at the water's edge in tidal reaches of dykes and rivers, also in saltmarshes, usually found burrowing under a mat of algae on sand.

Status *A. maritimus* is known from eleven hectads since 1980. This species was not accorded any status in the previous review (Hyman & Parsons 1992).

Threats The tidal margins of estuaries are particularly prone to pollution. The ectoparasitic ascomycete fungus *Botryandromyces heteroceri* (Maire) is associated with Heteroceridae (Castaldo *et al.* 2004).

Management and conservation Sites occupied that receive protection include the John Muir Country Park and parts of the Solway Merse subject to various designations.

Published sources Castaldo *et al.* (2004); Clarke (1973), Hyman & Parsons (1992), Löbl & Šmetana (2006), Pacheco (1964).

AULACOCHTHEBIUS EXARATUS Near Threatened

Order COLEOPTERA Family HYDRAENIDAE

Aulacochthebius exaratus (Mulsant, 1844). *Aulacochthebius* was instated as a genus distinct from *Ochthebius* by Hansen (1998) in his world review, and this has been accepted in the latest Palaearctic catalogue (Löbl & Šmetana 2004).

Identification The minute but distinctive adult is illustrated and keyed by Balfour-Browne (1958) and by Friday (1988a). Other stages in the life-cycle are undescribed.

Distribution Records since 1980 are for East Sussex, East and West Kent, and South Essex. Earlier records add the Isle of Wight, South Hants, West Sussex, and East Suffolk. The map provided by Foster (1990d) should be used in conjunction with the vice-county map of Balfour-Browne (1958, map 48). *A. exaratus* is a southern European species, ranging from southern England and the Netherlands to the Mediterranean as far as Italy, Greece, and North Africa.

Habitat and ecology *A. exaratus* is probably confined to lowland coastal situations in south-east England because of its need for warmth. Typically it occurs on wet clay, often in coastal freshwater ponds but also in cliff landslip seepage and in brackish water. Its life-cycle is unknown.

Status *A. exaratus* has been recorded from eleven hectads in England from 1980 onwards in fourteen locations, with 28 recorded hectads in all, ranging from South Hants to East Suffolk, but not being recently detected in either of these vice-counties.

Threats This species can occupy newly created ponds and cleared ditches, and it tolerates a wide range of stagnant and slow water conditions on coastal levels. However, it is under threat because of the loss of coastal fen habitats associated with urban encroachment and associated activities such as landfill, and abandonment of coastal defences.

Management and conservation *A. exaratus* occurs in many coastal levels receiving statutory protection, the majority of recent records coming from the Lewes Brooks SSSI.

Published sources Balfour-Browne (1958), Cadbury, Shardlow & Gurney (2002), Carr (1985a, 1985b, 1985c, 1987), Carr & Philp (1988), Foster, G.N. (1972, 1990d), Friday (1988a), Hansen (1998), Hodge (1979a), Leeming & England (2005), Ratcliffe (1977).

BEROSUS FULVUS VULNERABLE

Order COLEOPTERA Family HYDROPHILIDAE

Berosus fulvus (Kuwert, 1888). This species was known as *spinosus* (Steven) until Schödl (1991) promoted Kuwert's variety to species status.

Identification Balfour-Browne (1958) and Friday (1988a) key this species as *B. spinosus* in the British fauna. The larva described as *B.*

spinosus by Bøving and Henriksen (1938) probably belonged to *B. fulvus*.

Distribution The map provided by Foster (1987a) as of *spinosus* should be used in conjunction with that of Balfour-Browne (1958, map 23). Schödl (1991) saw material from East Sussex and West Kent, and a further review of museum material (Foster 1991) confirmed that old records of *B. spinosus* from South Hants, West Sussex, East Kent and South Essex referred to *B. fulvus*. It has not been recorded from Wales and the records for North-east Yorks and Dumfries require confirmation. This Palaearctic species is known with certainty from the Netherlands, France, Spain, Germany, Austria, Hungary, Turkey, Russia, Turkmenistan, Kazakhstan, Iran, and Mongolia. In the north-west it is confined to southern Sweden, around Öland and Gottland, with Estonia providing its northernmost station.

Habitat and ecology This species is confined to brackish water, in still, shallow water, often with very sparse vegetation, both near to the sea and, in central Europe, inland. The egg-case of "*B. spinosus*" described by Bøving & Henriksen (1938) contained only two eggs and was lens-shaped, 1-1.5 mm broad, with an appendage three to four times the length of the cocoon proper. The larvae of *Berosus* spp. are unusual among Hydrophilidae in that they are apneustic, obtaining oxygen from water by the use of pseudobranchiae; in consequence they can live in mud at the bottoms of ponds. Based on observations on "*B. spinosus"* and *B. luridus*, Bøving and Henriksen (1938) described pupation in *Berosus* spp. as taking place in a 3-4 mm long burrow in mud at the water's edge. *B. fulvus* flies readily. It has been noted at a mercury vapour light (Allen 1977, Queney 2009), indicating nocturnal or subcrepuscular flight.

Status *B. fulvus* has been recorded from eight English hectads from 1980 onwards. The IUCN criteria for Vulnerable status that are satisfied are B1ab and B2ab, i.e. restricted in both extent of occurrence and area of occupancy, with evidence of sites losses as suggested by the lack of modern records from the Wash and central southern England. Losses at a single site (see below) impact on this species and contribute to its decline.

Threats A site at Newhaven was destroyed when the site was used for landfill. Similar developments may affect other coastal sites, but this mobile species should be capable of colonising suitable temporary brackish habitats throughout its range, so abandonment of coastal defences might prove beneficial rather than deleterious.

Management and conservation *B. fulvus* will benefit from creation of pools with tidal influence on coastal reserves in the Home Counties. The possibility that the true *B. spinosus* exists, or has existed, in Britain should be borne in mind when undertaking field surveys or examining museum collections.

Published sources Allen (1977), Balfour-Browne (1958), Boukal *et al.* (2007), Bøving & Henriksen (1938), Carr & Philp (1988), Cuppen & van Maanen (1998), Foster, G.N. (1972, 1987a, 1991), Friday (1988a), Hansen (1987), van Nieuwenhuijzen (2005), Phillips (1982), Philp (1989), Queney (2009), Schödl (1991).

BEROSUS LURIDUS Near Threatened

Order COLEOPTERA Family HYDROPHILIDAE

Berosus luridus (Linnaeus, 1761).

Identification Balfour-Browne (1958) and Friday (1988a) key this species in the British fauna. Schödl (1993) has reviewed this species among other Palaearctic members of the subgenus *Berosus* s. s.

Distribution The most recent map (Foster 1987a) should be used in conjunction with that provided by Balfour-Browne (1958, map 25). Records since 1980 are for South Somerset, North Wilts, East Sussex, East and West Kent, South and North Hants, Surrey, West Norfolk, West Suffolk, Cambs, Beds, Hunts, Northamptonshire, South Lincs, Leics, South-east and South-west Yorks. Earlier records add South and North Devon, the latter only from Lundy Island, North Somerset Dorset, the Isle of Wight, South and North Essex, Herts, East Suffolk, East Norfolk, West Gloucester, Warks, Staffs, North Lincs, Notts, Cheshire, Mid-west Yorks, Dumfries, and Moray. The only Welsh record, from Swansea, Glamorgan, is unconfirmed, from an early list (Dillwyn 1829).

The distribution is, or was, highly disjunct, with an isolated Scottish population in Speyside and around the Moray Firth. *B. luridus* is known from Norway, Sweden, Finland, Denmark, the Netherlands, Belgium, Germany, France to the Pyrenees, Italy, Switzerland, Austria, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Serbia, Bosnia, Albania, Romania, Estonia, Latvia, Lithuania, Belarus, Ukraine, Russia, the Caucasus, and Turkey.

Habitat and ecology *B. luridus* lives in lowland ponds and slow drains with a peaty substratum. It is not, however, confined to acid water as, for example, it occurs in marl and clay lakes in the Republic of Ireland. In an analysis of over 60 sites for which physicochemical variables were available in the Netherlands, Cuppen and van Maanen (1998) noted a wide range of acidity but a low median value of pH at 4.4. Meyer & Dettner (1981) noted that adult numbers of this species peaked in May and July in a study on a German heath. The egg-case is oblong-triangular, has no ribbon appendage, and contains only one egg (Bøving & Henriksen 1938). Based on observations on "*B. spinosus* and *B. luridus*, Bøving and Henriksen (1938) described pupation in *Berosus* spp. as taking place in a 3-4 mm long burrow in mud at the water's edge. The larvae of *Berosus* spp. are unusual among Hydrophilidae in that they are apneustic, obtaining oxygen from water by the use of pseudobranchiae; in consequence they can live in mud at the bottoms of ponds.

Status *B. luridus* has been recorded from 30 hectads in England from 1980 onwards. There is considerable evidence of loss of range, in Scotland as a whole, in northern England except for one record near Doncaster (Merritt 2006), in Dorset, Broadland, and much of the Home Counties, and only an unconfirmed early record in Wales. A few of the earlier records may have been based on misidentification of *B. affinis*.

Threats Drainage of fenland and loss of heathland are the two main causes of habitat loss.

Management and conservation Maintenance of the open nature of heathland ponds would be the most practicable measure for the conservation of this species. This species has appeared in ponds following the destruction of surrounding vegetation by fire on heathland. *B. luridus* is found in a range of sites receiving protection, e.g. SSSI at Loch Vaa in Speyside, the Cross Drain in Lincolnshire, NNR such as Thorne Moors, Wicken Fen and wildlife reserves such as the palsa scar ("pingo") fen Thompson Common, owned by the Norfolk Wildlife Trust.

Published sources Angus (1964b, 1968b), Balfour-Browne (1958), Boukal *et al.* (2007), Bøving & Henriksen (1938), Carr & Philp (1988), Charman, Palmer & Philp (1985), Cuppen & van Maanen (1998), Denton (2005, 2007a), Dillwyn (1829), Duff (1993), Foster, A.P. (1983, 1984b), Foster, G.N. (1972, 1980a, 1980b, 1987a, 1993), Foster, Nelson & O Connor (2009), Friday (1988a), Gerend (2003), Hammond & Merritt (2008), Hansen (1987, 1996), Hess & Heckes (1996), Key (1994), Lane, Wright & Forsythe (2002), Lohez (2007), Lott (1995), Merritt (2006), Meyer & Dettner (1981), Palmer (1977, 1981b), Prokin *et al*. (2008), Queney (2004a), Schödl (1993), Sinclair (1976b, 1982), Skidmore, Limbert & Eversham (1985).

BIDESSUS MINUTISSIMUS ULNERABLE

A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Bidessus minutissimus (Germar, 1824).

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). The *B. minutissimus* species group has been revised by Fery (1991); there is a remote possibility that *B. coxalis* Sharp, a species of south-west Europe, occurs or could have occurred in Britain, being overlooked as *B. minutissimus*. The larva is not described.

Distribution The most recent map is provided by Lott (2006). There are records since 1980 for Herefordshire, Radnor, Caerfyrddyn, Ceredigion, Montgomery, Meirionydd, and Dumfries. There are earlier records for South Devon, Wigtown, and Kirkcudbright. *B. minutissimus* is predominantly an "Atlantic" species, ranging from southern Scotland and south-west Ireland to the Canaries, Algeria, Tunisia and Morocco, but also found in central Europe in Switzerland and Austria, and thence to Italy, Corsica, Sardinia and the Balearics.

Habitat and ecology The habitat is generally regarded as being clean, fine silt at the edges of

rivers near to their estuaries, often among the roots of plants such as reed-grass (*Phalaris arundinacea* L). The abundance of the bug *Micronecta poweri* (Douglas & Scott), which is similar in size, in such places may cause this species to be overlooked. However, in Wales the densest populations are associated with insolated remnant pools on coarse sand and shingle. They can occur in pools with extensive growths of filamentous algae, but populations are much sparser in pools clogged with silt. Some older records are for coastal lakes, and, in one case at least, the species has been found in a river subject to lead pollution in muddy beds of vegetation cut off from the main flow of the river. Lott (2006) linked the prevalence of *B. minutissimus* to river dynamics, with changes in direction resulting in new deposits of clean, exposed shingle that provide the right sort of marginal waters when the water level drops. The species is not found in brackish water though the species has been found in estuarine areas without tidal influence. The most recent record, from Herefordshire, is from a quarry pond, as was the last record in Ireland. *B. minutissimus* is capable of flight in the south of its range in Spain, but Kehl & Dettner (2007) observed that it had reduced flight musculature in Germany.

Status *B. minutissimus* has been recorded from nine hectads in Wales and Scotland from 1980 onwards and in 2009 from one site in England. The previous confirmed records for England were from South Devon up to about 1908, and the species was known at only one of five former stations in Scotland until 1991, shortly after which the stretch of river bank was destroyed by construction of gabions. Some larger Welsh rivers provide its stronghold in the United Kingdom and those sites recorded, together with the recently discovered Herefordshire site, comprise an Extent of Occurrence of 3,500 km² across nine sites: on the basis of continuing decline (i.e. greater losses in Scotland offset the single new find in England), the IUCN criteria satisfied for Vulnerable are B1ab i-iv and B2ab i-iv. This species is regarded as extinct in Ireland, the Isle of Man and the Czech Republic.

Threats This species survived considerable disturbance associated with construction of the Dumfries bypass across its last known site in Scotland, but did not survive bank-strengthening works. *B. minutissimus* has also tolerated long-term lead pollution of some of its Welsh sites. It has, however, been lost from the River Ken, which is subject to fluctuations in level associated with a hydroelectric scheme and from the Water of Luce following the creation of a sewage treatment system.

Management and conservation A Biodiversity Action Plan has been published for this species. Most of the running water in Wales receives protection through lying within designated sites, e.g. the River Wye/Afon Gwy SAC, Rheidol Shingles and Backwaters SSSI, Afon Rheidol ger Capel Bangor SSSI, and, for the Dyfi site, the edge of the Snowdonia National Park. Programmes for rehabilitation of rivers should take into account the occurrence of this species, but the precise requirement often quoted, *viz*. amongst grass roots in clean, fine silt, should not be regarded as absolute but rather as desirable: retention or reinstatement of the nature river dynamics should be the main aim. Wholesale fish introductions should be avoided, but a well structured river system with isolated pools providing refuges should provide some protection from angling excesses. A survey of rivers and quarries in Herefordshire is desirable.

Published sources Anonymous (2005a), Balfour-Browne (1940), Bameul (1984), Bilton & Foster (1986), Boukal *et al.* (2007), Boyce (1990), Boyce & Fowles (1988), Department of the Environment (1995b), Fery (1991), Foster, G.N. (1977b, 1981b, 1988b, 1994a, 2002, 2005a, 2008a), Foster & Carr (2004), Foster & Eyre (1992), Foster, Nelson & O Connor (2009), Fowles (1987), Friday (1988a), Hájek & Šťastný (2005), Kehl & Dettner (2007), Laurie & Erichsen Jones (1938), Lohez (2007), Lott (2005, 2006), Ribera *et al.* (1996), Sadler *et al*. (2004), UK Biodiversity Group (2000b), Wallace (1979), Watson (2009).

BIDESSUS UNISTRIATUS CRITICALLY ENDANGERED

A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Bidessus unistriatus (Goeze, 1777).

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). The larva is not described. The authority for this species has been identified as Goeze, not Schrank.

Distribution The most recent map is provided by Foster & Carr (2008). A record for East Sussex (Ratcliffe 1977) requires confirmation, as it appears that voucher material was not retained. There are recent published records for South Hants, East and West Norfolk. This is a widespread species in Europe, being rare in the northern and southern extremes, possibly found in Mongolia and China, and recently recorded from Turkey and Siberia.

Habitat and ecology *B. unistriatus* is confined to lowland, stagnant water bodies, mainly marl pits, and slow drains. Fluctuating meres on the Brecks have also been occupied in the past but not any of the palsa scar ("pingo") pool complexes. A typical habitat appears to be peaty mud in shallow water with fine grasses and moss. Although such sites may have high conductivity, *B. unistriatus* has not been found in brackish water despite its proximity in Hickling Broad. The New Forest site is a marl pond rich in vegetation, but with plenty of exposed soft mud. The monthly incidence of adults, with peaks in April and August, indicates breeding in midsummer. There is evidence of flight ability in south-west France (Bameul 1990).

Status *B. unistriatus* has been recorded from five hectads in England from 1980 onwards but, as a result of more recent survey, it is known to be confined to three sites within three hectads, with an Area of Occupancy which is substantially less than 10 km² and severely fragmented, and with evidence of continuing decline. An attempt to translocate the species within a complex of ponds in the New Forest was abandoned in 2008 when the donor population, from the only site in which more than a few individuals has been found since the 1980s, was found to be too weak to supply material. Only six individuals have been found in surveys of Norfolk Broads from 1977 to 2008. This is a Critically Endangered water beetle for which it is possible to invoke IUCN B2 criteria based not only on site data (ab(ii, iv)) but also on numbers of individuals and fluctuations (c (ii-iv)). A parsimonious reassessment of 199 records indicated that this species had only ever been recorded alive from 18 hectads. This species appears to have died out at former sites at Studland, Camber, south Cambridgeshire, and, more recently, the Breckland meres. Post-glacial sub-fossil records for this species are widespread within England, but those for the Somerset Levels have recently been referred to *B. grossepunctatus* Vorbringer, a species extinct in Britain.

Threats The former decline in this species is possibly explained in general terms by agricultural pollution, but the site in East Sussex was lost as a result of development of a caravan park. Other former sites, often former clay pits, have become overgrown or converted into angling lakes. The major, present day threat is saline incursion into the Hickling Broad area, potentially reducing the British population down to a minute subpopulation in Catfield Fen and a dwindling one in the New Forest.

Management and conservation A Biodiversity Action Plan has been prepared for this species. Catfield Fen and Hickling Broad are NNR, and the Ministry of Defence training area at Stanford, Norfolk, within which *B. unistriatus* occurred until recently, is managed for wildlife, and is part of the Brecklands Special Area of Conservation. The New Forest site lies within an area subject to range of statutory protection measures. Livestock watering is useful in keeping vegetation low and providing hoofmark pools considered suitable for breeding by this very small species.

Published sources Anonymous (1986a, 2005b), Balfour-Browne (1940), Bameul (1990), Denton (2006), Department of the Environment (1995), Erman *et al*. (2005), Foster, G.N. (1972, 1977c, 1981b, 1982b, 1985a, 2000a, 2000b, 2001b, 2001c, 2002, 2007a, 2009a), Foster & Carr (2004, 2008), Friday (1988a), Girling (1976, 1977, 1979b, 1980, 1982a), Hájek & Šťastný (2005), Hyman (1986), Nilsson (2001), Nilsson & Holmen (1995), Petrov (2002), Ratcliffe (1977), Shirt (1987), UK Biodiversity Group (1999).

CYBISTER LATERALIMARGINALIS DATA DEFICIENT

A great diving beetle

Order COLEOPTERA Family DYTISCIDAE

Cybister lateralimarginalis (De Geer). When found in Britain in the 19th Century, this species was known as *Dytiscus roeseli* Fuessly.

Identification The means for identifying this distinctive species were provided by Balfour-

Browne (1950). *Cybister* larvae are equally characteristic and are illustrated in most European studies (e.g. Franciscolo 1979).

Distribution Balfour-Browne (1950) traced the history of this species in Britain. It appears to have been intercepted as about three female adults, all in South Essex, between 1826 and 1836. A single adult female was found dead on a track in a nature reserve in Lancashire by Jim Thomas in 2005. The northernmost records are from Denmark, Sweden, Latvia, Lithuania, and Estonia, but *C. lateralimarginalis* is mainly known as a circum-Mediterranean species, ranging east to Kashmir and China.

Habitat and ecology *C. lateralimarginalis* is usually found amongst vegetation in the edges of lakes and base-rich ponds. However Nilsson & Holmen (1995) note that it often occurs in acid bog lakes and peat ponds with a quagmire of *Sphagnum* in Scandinavia. Ryndevich & Lundyshev (2005) found many larvae and pupae of C. *lateralimarginalis* in nests of mute swans (*Cygnus olor* (Gmelin)). *C. lateralimarginalis* flies readily.

Status A record based on a single individual is not enough to assign it to any category with confidence, so unfortunately this distinctive species must be placed in the data deficient category alongside obscurely known invertebrates in poorly studied groups. Wright (2009) has expressed some concern about the validity of the record. *C. lateralimarginalis* has been detected in a 7,000-year old deposit in Sweden (Lemdahl & Nilsson 1982), coinciding with the warmest postglacial period in northern Europe and Coope (2006) has reported a Palaeolithic deposit with this species in Suffolk. The flurry of records in the period 1826-1836 coincided not only with growing interest in recording Coleoptera but also with the draining of the East Anglian meres, a process completed in 1853 with the loss of Whittlesey Mere (Godwin 1978). These meres would have provided ideal conditions for this species during the warm post-glacial period. There is some evidence of expansion of range in the west, particularly in the Netherlands but *C. lateralimarginalis* is down to one site in Bohemia.

Threats No threats can be identified. This species has been noted in the diet of grey heron (*Ardea cinerea* L.) by Jakubas & Mioduszewska (2005), and greenshank (*Tringa nebularia* (L.)) (Anonymous 2009b).

Management and conservation Clearly this species should be actively sought for across much of England following the find in 2005. Proof of successful breeding should be obtained before reacting to the occurrence of an isolated individual. It is likely to be associated with still water habitats of man-made origin rather than with relict sites if it becomes established. At the time of writing (April 2009), it might be regarded as a valued novelty and as an indicator or global warming rather than as a species accorded high conservation status. With the re-establishment of large meres near to Whittlesey (Bowley 2007) must surely come the prospect of re-establishing the ancient fauna of which this species would have been a part.

Published sources Balfour-Browne (1950), Boukal *et al.* (2007), Bowley (2007), Coope (2006), Franciscolo (1979), Godwin (1978), Hájek & Šťastný (2005), Hodge & Jones (1995), Jakubas & Mioduszewska (2005), Lemdahl & Nilsson (1982), Lohez (2007), Nilsson & Holmen (1995), Roosileht & Selin (2004), Ryndevich & Lundyshev (2005), Silfverberg (2006), Sutton (2008), Thomas (2009); Wright (2009).

DRYOPS ANGLICANUS Near Threatened

Order COLEOPTERA Family DRYOPIDAE

Dryops anglicanus (Edwards, 1909).

Identification There is no effective treatment of *Dryops* in the British literature. There is, however, an account of all the British species in English by Olmi (1972), as well as accounts in Dutch by Drost (1992b), Italian by Olmi (1976), and German by Steffan (1961) and Jäch (1992). The language is immaterial as most *Dryops* species can only be identified with certainty by examining the genitalia, which are illustrated in all of the works indicated.

Distribution Records since 1980 are for West Suffolk, East and West Norfolk, Cambs, and Berwick. Earlier records do not add any vice-counties. A distribution map is provided by Foster (1995b). *D. anglicanus* is a northern and

central European species extending to the Adriatic and the central Russian steppe.

Habitat and ecology Adults occur throughout the year and larvae have been found in winter. This species is confined to wet vegetation at the edge of relict, lowland fen and fen carr, often in association with tussocks. Its larvae have been found under bark of wet, rotting tree debris.

Status *D. anglicanus* has been recorded from fifteen hectads in Scotland and England from 1980 onwards, with little evidence of contraction of range since 1980. The sites are exclusively relict and natural in origin, e.g. the palsa scar ("pingo") and Broadland fens of East and West Norfolk; Redgrave and Lopham Fens on the Suffolk/Norfolk border; Wicken Fen, Cambridgeshire; and Lurgie Loch Moss, a fen in Berwickshire overgrown by Scots Pine (*Pinus sylvestris* L.). The IUCN criteria for Vulnerable status that are satisfied are an Extent of Occurrence of less than 20,000 km² and an Area of Occupancy of substantially less than 2,000 km² in 20 localities. However it cannot be claimed that this species is in decline, though half of the known sites are in parts of the Broads threatened by rising sea levels and abandonment: on this basis the species is listed as Near Threatened.

Threats Drainage and pollution of natural fenland sites must result in localised extinction of this species. Redgrave and Lopham Fens are identified (Bennett 1996) as being at high risk of damage from excessive abstraction of water for public supply.

Management and conservation The association with rotting wood indicates a need to maintain fen carr habitats but maintenance of a tussocky fen may be just as important.

Published sources Bennett (1996), Boukal *et al*. (2007), Buczyński & Przewoźny (2008), Collier & Foster (1986), Drane & Warrington (2009), Drost (1992b), Foster, A.P. *et al*. (1986), Foster, G.N. (1983c, 1984d, 1993, 1995b), Foster & Sinclair (1982), Friday (1997), Jäch (1992), Jäch & Prokin (2005), Löbl & Šmetana (2006), Lohez (2007), Olmi (1972, 1976), Painter (1994), Steffan (1961).

DRYOPS AURICULATUS Near Threatened

Order COLEOPTERA Family DRYOPIDAE

Dryops auriculatus (Fourcroy, 1785).

Identification There is no effective treatment of *Dryops* in the British literature. There is, however, an account of all the British species in English by Olmi (1972), as well as accounts in Dutch by Drost (1992b), Italian by Olmi (1976), and German by Steffan (1961) and Jäch (1992). The language is immaterial as most *Dryops* species can only be identified with certainty by examining the genitalia, which are illustrated in all of the works indicated.

Distribution Records since 1980 are for North Somerset, South Hants, South Wilts, East Sussex, West Kent, East and West Norfolk, Cambs, Monmouth, Hereford, South-east and North-east Yorks. Earlier records add West Cornwall, Herts, Middlesex, Oxon, Mid-west Yorks, and Cumberland, but many early records are considered to be erroneous, especially where there is no reference to the very common *D. luridus*. A distribution map is provided by Foster (1995b). *D. auriculatus* is a northern and central European species, extending to the French Pyrenees, Spain (with some uncertainty – Montes & Soler (1986)) the Caucasus, Kyrgyzstan, and eastern Siberia.

Habitat and ecology This species inhabits shallowly flooded vegetation in low-lying fenland, including drains on grazing fen as well as palsa scar ("pingo") fens, and also heathland pools.

Status *D. auriculatus* has been recorded from 20 hectads in England and Wales from 1980 onwards. This species is more restricted in range than *D. similaris* and appears to be largely confined to natural habitats.

Threats Loss of fenland and heathland habitats must lead to localised extinction of this species. *D. auriculatus* is a host for several fungi in the Laboulbeniales.

Management and conservation No special measures can be identified. Many of the sites where it occurs are protected as reserves, e.g. Moccas Park NNR, or as SSSI. Skipwith Common is Special Area of Conservation.

Published sources Boukal *et al*. (2007), Carr (1997), Denton (2005, 2007a), Drake (1988), Drane & Warrington (2009), Drost (1992b), Duff (1993), Foster, G.N. (1993, 1995b), Hammond & Merritt (2008), Jäch (1992), Kirby (1998), Kodada & Jäch (2005), Löbl & Šmetana (2006), Lohez (2007), Montes & Soler (1986), Olmi (1972, 1976), Painter (1994), Steffan (1961), Watson & Foster (2006).

DRYOPS GRISEUS VULNERABLE

Order COLEOPTERA Family DRYOPIDAE

Dryops griseus (Erichson, 1847). This is not the same as *griseus* sensu auctt. Brit., which is largely referable to *D. similaris* Bollow.

Identification There is no effective treatment of *Dryops* in the British literature. There is however an account of all the British species in English by Olmi (1972), as well as accounts in Dutch by Drost (1992b), Italian by Olmi (1976), and German by Steffan (1961) and Jäch (1992). The language is immaterial as most *Dryops* species can only be identified with certainty by examining the genitalia, which are illustrated in all of the works indicated. The figure number of the aedeagophore by Steffan (1979, p. 271) was transposed for that of *similaris.*

Distribution Records since 1980 are for West Norfolk, Cambs, and South-east Yorks. Earlier records add East Sussex, West Suffolk and Mid-west Yorks. A distribution map is provided by Foster (1995b). *D. griseus* is a northern European species, extending to the central Russian steppe, stopping short of the Mediterranean high in the Alps in France.

Habitat and ecology *D. griseus* is confined to relict, lowland, temporary fen pools, such as those of the palsa scar ("pingo") fens and the fluctuating meres of the Breckland. It is usually found at the extreme edge of such pools amongst moss. A recent locality in Luxembourg was a slow flowing, muddy ditch with *Phalaris arundinacea* L. and *Glyceria maxima* (Hartm.) Holmberg, and a conductivity exceeding 1 mS/cm. *D. griseus* has been recorded (Weir 1996) as the host of the ascomycete fungi *Cantharomyces denigratus* Thaxter and *C. italicu* Spegazzini, but the identification of such a rare host species requires confirmation.

Status *D. griseus* has been recorded from eight hectads from 1980 onwards, and is the rarest of the *Dryops* known to occur in Britain. Drane & Warrington (2009) note that it has not been recorded on Wicken Fen since 1994, despite considerable recording activity there. Although listed by Shirt (1987) as rare, this species was formally added to the British list by Johnson (1992). The IUCN criteria for Vulnerable status that are satisfied are B1 ab(i, ii) B2 ab (i, ii) based on a Extent of Occurrence of about 4,000 km², with the distribution being severely fragmented across eleven fenland areas collectively less than 2,000 km² in Area of Occupancy: the evidence of decline is that populations in two of the areas have not been reported since the 1980s, one of these being affected by water abstraction.

Threats Loss of fenland habitats, in particular by extraction of groundwater from the Breckland, threatens the continued survival of this species in Britain. *D. griseus* is a host for several fungi in the Laboulbeniales.

Management and conservation Maintenance of fluctuating water tables in natural fenland is considered essential for survival of the wetland margin habitat of this species.

Published sources Boukal *et al*. (2007), Drane & Warrington (2009), Drost (1992b), Foster, G.N. (1983c, 1993, 1995b), Gerend & Callot (2001), Hammond (2004), Hammond & Merritt (2008), Hodge & Jones (1995), Jäch (1992), Jäch & Prokin (2005), Johnson (1992), Kodada & Jäch (2005), Löbl & Šmetana (2006), Olmi (1972, 1976), Painter (1994, 1999), Shirt (1987), Steffan (1961, 1979), Weir (1996).

DRYOPS NITIDULUS Near Threatened

Order COLEOPTERA Family DRYOPIDAE

Dryops nitidulus (Heer, 1841).

Identification There is no effective treatment of *Dryops* in the British literature. There is, however, an account of all the British species in English by Olmi (1972), as well as accounts in Dutch by Drost (1992b), Italian by Olmi (1976), and German by Steffan (1961) and Jäch (1992). The language is immaterial as most *Dryops* species can only be identified with certainty by

examining the genitalia, which are illustrated in all of the works indicated.

Distribution Records since 1980 are for South and North Devon, South Wilts, West Norfolk, Glamorgan, Pembroke, Ceredigion, Anglesey, Mid-west Yorks, South and North Northumberland, the latter on Holy Island, and Roxburgh. Older records add South Hants, Cambs, South and West Lancs, and Westmorland. A distribution map is provided by Foster (1995b). *D. nitidulus* is a central European species, reaching Norway, Sweden and the Baltic States in the north, south to eastern Spain, the Balkans and Turkey.

Habitat and ecology Many records are for duneslacks, where the species has often been located only by pitfall trapping (e.g. Foster 1989a), or as a result of activity away from water (e.g. Halstead 1990). Other records are for rivers and streams, often in mountainous areas. In the Northhouse Burn, Roxburghshire, adults can be flushed from the roots of grasses growing on silt banks in areas of intense abrasion, and this association with coarse soil may explain the species' presence in such different areas. This same explanation may apply to the species' occurrence in landslip pools (Armitage 1982). It is more difficult to explain the former presence of this species at Wicken Fen NNR, Cambridgeshire. Queney (2009) describes an encounter on a railway train indicating recent flight.

Status *D. nitidulus* has been recorded from twelve hectads from 1980 onwards. The vulnerable status is justified on the basis of the fragility of the habitats occupied, and on apparent decline over much of its range. Drane & Warrington (2009) note that it has not been recorded on Wicken Fen since 1928, despite considerable recording activity there. With twelve modern locations spread over much of lowland Britain the criteria for the IUCN status of Vulnerable are not quite satisfied: the Near Threatened category is appropriate.

Threats Stream regulation and abstraction destroy the habitat of this species, as does lowering of water tables in dune slack systems. Construction of golf links and other coastal developments are therefore considered deleterious.

Management and conservation Maintenance of water tables in duneslacks appears to be required.

Published sources Armitage (1982), Booth (2002), Boukal et al. (2007), Darby (2009), Drane & Warrington (2009), Drost (1992b), Eyre, Luff & Lott (2000), Foster, G.N. (1989a, 1995b), Fowles (1990), Halstead (1990), Hammond & Merritt (2008), Harrison (1994), Jäch (1992), Löbl & Šmetana (2006), Lott (1990), Olmi (1972, 1976), Pope (1969), Queney (2009), Steffan (1961).

DYTISCUS DIMIDIATUS Near Threatened
A great diving beetle

Order COLEOPTERA Family DYTISCIDAE

Dytiscus dimidiatus (Bergsträsser, 1778).

Identification The adult is keyed by Balfour-Browne (1950) and Friday (1988a). A key to adult British *Dytiscus* is also provided by Sutton (2008). The larva is illustrated and keyed by Nilsson (1982a). Sutton and Wilkins (2005) include this species in a review of larger water beetles.

Distribution The most recent map is provided by Sutton (2008). Records since 1980 are for South Devon, South and North Somerset, East Sussex, East Kent, East and West Norfolk, Cambs, Hunts, Monmouth and South Lincs. There are older records for East Cornwall, Surrey, South Essex, Salop, Glamorgan, South-west and Mid-west Yorks, and Durham. This is a West Palaearctic species, ranging to North Africa and the Caucasus.

Habitat and ecology *D. dimidiatus* occurs in rich fen vegetation in lowland drains and ponds. Beebee (2002) noted its preference for rhynes (Somerset Levels ditches) that were at least partly shaded. Rondelaud (1979) demonstrated that *D. dimidiatus* will consume the dwarf pond snail *Galba truncatula* (Müller) both in the field and in the laboratory. In Germany, first instar larval numbers peaked in April and May, with second and third instars in May (Braasch 1989a). Owen (1990) noted a fully fed larva in June at Woodwalton Fen. *D. dimidiatus* adults trapped in early April in the Broads had fully developed internal genitalia, the males carrying spermatophores indicative of recent copulation

(G.N. Foster, unpublished observations). In Switzerland, adult numbers had a single peak in June (Brancucci 1980). It appears that this species breeds in the spring and early summer. This species has been recorded attracted to light (Bembenek & Krause 1969, Kahlberg 2004) and has been noted in flight at dusk. Mark-and-recapture work (Brancucci 1980) has demonstrated movements between three ponds in a 150 metre long row, but not into ponds a further 100 metres away.

Status This species is concentrated in the Somerset Levels, the Gwent Levels, the Cambridgeshire Fens, Broadland and the coastal fens of Kent and Sussex, with 24 hectad records from 1980 onwards. The records for ponds in Cornwall and Durham probably indicate isolated colonisation events. This species has not been recorded from Askham Bog since 1943, with later Yorkshire records only for Hob Moor in 1952 and the Thorne Moors in 1965, again indicating the potential for this species to lose ground.

Threats The greatest threat to this species is posed by the conversion of grazing fen to arable land, with the associated loss of dykes and fall in water table (Driscoll 1983, 1985).

Management and conservation A cycle of ditch cleaning to ensure the provision of exposed and richly vegetated - but not overgrown - ditches is essential for the survival of this species on sites such as Woodwalton NNR, Wicken Fen NT Reserve, the RSPB Reserves of Dungeness, Nene Washes and the Ouse Washes, Catfield Fen operated as a reserve of Butterfly Conservation, neighbouring Broadland owned by the Broads Authority, the Somerset Levels and the Romney Marsh.

Published sources Balfour-Browne (1950), Beebee (1991, 2002), Bembenek & Krause (1969), Blair (1917), Boyce (2004), Braasch (1989a), Brancucci (1980), Carr (1983d), Carr & Philp (1988), Denton (2007a), Drane & Warrington (2009), Driscoll (1983, 1985), Duff (1993), Eve (1966), Eyre & Foster (1984), Eyre, Woodward & Luff (2005), Fitter & Smith (1979), Foster, A.P. (1983, 1984b), Foster, G.N. (1970, 1972, 1973b, 1980b, 1985b, 2004a), Foster & Eyre (1992), Friday (1988a, 1997), Hammond & Merritt (2008), Kahlberg (2004), Lambert (1996), Lohez (2007), Merritt (2007), Nilsson (1982a), Owen (1990), Painter (1994), Rondelaud (1979), Roughley (1990), Sinclair (1982), Skidmore, Limbert & Eversham (1985), Sutton (2002, 2008), Sutton & Wilkins (2005), van de Vijver *et al.* (1997).

DYTISCUS LAPPONICUS Near Threatened
A great diving beetle

Order COLEOPTERA Family DYTISCIDAE

Dytiscus lapponicus (Gyllenhal, 1808).

Identification The adult is keyed by Balfour-Browne (1950) and Friday (1988a). The larva is illustrated and keyed by Nilsson (1982a). Sutton (2008) includes this species in a review of larger water beetles.

Distribution The most recent map is provided by Sutton (2008). Foster (1985b) noted a correlation of the Scottish distribution with that of the 22º C maximum summer summit isotherm (Conolly & Dahl 1970). Records since 1980 are for Caernarfon, Mid Perth, Kintyre, Banff, East and West Inverness, West Ross, East Sutherland, Caithness, Skye, Raasay, Arran, Harris, Islay, Lewis, North Uist, and the Shetland Islands. There are older records for Argyll, Moray, West Sutherland, Eigg, Jura, Mull, Rum, Soay, South Uist, Ulva, and the Orkney Isles. *D. lapponicus* is a northern Palaearctic species, ranging from Ireland through Fennoscandia to west Siberia. There are isolated populations in central Europe and the subspecies *disjunctus* Camerano is confined to the Italian Maritime Alps, it being considered extinct in France (Queney 2004b) and doubtful in Bohemia (Boukal *et al.* 2007). This species occurs in low-lying areas in the Netherlands and Belgium.

Habitat and ecology *D. lapponicus* occurs in exposed lochans in Scotland, often on low ground north of the Great Glen but usually in mountainous regions. The lochans occupied are typically permanent and have a peat substratum and have no large outlets from which the sites might be colonised by fish. Occupancy of lochs with bare, boulder-strewn bottoms is unusual, despite early descriptions of the archetypal nature of this habitat. The best-known Welsh site is also unusual, being a dammed lake 210 metres above sea level. Balfour-Browne (1913) recorded that adults could overwinter in soil below the water, that they re-emerged in March,

laid eggs from then until June in grass stems, and that the larvae were fully grown 6-9 weeks after eclosion. Pupation took place in cells above the water and lasted three weeks, with the imago remaining in the pupal cell for at least a week before breaking out and immediately seeking the water. There is circumstantial evidence of flight in *D. lapponicus* in Scotland (Owen 1988), but individuals capable of flight are probably very rare. Buczyński & Serafin (2005) note a case where a specimen was attracted to a light trap by crawling up the white sheet, indicating how some false flight records might be generated.

Status *D. lapponicus* has been recorded from 24 hectads in Scotland and Wales from 1980 onwards. The total number of hectads ever recorded is only 51. *D. lapponicus* can no longer be found on the Rannoch Moor plateau. Interglacial occurrences of *D. lapponicus* are fairly common though there appear to only one record from the Flandrian, Malcolm Greenwood having found material in a deposit in Derbyshire dated to 2600 B.P.

Threats Most sites for this species are remote and cannot be considered under threat of human development, but many sites must have been lost because of introduction of fish. Previous attempts to afforest Flow Country raised bogs have resulted in damage to tension pool ("dubh lochan") complexes. The main threat now must be rising summer temperatures.

Management and conservation The most recently known site in Wales is an SSSI, as are many of the Scottish sites. Maintenance of individual pool isolation is essential to minimise access by fish.

Published sources Allen, A.J.W. (1998), Angus (1964b), Bacchus (1980), Balfour-Browne (1913, 1950), Bameul (1984), Beebee (1991), Boukal *et al.* (2007), Buczyński & Serafin (2005), Carr (1982), Conolly & Dahl (1970), Downie *et al*. (1998a, 1998b), Foster, G.N. (1967, 1978b, 1985b, 1990b, 2004a), Foster & Eyre (1992), Foster *et al.* (1991), Friday (1988a), McCann & Moran (1986), Miller, White & Young (1979), Nilsson (1982a), Owen (1977, 1979, 1988), Ratcliffe & Oswald (1988), Roughley (1990), Spirit (1986), Stewart (1989), Sutton (2008), Sutton & Wilkins (2005), van de Vijver *et al.* (1997), Waterston *et al.* (1981), Welch (1983).

ELODES TRICUSPIS VULNERABLE

Order COLEOPTERA Family SCIRTIDAE

Elodes tricuspis (Nyholm 1985). *E. tricuspis* was reviewed as *E. elongata* Tournier by Hyman & Parsons (1992), the synonym applied now being *elongata* sensu Klausnitzer nec Tournier.

Identification The *Elodes* species are particularly difficult to identify since the adults are active briefly and only the males can be determined with confidence. The larvae are distinguished from those of *Elodes minuta* (L.) by Zwick (2007) and from other scirtid species by Zwick & Zwick (2008).

Distribution The earliest record is for Sherwood Forest, Nottinghamshire in the 19th Century by W.G. Blatch. Jonty Denton identified a male taken in Windsor Great Park in 1934, and another in A.E. Gardner's collection taken at Frensham, Surrey, in 1954. Tony Drane found this species at Brampton Bryan, Herefordshire in 1981, and there are two records for Parham Park, West Sussex in 1996, by Peter Hodge and Professor John Owen. The most recent record is by Bob Marsh from Mid-west Yorks in 1999. *E. tricuspis* is known from Austria, Belgium, the Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Latvia, the Netherlands, Norway, Poland, Russia, Sweden, Switzerland, and the Ukraine.

Habitat and ecology *E. tricuspis* adults are associated with damp places, recorded from tree foliage, including hawthorn by a pond. The five, fully dated, records in England are all for June. Drost (2008) singled out *E. tricuspis* among Dutch *Elodes* as not being associated with running water. The larva lives in the water and burrows into mud or sand in order to pupate. The larvae of other *Elodes,* which may have five or more instars, require almost two years to complete development, and it would appear that eggs might need to overwinter.

Status *E. tricuspis* is recorded from three hectads since 1980. As *elongata*, it was originally rated Rare by Shirt (1987) but Indeterminate by Hyman & Parsons (1992). There has been only one additional site discovered since then, and this species can be regarded with some confidence as the rarest

known scirtid in Britain and the species most under threat perhaps being associated with park woodland. Although the known occurrence might qualify this species for the IUCN Endangered status, the difficulties associated with capturing and identifying it must be taken into account. Equally, downgrading it to Data-Deficient would fail to recognise its importance as the aquatic beetle specifically associated with old parkland. This species qualified as Vulnerable on the basis of an Extent of Occurrence of ca 18,000 km² of a severely fragmented population in a very small Area of Occupancy. There are insufficient records to be certain that this species is in decline, hence the choice of D2.

Threats The association with old parkland, and our current ignorance about the precise habitat of the larvae, suggest that the greatest risk might be associated with inappropriate management of sites conserved for reasons other than wetland diversity.

Management and conservation Autecological research is needed to establish the requirements of both larvae and adults in British habitats.

Published sources Boukal *et al.* (2007), Denton (2007a), Drane (1990), Drost (2008), Hyman & Parsons (1992), Löbl & Šmetana (2006), Zwick (2007), Zwick & Hecht (2008), Zwick & Zwick (2008).

ENOCHRUS NIGRITUS Near Threatened

Order COLEOPTERA Family HYDROPHILIDAE

Enochrus nigritus (Sharp, 1872). This species was formerly known as *E. isotae* Hebauer (Schödl, 1997).

Identification The means of distinguishing this species from *E. affinis* and *E. coarctatus* was given by Foster (1984c). The British species of *Enochrus* are keyed by Friday (1988a) and Hansen (1987). *E. isotae* may be regarded as the pale colour form of *E. nigritus* prevalent in England.

Distribution Records since 1980 are for South and North Hants, East Sussex, Berks, Oxon, West Suffolk, East and West Norfolk, Cambs, Hunts, Hereford, Anglesey, and Cheshire. Earlier records add South Essex, Surrey and Herts. There is no published distribution map. *E. nigritus* is also known from Morocco, Spain, Portugal, France, Belgium, the Netherlands, Switzerland, Italy, Croatia, Yugoslavia (Montenegro), Macedonia, Albania, Bulgaria, Romania, Greece, European Russia, Ukraine, Turkey, Azerbaijan, Iran, and Kazakhstan.

Habitat and ecology *E. nigritus* occurs in mesotrophic and base-rich fens in lowlands. The life history details of *Enochrus* species appear to vary considerably from one species to another and the life history of individual British species has not been described. An egg-case is produced, sometimes under water, and larval development may last between one and two months. Adults feed on algae and decaying plants whereas the larvae are predaceous.

Status *E. nigritus* has been detected in 38 hectads in England and Wales from 1980 onwards. It would appear that this species has been lost around London.

Threats The major risk appears to be posed by excessive abstraction of water in the Breckland adversely affecting the hydrology. Loss of wet heathland habitats will also have contributed to its decline.

Management and conservation Maintenance of undisturbed, shallow, exposed fen pools is necessary for this species. Two of the West Norfolk palsa scar ("pingo") fens, Thompson Common and Foulden Common, are protected as reserves of the Norfolk Wildlife Trust, as is Wretham Heath. Another palsa scar ("pingo") fen is an SSSI. This species also occurs at Chippenham Fen NNR, and Wicken Fen NNR. Its occurrence in secondary habitats in old fenland terrain such as Moccas Park indicates that the creation of new ponds – or ditches if they do not drain a site – will be beneficial.

Published sources Anonymous (1986a), Bilton (1988), Bratton (2001), Denton (2005, 2007a), Drane & Warrington (2006), Foster, G.N. (1982a, 1983c, 1984c, 1993), Friday (1988a), Hansen (1987), Hebauer (1981), Hodge (2006), Hodge & Jones (1995), Kirby (1998), Lohez (2007), Ryndevich (2003, 2007), Schödl (1997), Sinclair (1982), Watson & Foster (2006).

EUBRIA PALUSTRIS Near Threatened
A water penny beetle

Order COLEOPTERA Family PSEPHENIDAE
Eubria palustris (Germar)

Identification The larva and pupa were described by Bertrand (1939), the larva being flattened and disc-like ("onisciform") and referred to as a water penny.

Distribution Records since 1980 are for South Devon, South Wilts, Dorset, South Hants, Berks, Oxon, Monmouth, Brecon, Ceredigion, Caernarfon, Anglesey, South-east, North-east, South-west and Mid-west Yorks, and Westmorland. Earlier records add East Sussex, the Isle of Wight, North Hants, and Durham. There is an early 19th Century record for "Scotland" by the Reverend William Little, a naturalist active mainly in Dumfries. *E. palustris* is known from Austria, Belgium, Croatia, the Czech Republic, Denmark, Finland, Germany, Greece, Hungary, Italy, Latvia, the Netherlands, Poland, Romania, Russia to western Siberia, Slovakia, Slovenia, Spain, Switzerland, Ukraine, and Yugoslavia.

Habitat and ecology The larvae live in headwaters and seepage on cliffs or in calcareous seepages in fens, and graze on algae. The short-lived adults are found in adjacent vegetation from April to September with a strong peak in June.

Status There are records for 20 hectads since 1980, data on occurrence and occupancy being insufficient to raise the status to Vulnerable.

Threats Stabilisation of cliffs will prevent the formation of new habitat. Two fen sites, Lashford Lane in Berkshire and Weston on the Green in Oxfordshire, have been lost through encroachment of reedswamp or wet woodland. An inland site has been threatened by development of housing.

Management and conservation Some key sites are protected by designation, for example along the "Jurassic Coast" Special Area of Conservation and Ramsar site of Cors Erddreiniog, the SSSI and reserve of the Gwent Wildlife Trust at Henllys Bog. Jones's Mill near Pewsey is an SSSI. Grazing of calcareous fen appears essential to maintain a habitat similar to that provided by soft rock cliffs.

Published sources Bertrand (1939, 1972), Boukal *et al*. (2007), Darby (2009), Drane (1990), Fowler & Donisthorpe (1913), Hyman & Parsons (1992), Löbl & Šmetana (2006).

GRAPHODERUS BILINEATUS
REGIONALLY EXTINCT
The Chequered History Beetle Appendix to Bern Convention
Annexes II & IV of EC Habitats Directive 92/43/EEC *Natura* 2000 Initiative

Order COLEOPTERA Family DYTISCIDAE
Graphoderus bilineatus (De Geer, 1774).

Identification The adult is keyed by Angus (1976) and Friday (1988a). The larva is illustrated and keyed by Nilsson (1982a). The adult is illustrated by Bameul (1994).

Distribution This species is known in Britain from just north of Catfield Fen, East Norfolk. The specimens, taken in 1905, 1906 and 1910 by Professor Balfour-Browne and Hudson Beare, were recognised as belonging to a species distinct from *G. cinereus* by Angus (1976). Foster (1996) provided records of *G. bilineatus* from, in alphabetical order, Austria, Belarus, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Romania, Russia (to west Siberia), the Slovak Republic, Sweden, Switzerland, Turkestan, Ukraine, and the former Yugoslavia.

Habitat and ecology Galewski (1971) included *G. bilineatus* among the relatively limited group of dytiscids confined to large, permanent ponds and lakes. Such species are rarely if ever found in small, temporary water bodies, the characteristic habitat of most water beetles. Nilsson & Holmen (1995) describe the main habitat as sheltered but sunny parts of deep ponds and lakes with dense marginal vegetation. Cuppen (2005) provides a detailed description of the typical sites in the centre of the Netherlands: ditches and canals were in cut reedfen and shading by trees was not common; ditches and canals were between 2.5 and 25 m wide (often around 10 m) with a depth of 50-150 cm; the water was clear without phytoplankton; the

bottom was peaty with a very weak consistency and the banks were steep or undercut, the water and the land being sharply delimited with the banks being very hard; aquatic vegetation was sparse with greater bladderwort (*Utricularia vulgaris* L.) as the most common and most abundant species; most other species being less frequent and at low abundance. *Elodea*, *Ceratophyllum*, *Potamogeton* spp. and duckweeds were notably absent from preferred sites, with emergent plant cover (*Carex*, *Phragmites* and *Thelypteris*) most often low in the water but extensively covering the banks; most often *G. bilineatus* was taken at the dead ends of ditches and canals with accumulations of rootstocks, peat and debris, also in more sheltered places with some emergent plants. This description is produced at length because it accurately describes the former British locality, which is still occupied by most of the fauna found in the 1900s, the principal difference possibly being a greater amount of tree growth, though the trees are cut back during periodic ditch clearance. A particular interesting feature of the Dutch work is recognition of the importance of 'corners', defined as a distinct angle in a waterway or a dead end of a ditch: the only site known precisely for *G. bilineatus* is the dead end of a ditch leading off the River Ant. In a larger survey (Cuppen *et al.* 2006) half of the samples of *G. bilineatus* came from ditches with a width of less than 5 metres.

A distribution model based on the Dutch data predicts the presence of the beetle with a probability of 70 or more per cent in 141 square kilometres of the peat bog area. The best performing model was based on the distribution of ten common plants including Canadian pondweed (*Elodea canadensis* Michx.), water soldier (*Stratiotes aloides* L.), yellow and white water lilies (*Nuphar lutea* (L.) and *Nymphaea alba* L.). Investigation of 133 square kilometres of this area (the species was already known from eight squares in recent periods) resulted in 44 grid squares (34%) with *G. bilineatus*, a much lower percentage than the model predicted (Cuppen *et al.* 2007). Most new grid squares were in or in the vicinity of localities with well known populations.

The life cycle is seemingly univoltine with oviposition in early summer. Eggs are placed above the water surface, chiefly in hollow plant stems (Wesenberg-Lund 1912). The larvae swim in open water, capturing cladocerans. *G. bilineatus* and *G. cinereus* adults had similar phenologies in Switzerland (Brancucci 1980) with peaks in May and July. It is assumed that adults overwinter in water. This species has recently been detected in flight in Sweden. The egg-parasitoids *Caraphractus cinctus* Walker is recorded from this species.

Status This species is extinct in Britain. There have been repeated failures to relocate the species at Catfield, including the use of traps. *G. bilineatus* is reported as extinct or under threat in many parts of its range except Scandinavia. It is now known from only a single locality in southern Bohemia and is classified as critically endangered in the Czech Republic (Hájek 2004). There are twenty records of *G. bilineatus* in Germany after 1980, fifteen of them after 1990, with substantial evidence of decline (Hendrich & Balke 2003). The most extensive recent research is in the Netherlands, where it was formerly widely distributed but where it is now restricted to peat bog areas of Friesland, Overijssel, Utrecht, and Zuid- and Noord-Holland.

Threats Abroad, the decline in this species has principally been associated with eutrophication of the habitat, though the loss of the site in Médoc at Marais de la Perge almost certainly came about through invasion by or introduction of the Red Swamp or Louisiana Crayfish (*Procambarus clarkii* (Girard)) (Anonymous 2009a).

Management and conservation The conservation of this species in Europe as a whole is complicated by the difficulties of keeping voucher material, its collection being prohibited in those countries that are signatories to the Bern Convention. The European Directive on Habitats has resulted in the Conservation (Natural Habitats, &c.) Regulations 1994 in the UK, particularly concerned with European Protected Species (EPS) and including *G. bilineatus*. Possessing an EPS taken from the wild within the European Community after 10 June 1994 requires a license.

G. bilineatus has a history of misidentification in Britain despite the relatively distinctive body outline of the adult. It was not recognised for 70 years, during which time one specimen was selected as the neotype for *G. cinereus*, necessitating a request to the International Commission of Zoological Nomenclature

(ICZN) to set aside the designation. It should be noted that the specimen chosen (figured in ICZN 1961) had been taken by Professor Balfour-Browne near Catfield on 9 August 1905, and was not, as published in the original proposal (Balfour-Browne 1960a), a specimen without locality data from the Power Collection. This species was taken by several people during a meeting in Bordeaux without its being recognised as distinct from *G. cinereus* in the field. Holmen (1993) has noted that larval exuviae cannot be used safely to separate this species from other *Graphoderus*. On this basis, it would be essential to license *bona fide* researchers to ensure that voucher specimens could be subject to validation, rather than increasing the risk of concealed activities.

Reintroduction must be considered, preferably using donor sites in the Netherlands where it has recently been established that the species can still be found locally in numbers.

Published sources Angus (1976), Anonymous (2009), Balfour-Browne (1960a), Bameul (1994), Boukal *et al.* (2007), Brancucci (1980), Cuppen (2005), Cuppen, Koese & Sierdsma (2006), Cuppen, Vorst, Koese & Sierdsma (2007), Foster, G.N. (1996), Foster *et al*. (2007), Friday (1988a), Fursov (2000), Galewski (1971), Hájek (2004), Hájek & Šťastný (2005), Hendrich & Balke (2000, 2003), Hodge & Jones (1995), Holmen (1993), International Commission of Zoological Nomenclature (1961, 1989), Koese & Cuppen (2006), Nilsson (1982a), Nilsson & Foster (1987), Nilsson & Holmen (1995), Shirt (1987), Sierdsma & Cuppen (2006), Telnov *et al.* (2008), Wesenberg-Lund (1912).

GRAPHODERUS CINEREUS VULNERABLE

A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Graphoderus cinereus (Linnaeus, 1758).

Identification The adult is keyed by Angus (1976) and Friday (1988a). The larva is illustrated and keyed by Nilsson (1982a) and can be distinguished from the other British species with care in the third instar.

Distribution The most recent map is provided by Foster (1985b). There are modern records for Dorset, East Sussex, East Kent and Surrey, and older records for South Essex, East Norfolk and Hereford. The vice-county records give a false impression, the true distribution being highly restricted: Studland Bay and Brownsea Island, the Sussex Levels from Eastbourne, Pevensey and Pett, Dungeness, the Black Pond at Esher, Great Bookham Common, Warlies Park near Epping Forest, and Catfield Fen. *G. cinereus* is a widely distributed species in the Palaearctic, ranging from the Ebro delta in Spain to south-east Norway, and east to Siberia and Mongolia.

Habitat and ecology *G. cinereus* occurs in richly vegetated lowland ponds and ditches. Peaks of adult abundance in May and July in a Swiss population indicate breeding in early summer with emergence of new adults in the summer. Galewski (1990) notes larval development in more temporary waters in May and June in Poland. Ryndevich & Lundyshev (2005) found a larva of *G. cinereus* in the nest of a marsh harrier (*Circus aeruginosus* L.). Larvae have been found, with those of *G. zonatus*, in the submerged part of the nests of bittern (*Botaurus stellaris* (L.) (Buczyński, Kitowski & Rozwałka 2004). The adults appear to overwinter at the breeding sites, either in the water or in moist moss. Kehl & Dettner (2007) could not induce this species to fly.

Status *G. cinereus* has been recorded from six hectads in England from 1980 onwards, and in only fourteen in total, clear evidence of decline. This species is known from Neolithic deposits in the Somerset Levels but is not extant there, and the only other British records are in the 19th Century for the Cambridgeshire and Huntingdonshire fens. Despite several surveys, *G. cinereus* has not been found in Epping Forest since it was discovered there in 1954, and appears to have been lost from Moccas Park in Herefordshire. The IUCN criteria for Vulnerable status are satisfied based on area of occupancy, with three sites known since 2000, another up to 1993, and two more known in the 1980s. The extent of occurrence is ca 22,000 km², too high for the IUCN threshold of 20,000 km² even if based on the more recent records alone. The distribution is also marginal to the thresholds for D2, i.e. 20 m² or less in five or fewer localities.

Threats Local extinction in the fens north of Cambridgeshire indicates that the greatest threat is posed by drainage of old fen systems. Loss from the Pevensey Levels indicates sensitivity to

poor water quality. The Moccas Park site was once eutrophicated by Canada Geese (*Branta canadensis* (L.)) but the main concern now is that the main lake now dries too much in most summers to support this species. However, the species is apparently able to colonise new habitats.

The report of a specimen found in the oesophagus of a mallard (*Anas platyrhynchos* L.) shot down on the Pett Levels in East Sussex (Balfour-Browne 1960b) provides an example of predation by birds.

Management and conservation Studland Heath is part of the Dorset Heaths (Purbeck and Wareham) and Studland Dunes SSSI. Brownea Island is part of the Poole Harbour SSSI and the Dorset Heathlands SPA. Catfield Fen is a National Nature Reserve managed by Butterfly Conservation and a site nearby Catfield Fen, where the beetle occurs, is owned by the Broads Authority. At Studland, *G. cinereus* has occurred in the edge of a steep-sided pond dug for fire-fighting, indicating the value of creating new ponds in fenland areas. Its recent detection in the Open Pits, Dungeness (Andy Godfrey, pers. comm.) may be associated with management of the vegetation, in particular removal of willow scrub and reintroduction of grazing (Akers & Allcorn 2006).

Published sources Akers & Alcorn (2006), Angus (1976, 1977b), Baker, Bull & Lambley (2008), Balfour-Browne, F. (1950), Balfour-Browne, J. (1960a), Banks (1990), Brancucci (1980), Buczyński, Kitowski & Rozwałka (2004), Carr (1985d), Denton (2005, 2007a), Eve (1962), Forster (1954), Foster, G.N. (1972, 1985a, 1985b), Friday (1988a), Galewski (1990), Girling (1984a), Godfrey (pers. comm.), Hodge & Jones (1995), Kehl & Dettner (2007), Lohez (2007), Nilsson (1982a), Owen (1976a), Philp & Clarke (1969), Ryndevich & Lundyshev (2005), Salmon (2009), Service (1968), Warrington (2006), Watson & Foster (2006).

GRAPHODERUS ZONATUS CRITICALLY ENDANGERED

Spangled diving beetle Schedule 5 of the Wildlife & Countryside Act

Order COLEOPTERA Family DYTISCIDAE

Graphoderus zonatus (Hoppe, 1795). The English form is the subspecies *zonatus zonatus*.

Identification The adult of this species is keyed by Angus (1976) and Friday (1988a). The larva is illustrated and keyed by Nilsson (1982a), and is further described by Denton (1995).

Distribution This species is known in Britain only from Woolmer Forest, North Hants, from which it was originally recorded as *G. cinereus*. *G. zonatus* is known in Europe from Armenia, Austria, Belgium, Bulgaria, Byelorussia, Croatia, the Czech Republic, Denmark, France, Georgia, Germany, Hungary, Lithuania, Luxembourg, Moldavia, the Netherlands, Poland, central and southern Russia, Slovakia, Slovenia, Sweden, Switzerland, Ukraine, and Yugoslavia. In Asia it occurs in China, Japan, Mongolia, and Turkey. In addition, the form *G. zonatus verrucifer* (Sahlberg) is known from Estonia, Finland, Italy, Latvia, Norway, northern Russia, Siberia, and Sweden.

Habitat and ecology The larvae are free-swimming using their neutral buoyancy to cruise, capturing any passing prey. In captivity young larvae fed on Cladocera, as has been observed in the field, and older larvae would feed on *Notonecta* nymphs.

In 1995, a survey of Woolmer Pond (Denton 1995) demonstrated the presence of larvae from April to July, with 3rd instars into August. Newly emerged adults occurred at the end of June, having pupated at the bases of rush tussocks. Larvae showed a preference for open water. A correlation between larval densities in 1995 and adult densities in the same areas in the previous year indicated that adults overwinter out of the water close to sites used for breeding the following year. Within the Woolmer Forest area, this species occurs in a wide range of pools, most of which are relatively recent in origin and which vary considerably in vegetation, pH, depth and degree of permanence. For example, Cranmer Pond is a deep, permanently flooded pond at pH 4 with the bottom covered by *Sphagnum*. Other ponds in the area result from military activities, including a swimming pool, gun emplacements and the construction of shooting range butts and a railway. Several of the pools receive inflow and are less acidic, having pH from 5.5 to 6.5, and one, which has been limed, has a pH in the range 7.0-7.5. Some pools more recently created for the breeding of natterjack toads (*Epidalea calamita* (L.)) have also supported adult beetles. Teneral adults of *G.*

zonatus have been found in many of these ponds, indicating successful breeding.

Denton (2007b) has studied pupation in this species. The majority of pupation sites were on sandy ground and the walls of the cells were made of sandy material excavated from beneath the surface detritus in terrain not available in the peaty ground around the other breeding sites in the Forest. The only *G. zonatus* pupae found amongst surrounding heather (*Calluna vulgaris* (L.)) was under a well-rotted pine log. The barren, sandy draw-down zone around the outer shore of Woolmer Pond is very exposed, and the limited cover provided by logs and stones may be a limiting factor in the recruitment of new individuals.

The huge numbers present in 2001 were followed by a crash in 2002, with *G. zonatus* not being seen again in the main pond until 2007, when good numbers of larvae were again present. The reason for the crash appears to be related to the excessive flooding which resulted in the loss of all the marginal *Sphagnum* beds which were extensive before 1999. It was in these beds that the adult *G. zonatus* could be found. Thus it would appear that the population in Woolmer Pond is also limited by lack of habitat during the adult stage.

Abroad, *G. zonatus* is mainly recorded from small, sandy lakes with dense marginal vegetation and some peat substratum, usually in moorland. Larvae have been found, with those of *G. cinereus*, in the submerged part of the nests of bittern (*Botaurus stellaris* (L.)) (Buczyński, Kitowski & Rozwałka 2004).

In Sweden the two subspecies coexist, the nominate form with a normal, smooth female and males with 29-46 adhesive discs on the palette of each protarsus, and *verrucifer*, with dimorphic females, one of which has granulate elytra, the other being normal, and males with 36-97 discs on the protarsal palette. The Italian population of the granulate *verrucifer* is confined to montane lakes. The British material is of the nominate form, lacking the granulate female. The more southerly distribution of the nominate form is presumably linked to its absence from numerous, apparently suitable habitats in Scotland. *G. zonatus verrucifer,* which is generally northern in distribution, has poor flight ability (Eriksson 1972).

Status Angus (1976) noted that Woolmer Bog had changed in character since Gilbert White's description in 1789, when Woolmer Pond was described as having a clean, sandy bottom. This was corroborated by the record for *Hygrotus novemlineatus* (Curtis 1855). Balfour-Browne (1940) noted that the bottom of Woolmer Pond was covered with peat in 1938, and Angus (1976) suggested that the area had therefore become suitable for colonisation by *G. zonatus* relatively recently. Woolmer Pond is over a thousand years old, there being reference to 'Wulfamere' in the 9th Century: analysis of its bottom silt indicates that it arose as a peat cutting. Woolmer Pond is the largest of the dystrophic pools in the area, all being fed by base-poor groundwater. Cranmer Pond, dug as a peat cutting in 1895, is not the Cranmer Lake to which White referred in 1789. Either may have been suitable for *G. zonatus* over a much longer period than Woolmer Pond itself, perhaps during the period, again reported by White, when Woolmer Pond supported fish, which would be inimical to the survival of this beetle. There is considerable evidence that *G. zonatus* is insensitive to pH with base-enrichment being presumed damaging only in that predatory fish could survive.

Until a programme of reintroduction began in the 1980s, Woolmer Forest was the only known inland breeding station for the natterjack toad in Britain. A combination of acidification and loss of heathland habitats is considered to be the cause for its rapid decline. These same factors may explain this isolated, apparently new population of *G. zonatus*, i.e. acidification of Woolmer Pond resulting in suitability for colonisation by *G. zonatus* from neighbouring heathland sites that are no longer extant. However, the possibility that this elusive species simply escaped the attention of naturalists cannot be ruled out. White (1789) recorded that the lakes at Woolmer were "stocked with carp, tench, eels, and perch: but the fish do not thrive well, because the water is hungry, and the bottoms are a naked sand". The named fish no longer occur in the area, and their loss would have allowed the beetle to become more widespread within the Woolmer Pond catchment.

The IUCN criteria for Critically Endangered status are based on the single location with the population showing extreme fluctuations, the

extent of occurrence being less than 100 km^2 and the area of occupancy of less than 10 km^2. Abroad *G. zonatus* has rarely attracted a threat status but it is considered extinct in Luxembourg (Gerend 2003) and Voronezh Oblast, Russia (Prokin 2007).

Threats Slurry from a pig-rearing enterprise escaped *via* road drains into one of the ponds in which *G. zonatus* occurred in 1987 (Banks 1988). When this polluting activity ceased, the beetle population recovered. Another risk encountered was vegetation loss and enrichment caused by geese. Denton (2007b) has described the extreme changes in water levels of Woolmer Lake, and the impact of these changes on the *Graphoderus*. A pond limed annually as part of a programme to maintain breeding by natterjacks continues to support this species. High pH in itself does not appear to constitute a direct threat to this species, but, as with many beetles, the risk is that less acidic water supports the fish that can severely reduce *G. zonatus* larvae by predation.

Management and conservation A Biodiversity Action Plan was prepared for this species. Woolmer Forest is owned by the Ministry of Defence. Management plan objectives for the site include recognition of the need to protect *G. zonatus*. Woolmer Lake was partially excavated in 1986 to remove fine sediment and to increase the period of water availability. This was beneficial for *G. zonatus*, which is common among weedy, wave-washed shores of similar lakes in Jutland. The activities at Woolmer intended to build up populations of natterjack toads are also beneficial to *G. zonatus* in that new habitats are being created and monitored. Also, natterjack tadpoles occur in shallow, temporary waters whereas *G. zonatus* lives in deeper waters. The overlap between these two threatened species is low, and the present management programme addresses the need to conserve both species.

Material from Woolmer has been introduced into neighbouring sites, the survey of which had previously demonstrated the absence of this species. *G. zonatus* has not been detected in these sites. Any further attempts at translocation should be prefaced by genetic characterisation of the Woolmer population.

Published sources Allen (1953), Angus (1976), Anonymous (2005a), Banks (1988), Beebee (1987), Beebee & Denton (1994), Bergsten, Töyrä & Nilsson (2001); Buczyński, Kitowski & Rozwałka (2004), Curtis (1885), Denton (1994, 1995, 1996, 2007b), Department of the Environment (1995), Drost & Cuppen (2006), Eriksson (1972), Foster, G.N. (1985b, 2002), Friday (1988a), HMSO (1992), Gerend (2003), Hájek & Šťastný (2005), Hodge & Jones (1995), Key (1998), Löbl & Šmetana (2003), Nilsson (1982a, 1986a), Nilsson & Holmen (1995), Pederzani (1986), Pederzani & Marini (1988), Petzold *et al*. (2006), Prokin (2007), Shaverdo, Short & Davaadorj (2008), Shirt (1987), Štastný (2001), Töyrä (1997), UK Biodiversity Group (1999), White (1789), Woolmer Conservation Group (2006).

GRAPTODYTES FLAVIPES VULNERABLE

A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Graptodytes flavipes (Olivier, 1795). This name was validated by the International Committee on Zoological Nomenclature (1956) following a request by J. Balfour-Browne (1952), but the name *G. concinnus* (Stephens) is occasionally used by some authors.

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). A key to European members of the *Graptodytes aequalis* group includes *G. flavipes* (Fery 1995). The larva was described by Bertrand (1931).

Distribution The most recent map is provided by Foster (1983b); it should be used in conjunction with the vice-county map of Balfour-Browne (1940, map 53). Records since 1980 are for West Cornwall, Dorset, and South Hants, also from East Sussex in 1978, Surrey in 1965 and Skomer, Pembroke, in 1966. Older records are for South Devon, the Isle of Wight, North Hants, West Kent, North Essex, Berks, and Cambridgeshire. Although *G. flavipes* ranges across central Europe to Siberia and Mongolia (Fery 1995), it is primarily an "Atlantic" species, found near to the coast from Wales to Portugal.

Habitat and ecology *G. flavipes* occurs in shallow pools, usually on an exposed substratum, on lowland heaths. It can also occur in pools in dried-out streambeds. This species is capable of flight.

Status G. *flavipes* has been recorded from 17 hectads in England from 1980 onwards. It is still common in the Lizard area, on some Dorset heaths and in the New Forest, the other three records being for isolated sites, possibly temporary populations. This species has contracted in range, no longer being recorded in Wales, in East Anglia, the London area or the Surrey heaths other than as a single record for Bookham Common in 1965. *G. concinnus* was described from Gravesend (Stephens 1835) but the name almost certainly refers to another species (Balfour-Browne 1952). This species qualifies for the IUCN Vulnerable status on the basis of extent of occurrence (ca 7,000 km²), confinement to three areas within an area of occupancy maximally of 1,700 km² and the decline in range as indicated above.

Threats Loss of wet heathland habitats, mainly through urbanisation, appears to be the sole reason for the contraction in range of this species.

Management and conservation Sites such as the Lizard NNR, Morden Heath NNR, Skomer NNR and parts of the New Forest receive statutory protection. Maintenance of open heath pools appears to be essential, and occasional heathland fires may be beneficial in preventing overgrowth of ponds.

Published sources Appleton (2004), Balfour-Browne, F. (1940, 1952), Balfour-Browne, J. (1952), Bertrand (1931), Bilton *et al*. (2009), Denton (2005, 2007a), Fery (1995), Foster, A.P. (1984a), Foster, G.N. (1983b, 1988b), Friday (1988a), Hodge (1979a), International Commission on Zoological Nomenclature (1956), Painter (1994), Sage (1977), Shirt (1987), Stephens (1835), Twinn (1958).

GYRINUS NATATOR REGIONALLY EXTINCT

A whirligig beetle

Order COLEOPTERA Family GYRINIDAE

Gyrinus natator (Linnaeus, 1758).

Identification The method of distinguishing this rare species from the commonest British whirligig species, *G. substriatus* Stephens, has been provided by Angus & Carr (1982), Carr (1983a), Friday (1988a), Holmen (1987a), and Foster (2008b): the differences are fully illustrated by Drost (2009). Balfour-Browne's (1950) treatment of *G. natator*, including many records of its so-called "type form", is based on *G. substriatus*. The larva is undescribed.

Distribution The most recent map is provided by Foster (2008b). This species is widespread in Ireland (Foster, Nelson & O Connor 2009). The British records are for two fens in Westmorland and Cumberland. *G. natator* also occurs in Fennoscandia, France, Belgium, the Netherlands, Germany, Poland, and east to Siberia and China.

Habitat and ecology This species occurs in sheltered habitats in Ireland and on the Continent, for example beneath trees or amongst tree roots at the edge of lakes and rivers. Huldén (1983) noted that *G. natator* is partly nocturnal in activity. In Ireland, it can occur in extremely small pools in old peat cuttings, as well as in slow-flowing ditches in relatively unstable habitats such as turloughs. Svensson (1985) found this species to have poor survival in comparison to *G. aeratus* and *G. substriatus*. Although little is known about the life-cycles of individual species of whirligig beetle, the occurrence of teneral adults of most species in July and August indicates breeding in the early summer by overwintered adults, some of which may survive for more than one season. Fully grown larvae are to be found later in the season and sometimes in early March, the latter indicating the possibility that they too can overwinter. The larvae have filamentous abdominal gills and live as predators on the bottom. Larvae have been found to spin a tough pupation cocoon, secured to plant structures just above the water. It is likely that most species of *Gyrinus* are capable of flight, though van der Eijk (1983) demonstrated that only a small proportion of a population of *G. marinus* Gyllenhal, a common species in Britain, would fly from April to October, usually above an air temperature of 17º C and in bright sunlight. Parasitisation of pupae by ichneumonids (*Hemiteles* spp.) is known, and adult gyrinids are subject to several forms of parasitisation including mites (*Eylais* sp.) and several ascomycete fungi in the genus *Laboulbenia* (Balazuc 1971).

Status The true *G. natator* can no longer be found at Newton Reigny Moss and Cliburn Moss, where it was found in 1902. Both sites

were formerly cut for peat and have become partly dominated by fen carr, and may no longer be suitable for this species despite an apparent association with shade. Newton Reigny Moss has also suffered from eutrophication. It should be regarded as extinct in Britain, but there is a possibility that it has been overlooked either because of its cryptic habit or because of its similarity to *G. substriatus*. Bameul (2004) critically reassessed the distribution of *G. natator* in France and found it to be confined to a small area of Les Landes, echoing its western distribution in the British Isles. Drost (2009) has reassessed its status in the Netherlands, demonstrating that the last record was in 1930. This species attracts Red List status in almost all European countries where this type of evaluation has taken place, though it continues to be well established in Scandinavia.

Threats Loss of habitat is the most likely explanation of the supposed extinction of this species, particularly as a result of carr encroachment on old cutover bogs, which continue to support this species in Ireland. There is also the possibility of competition with *G. substriatus*, by analogy with the relationship established by Svensson (1992) between *G. substriatus* and *G. opacus* Sahlberg.

Management and conservation This species' extinction in Britain should periodically be reassessed. In the event of its rediscovery or successful reintroduction, populations will need to be maintained by preventing peat cuttings from becoming overgrown, but, at the risk of appearing contradictory, retaining some shading. It is a candidate for reintroduction from Ireland into managed bogs in England, but the potential parasite burden associated with *Gyrinus* species might be seen as an obstacle.

Published sources Angus & Carr (1982), Balazuc (1971), Balfour-Browne (1950), Bameul (2004), Carr (1983a), Carron (2008), Drost (2009), van der Eijk (1983), Foster, G.N. (1985b, 2008b), Foster, Nelson & O Connor (2009), Foster *et al*. (1992), Friday (1988a), Holmen (1987a), Huldén (1983), Nelson (1997), Nelson & Anderson (1999), Ratcliffe (1977), Sinclair (1997), Svensson (1969, 1985, 1992).

GYRINUS SUFFRIANI VULNERABLE

A whirligig beetle

Order COLEOPTERA Family GYRINIDAE

Gyrinus suffriani (Scriba, 1855).

Identification This species is keyed by Balfour-Browne (1950), Friday (1988a), Holmen (1987a) and Foster (2008b). The vulval sclerites depicted by Balfour-Browne (1950, Fig. 87, p. 339) were mislabelled, those of *G. suffriani* being A, not E. The larva has been described by Bertrand (1951) and Saxod (1965b), the latter having also described and illustrated the pupa.

Distribution The most recent map is provided by Foster (2008b); it should be used in conjunction with the vice-county map of Balfour-Browne (1950, map 49). Recent published records are for East Sussex, East Kent, Oxon, West Norfolk, Glamorgan, and Anglesey. Other old records are for West Sussex, East Suffolk, South Lincs, and Kirkcudbright. It appears to be either sporadic or rare throughout its range, which includes much of Europe, but not Ireland (the record for Kerry is based on *G. aeratus*) or Iberia. It is also reported from Turkey, Syria, the Caucasus and Transcaucasus. It is found in all countries of Fennoscandia, Estonia and Latvia, but is not known from adjacent parts of Russia.

Habitat and ecology *G. suffriani* is a cryptic, exceptionally fast-moving species most typically associated with the edges of reed beds and other emergent vegetation, possibly staying under water longer than other whirligig species. It is entirely confined to lowland fens, some of which dry out in the summer. This species may be confined to base-rich water in Britain. Svensson (1969), however, noted its exclusive association with oligotrophic and dystrophic waters in southern Sweden. Although little is known about the life-cycles of individual species of whirligig beetle, the occurrence of teneral adults of most species in July and August indicates breeding in the early summer by overwintered adults, some of which may survive for more than one season. Oviposition by *G. suffriani* has been observed in late spring, and development to the adult was completed in about 56 days under laboratory conditions (Saxod 1965a). Fully grown larvae are to be found later in the season and sometimes in early March, the latter indicating the

possibility that they too can overwinter. The larvae have filamentous abdominal gills and live as predators at the bottom of the water body. Larvae have been found to spin a tough pupation cocoon, secured to plant structures just above the water. It is likely that most species of *Gyrinus* are capable of flight, though van der Eijk (1983) demonstrated that only a small proportion of a population of *G. marinus* Gyllenhal, a common species in Britain, would fly from April to October, usually above an air temperature of 17º C and in bright sunlight. Parasitisation of pupae by ichneumonids (*Hemiteles* spp.) is known, and adult gyrinids are subject to several forms of parasitisation including mites (*Eylais* sp.) and several ascomycete fungi in the genus *Laboulbenia* (Balazuc 1971). *L. gyrinicola* Spegazzini was recorded from *G. suffriani* in Sussex by Balazuc (1971), and Weir (1996) has recorded infection with *L. fennica* Huldén.

Status *G. suffriani* has been recorded from twelve hectads in England and Wales from 1980 onwards. It is known from one of the Breckland palsa scar ("pingo") fen sites. It still occurs in the Norfolk Broads and was recently recorded from Crymlyn Bog. It appears to be extinct in Scotland, its only known site, the Maxwelltown Loch, having been drained in the 19th Century. This species is known from Neolithic, Iron Age and post-Iron Age deposits in the Somerset Levels but it is not extant in south-west England. The IUCN criteria for Vulnerable status that are satisfied are B2ab, the area of occupancy being less than 2000 km^2, with a severely fragmented populations in decline.

Threats This species is at risk from habitat loss, particularly through drainage and water extraction, but also through loss of water quality, including any pollution likely to result in reduced amounts of dissolved oxygen.

Management and conservation Crymlyn Bog, Cothill and Wicken Fens are NNR. Thompson Common is a reserve of the Norfolk Wildlife Trust. Most known sites are SSSI.

Published sources Angus (1968a), Balazuc (1971), Balfour-Browne (1950), Bertrand (1951), Biggs & Ashby-Crane (1989), Bilton (1990a, 1990b), Boukal *et al.* (2007), Carr (1981), 1985b), Carr & Philp (1988), van der Eijk (1983), Foster, G.N. (1971, 1974, 1985b, 1993, 2008b), Foster & Eyre (1992), Foster & Lazell (1968), Friday (1988a), Girling (1977, 1978, 1979a, 1979b, 1984a), Holmen (1987a), Kirk-Spriggs & Mann (2000), van Nieuwenhuijzen (2005), Rutanen (2004), Saxod (1965a, 1965b), Shaw (2004), Svensson (1969), Weir (1996).

HALIPLUS FURCATUS CRITICALLY ENDANGERED

Order COLEOPTERA Family HALIPLIDAE

Haliplus furcatus (Seidlitz, 1887).

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). The larva is keyed in the European fauna by van Vondel & Dettner (1997), who provide the most recent review.

Distribution The most recent map (Foster 1981b) should be used in conjunction with the vice-county map of Balfour-Browne (1940, map 25). The complete distribution of this Palaearctic species is given by Drost & van Vondel (1986). However, each of these maps predates records from a West Norfolk palsa scar ("pingo") fen complex and from a relict, impermanent pond in Oxon. *H. furcatus* occurs in Denmark, Sweden, Finland, France, Belgium, the Netherlands, Germany, Poland, Estonia, former Czechoslovakia, Austria, Italy, Romania, and southern and central parts of the former USSR east to Siberia.

Habitat and ecology This species is confined to low-lying temporary pools, usually with relict status, such as West Norfolk palsa scar ("pingo") fens or Dutch duneslack pools. The species has a history of discovery and disappearance, almost certainly associated with a well-developed ability to survive drying out of ponds rather than with colonising behaviour.

Status *H. furcatus* was recorded from North Somerset in 1916, South Somerset in 1935-7, West Norfolk in 1987, and most recently in Oxon in 1996, this providing the only modern site, the Norfolk site having been surveyed several times since 1987 without success. A record claimed for Ebernoe Common, West Sussex, in 1999 cannot be confirmed because the specimen has been lost.

Threats The spasmodic occurrence of *H. furcatus* places it at extreme risk of extinction because of loss of habitats, destroyed either by drainage or possibly even by permanent flooding. Disposal of grain - or its use as bait for wildfowl as practised at the Oxfordshire site - will cause damage by enrichment. Boukal *et al.* (2007) note its sensitivity to habitat disturbance, in particular changes to the shore zone.

Management and conservation Biggs *et al.* (1994) indicated the association of *H. furcatus* with temporary water, in a paper emphasising the hazards of uninformed pond management. The palsa scar ("pingo") fen site in Norfolk is an SSSI. The Oxfordshire site, which supports other fen remnant species, should be considered for statutory protection: it and its beetles are mentioned in passing in the Cherwell Biodiversity Action Plan (www.cherwell.gov.uk/media/pdf/a/h/Full_BAP_2005-2010_low_res.pdf).

Published sources Angus (1988), Balfour-Browne (1940), Bameul (1994), Biggs *et al*. (1994), Boukal *et al.* (2007), Buczyński & Przewoźny (2009), Collinson *et al*. (1993, 1995), Drost & van Vondel (1986), Foster, G.N. (1981b, 1993, 2001a), Friday (1988a), Hodge & Jones (1995), Holmen (1987a), Lohez (2007), Prokin (2006), Queney (1999, 2002b), Shirt (1987), Sussex Biodiversity Record Centre (1999), van Vondel & Dettner (1997).

HALIPLUS VARIEGATUS VULNERABLE

Order COLEOPTERA Family HALIPLIDAE

Haliplus variegatus (Sturm, 1834).

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). The original illustration of the larva by Schiødte (1864) was reproduced by Walsh & Dibb (1954). The larva is keyed in the European fauna by van Vondel & Dettner (1997), who provide the most recent review of this species.

Distribution A published map was last provided by Foster (1981b). Records since 1980 are for West Cornwall, North Somerset, the Isle of Wight, South Hants, East Sussex, East and West Norfolk, Cambs, Anglesey, and North Lincs. *H. variegatus* occurs in Ireland, the south of Norway, Sweden and Finland, thence south to Spain, Italy, Greece, Algeria, Israel, Turkey, and Syria, records further east being in doubt.

Habitat and ecology *H. variegatus* is associated with lowland fens with stagnant water overlying peat or clay. In Ireland, it is associated with cutover peat bogs and turloughs. Larvae have been obtained in the summer. Their morphology indicates association with stoneworts (Holmen 1987a).

Status *H. variegatus* has been recorded from 21 hectads in England and Wales from 1980 onwards, with evidence of substantial decline and contraction of range in the English Midlands, but with continuing occupancy of the extremities of its range in Anglesey, the Lizard, the Broads and the Lincolnshire coast. Denton (2005) notes it as extinct in Surrey. This species was found in one sample of the British Countryside Survey in 1990. This species might not qualify for the Vulnerable status were it not for reappraisal based on Red Lists in other European countries. According to Foster, Nelson & O Connor (2009) it is rated as Vulnerable in Ireland and Norway, Critically Endangered in the Czech Republic, and Near Threatened in Poland, also as extinct in Luxemburg, and using earlier criteria as Red Data Book 2 in Germany. Holmen (1981) described it as in decline in Denmark, possibly because of pollution. There would appear to be sufficient grounds to classify it as Vulnerable in Great Britain.

Threats Loss of peat from fenland drainage systems (Burton & Hodgson 1987), thereby altering the substratum, is particularly likely to affect this species. Species such as *Rhantus suturellus* (Harris) and *Gyrinus minutus*, which have also declined in East Anglia, are still common in the north whereas *H. variegatus* has never been recorded reliably in northern Britain.

Management and conservation Management that retains some peat substratum with permanent, base-enriched water appears to be appropriate for this species. Recent records include sites receiving statutory protection in the New Forest SAC, in the Saltfleetby-Theddlethorpe Dunes NNR, and the Brading Marshes to St. Helen's Ledges SSSI in the Isle of Wight, the latter including an RSPB reserve. This species occurs in cutover bogs in Ireland.

Published sources Angus (1988), Balfour-Browne (1940), Burton & Hodgson (1987), Carron (2008), Denton (2005, 2007a), Driscoll (1978), Duff (1993), Eyre, Foster & Carr (1992), Foster, G.N. (1972, 1981b, 1988b, 1993, 2000a), Foster, Nelson and O Connor (2009), Friday (1988a), Goldie Smith (1987), Hammond & Merritt (2008), Holmen (1981, 1987a), Lohez (2007), Painter (1994), Pope (1969), Porter (1995), Schiødte (1864), van Vondel & Dettner (1997), Walsh & Dibb (1954).

HALIPLUS VARIUS CRITICALLY ENDANGERED

Order COLEOPTERA Family HALIPLIDAE

Haliplus varius (Nicolai, 1822).

Identification The adult is keyed by Friday (1988a). The larva was described by van Vondel (1996) and keyed in the European fauna by van Vondel & Dettner (1997), who provide the most recent review of this species.

Distribution This species is known from two sites near to Robertsbridge, East Sussex. *H. varius* is known from Finland, north and west Russia, France (with modern records in Lohez (2007) and Queney (2009)), the Netherlands, southern Germany, Poland, northern Italy, and Austria.

Habitat and ecology The habitat in England is mud-bottomed ponds with algae in partial shade, and is recorded abroad from slow-flowing water over sand. Other members of this species group are associated with stoneworts. Although this is a lowland species, it is not known from coastal marshes in Britain.

Status This species was discovered in Britain in 1981 at a site where it was last found in 1982. A further site discovered in 1992 was found to support the beetle. Its similarity to *H. obliquus* (Fabricius) may have led to its being overlooked in the past, though no old material has yet been detected. It appears to be confined to old, man-made sites in East Sussex. The IUCN criteria for Critically Endangered status that are satisfied are based on its being known from only one location, the Extent of Occurrence being within the 22ha of a single reservoir. The probability of extinction is high based on loss from one of two known sites, certainly more than the 50 % within 10 years required for this IUCN category.

Threats The restricted range places this species at extreme risk from loss of habitat. The extant site is used for fly-fishing and may be damaged – or possibly improved - by activities intended to facilitate angling from the shore.

Management and conservation Neither site from which it has been known has formal protection as a conservation area.

Published sources Friday (1988a), Hodge (1993), Hodge & Jones (1995), Holmen (1987a), Lohez (2007), Parry (1982), Prokin (2006), Queney (2009), van Vondel (1996), van Vondel & Dettner (1997).

HELOCHARES OBSCURUS VULNERABLE

Order COLEOPTERA Family HYDROPHILIDAE

Helochares obscurus (O.F. Müller, 1776). Records for *H. obscurus* pre-dating Hansen's treatment (1982) can almost certainly be referred to *H. punctatus*.

Identification In referring to *H. obscurus*, Kevan (1967) was including the more frequent *H. punctatus*. Hansen (1982) distinguished between *H. obscurus* and *H. punctatus*, and Friday (1988a) keys all three species of the British fauna.

Distribution Records since 1980 are for East and West Norfolk, Hunts, and Hereford, with a 19th Century record for Whittlesey Mere, Cambs and a postglacial sub-fossil from North Lincs. The most recent British distribution map is provided by Foster (1982c). *H. obscurus* is also known with certainty from the Netherlands, Denmark, Norway, Sweden, Finland, Poland, France, Iran, Italy, Austria, the Czech Republic, Hungary, former Yugoslavia, Greece, Georgia, and Russia to Siberia.

Habitat and ecology In the Netherlands, *H. obscurus* replaces the otherwise commoner *H. punctatus* in the sandy coastal dune area, as well as occupying clay areas and peat bogs. The Dutch distribution has been related to stagnant waters with a high pH, high conductivity and high chlorinity with a luxuriant vegetation of

floating and submerged plants on mineral soils. Slow running water is also occupied, preference being for regulated lowland streams, ditches and canals. The habitats in England resemble the stagnant water description, except that they lack chloride. *H. obscurus* has two peaks of abundance as adults, indicating a single generation each year with larvae in the summer. The females carry egg-cases under their body until the larvae hatch.

Status *H. obscurus* has been recorded from eleven hectads in England since 1980. The distribution appears to be relict in East Anglian fenland and in or near fens on Ice Age depressions in Herefordshire.
The IUCN criteria for the Vulnerable status that are satisfied are based on an extent of occurrence of 8,100 km^2, the populations being severely fragmented with only the Norfolk Broads, the fenland area most at risk from marine incursion, providing a stronghold covering several sites, and on an area of occupancy. Although there are seventeen modern locations the area of occupancy is considerably less than 2,000 km^2.

Threats The occurrence of this species in disturbed habitats in relict fenland areas suggests that it would be at risk from overgrowth of ponds on ungrazed or unmanaged reserves.

Management and conservation Maintenance of open water habitats in fenland areas should be beneficial. Ramsey Heights is a reserve of the Wildlife Trust for Bedfordshire, Cambridgeshire, Northamptonshire and Peterborough. Moccas Park is a NNR and the Halvergate Marshes an RSPB Reserve. Some records for this species should be reappraised on the basis of potential confusion with the other two species.

Published sources Boukal *et al.* (2007), Carr (1983d), Cuppen (1986a), Foster, G.N. (1980a, 1980b, 1982c, 1983a), Friday (1988a), Hammond (2001), Hansen (1982, 1987), Hebauer & Ryndevich (2005), Hodge & Jones (1995), Kevan (1967), Lohez (2007), Sinclair (1982), Watson & Foster (2006).

HELOPHORUS LATICOLLIS
ENDANGERED

Order COLEOPTERA Family HELOPHORIDAE

Helophorus laticollis (Thomson, 1854).

Identification Angus (1992) keys the adult and third instar larva within the Palaearctic fauna. He also describes the egg cocoon. Kevan (1965) and Friday (1988a) key the adult stage within the British fauna. Balfour-Browne's treatment (1958) is potentially confusing as it included misidentifications based on *H. strigifrons* and a taxon he referred to as *phalleterus* Sharp (1958, Fig. 60) was based on an aedeagophore of *laticollis* being associated with a specimen of *flavipes* (Kevan 1966; Angus 1971). Hansen (1987) keys the adult stage within the Fennoscandinavian fauna.

Distribution The map published by the UK Biodiversity Group (1999) contained several errors, none of them derived from the recording scheme despite that being given as a source. A corrected map (Foster 2000b) is available. Originally found on heathland in Dorset, South Hants and Surrey, *H. laticollis* is presently confined to the New Forest (South Hants). The English population is isolated as this species is centred on northern Europe from Scandinavia south-west to the Netherlands, where it has recently been rediscovered, and east to Moscow, with other outlying populations in central French mountains, southern Germany and Iceland. Its presence in the Czech Republic is considered doubtful.

Habitat and ecology *H. laticollis* is found in shallow grassy pools on heathland. Unlike other British *Helophorus*, which place their egg cocoons in mud beside water, *H. laticollis* places its cocoons among vegetation in the water (Angus 1973).

Status The count of hectads from 1980 onwards is three, the total confirmed records amounting to only seven hectads. *H. laticollis* is known from Late Glacial deposits in Warwickshire (Osborne 1973). This species was listed as Vulnerable (Shirt 1987), but the isolation of the New Forest population puts it at much greater risk. The IUCN criteria for Endangered status are satisfied in that the species is known only

from five locations in an area of the New Forest corresponding to an extent of occurrence of 750 km^2 with an area of occupancy of no more than 20 km^2 and a decline from seven to three hectads.

Threats Loss of heathland is clearly largely responsible for the decline of this species, which was probably always restricted to Surrey and New Forest wet heathland since recording began. Desiccation of heathland areas in the New Forest could result in extinction of this species in Britain.

Management and conservation A Biodiversity Action Plan has been produced. Maintenance of exposed temporary pools and wet heath is essential for the survival of this species. Most of the areas in which it occurs lie within the New Forest SAC.

Published sources Angus (1971, 1973, 1988, 1992), Balfour-Browne (1958), Boukal *et al.* (2007), Cuppen (1999), Denton (2007a), Department of the Environment (1995), Foster G.N. (1987a, 1999, 2000a, 2000b, 2005a, 2007a), Friday (1988a), Hansen (1987), Kevan (1966), Osborne (1973), Shirt (1987), UK Biodiversity Group (1999).

HELOPHORUS TUBERCULATUS
VULNERABLE

Order COLEOPTERA Family HELOPHORIDAE

Helophorus tuberculatus (Gyllenhal, 1808).

Identification Angus provides an illustration of the adult (1992 Fig. 25 d) and keys the adult and third instar larva within the Palaearctic fauna. Balfour-Browne (1958) and Friday (1988a) key the adult stage within the British fauna and Hansen (1987) keys it within the Fennoscandinavian fauna.

Distribution This species has been reported in sufficient numbers to indicate breeding in North Lincs, South Lancs, South-east and North-east Yorks, Dumfries (three separate records from near to Dumfries), and Lanark. Other records are for North Somerset, East Sussex, South Essex, Warks and Mid-west Yorks. The most recent map is provided by Foster (1987a). *H. tuberculatus* is a Holarctic species, with scattered records over much of northern and central Europe.

Habitat and ecology *H. tuberculatus* breeds on wet moorland and in fens and bogs, often in association with burnt ground. One area of the North Yorkshire Moors where it occurs - and from where the larva was described - had a covering of *Polytrichum commune*. Hedw. and *P. piliferum* Hedw. in 1979, three years after a fire in a particularly hot summer had burnt the peat down to the underlying clay. Specimens were mainly found here by extraction of peat and moss from November to June using Tullgren funnels (Booth 1981). Another find in the vicinity (Kenward 1977) in 1976 was associated with peat burnt a year earlier. The dark and tuberculate form of *H. tuberculatus* causes it to resemble a piece of charcoal, and this may be an adaptation to fire-swept areas of boreal forest and tundra. The distinctive features of this species have assisted its detection as sub-fossil fragments - in Roman Carlisle and in York. The most extraordinary record of *tuberculatus* is for a specimen found in an emergence trap on a sewage filter bed in Birmingham (Angus 1973), perhaps another case of association with (activated) charcoal. A single specimen has also been reported from the blossom of rowan (*Sorbus aucuparia* L) (Parry 1979).

Status *H. tuberculatus* has been recorded from seven hectads, all in the northern half of England, from 1980 onwards. This species appears to have died out in Scotland and in the Home Counties. Its spasmodic reoccurrence, combined with its cryptic habit, indicates that it could be rated as near threatened rather than as vulnerable. The IUCN criteria for Vulnerable status that are satisfied are based on an extent of occurrence of 7,100 km^2 based on seven localities in a severely fragmented population across northern England and the stated decline in range.

Threats Moorland drainage and lapse in muirburn will reduce the areas available to this species. Some of the sites where this species occurs are fragments of areas from which peat is still being extracted. It is possible that this species benefited disproportionately during the steam age, in that moorland beside railways was more regularly burnt than would be natural.

Management and conservation Provision of boggy conditions associated with periodic burning is essential for survival of this species, but it must be recognised that it does not appear to survive in any one area for any length of time. The North Yorkshire Moors area lies within a National Park. The Chat Moss site is part of the Astley & Bedford Mosses SSSI, and Haxey Grange Fen is also an SSSI.

Published sources Allen (1960), Angus (1973, 1992), Balfour-Browne (1958), Booth (1981), Bratton (1990a), Foster, G.N. (1972, 1987a), Friday (1988a), Hammond & Merritt (2008), Hansen (1987), Kenward (1975, 1977, 1984), Lennon (1878, 1895), Parry (1979), Pearce (1949), Shaw (2004).

HETEROCERUS FUSCULUS
VULNERABLE

Order COLEOPTERA Family HETEROCERIDAE

Heterocerus fusculus (Kiesenwetter).

Identification The most recent key is by Clarke (1973).

Distribution Records since 1980 are for East Kent, Dorset, the Isle of Wight, South Hants, and Anglesey. Older records add Leics, and are dominated by finds in the Isle of Wight. Clarke (1973) noted that the species was confined from Plymouth to the Isle of Wight, but it has been found on The Ayres in the Isle of Man by Adrian Fowles (Luff 1996) and Hyman and Parsons (1992) note that it has been recorded from East Anglia. This is a western Palaearctic species with three subspecies, *fusculus fusculus* being distributed from Portugal and Britain to Turkey, Iran, Kazakhstan, and eastern Siberia, north to Sweden and Finland.

Habitat and ecology This species lives in galleries in mud close to the high tide mark and often in association with sea-cliffs. Clarke (1973) describes how Swedish populations are often mixed with those of *Heterocerus fenestratus* (Thunberg).

Status *H. fusculus* is known from six hectads since 1980. Despite the threats identified by Hyman & Parsons (1992) this species was retained at Nationally Notable B as in Ball (1986). The IUCN criteria for the Vulnerable status are based on an area of occupancy associated with narrow coastal strips in six hectads, but the extent of occurrence is over 33,000 km². Loss of the species habitat in natural coastal structure within the small area occupied indicates that the population must have suffered a decline and some fragmentation.

Threats Hyman & Parsons (1992) previously identified that this species as threatened by cliff stabilisation schemes and the construction of sea defences, that coastal developments might reduce the amount of available habitat, and that natural succession of that habitat might make further reductions.
The ectoparasitic ascomycete fungus *Botryandromyces heteroceri* (Maire) is associated with Heteroceridae (Castaldo *et al.* 2004).

Management and conservation The importance of natural landslips was recognised by Hyman & Parsons (1992). Whilst sea level changes will ensure no shortage of unstable cliffs in future intervention to stabilise the coastal strip will inevitably restrict the amount of natural habitat available.

Published sources Boukal *et al*. (2007), Castaldo *et al.* (2004), Clarke (1973), Hyman & Parsons (1992), Löbl & Šmetana (2006), Lohez (2007), Luff (1996).

HYDRAENA MINUTISSIMA Near Threatened

Order COLEOPTERA Family HYDRAENIDAE

Hydraena minutissima (Sturm, 1829). Although Hansen (1998) made a case for use of the name *flavipes* Sturm, 1836, this change has not been applied in the latest catalogue (Löbl & Šmetana 2004.

Identification Friday (1988a) and Balfour-Browne (1958) key this species in the British fauna.

Distribution Records since 1980 are for West and East Cornwall, South and North Devon, Worcester, Radnor, Ceredigion, Caernarfon, South and North Northumberland, Cumberland, Dumfries, Ayrshire, Peebles, Roxburgh, and Berwick. Earlier records add South Somerset, Surrey, Oxon, Hereford, Warks, Salop, Glamorgan, Denbigh, North-east Yorks,

Kirkcudbright, West Perth, Fife, Moray, East Inverness, and East Ross. The most recent map (Foster 1990d) should be used in conjunction with that provided by Balfour-Browne (1958, map 67). *H. minutissima* is a western European and Mediterranean species, ranging south from Scotland and Ireland to Spain and the Balkans, and north to Latvia and Lithuania.

Habitat and ecology *H. minutissima* is typically associated with the edges of fast running streams with rocky crevices and moss. It can occur in base-poor waters but is found on limestone and ultrabasic rocks. In north-west Spain García-Criado *et al*. (1999) have noted this species as part of a high altitude assemblage in waters averaging pH 8.2 in association with *Riolus subviolaceus* (Müller), a species normally associated with calcareous water in Britain. Although this species would appear to be flightless in Britain, it is known to fly in Austria.

Status *H. minutissima* is known from 23 hectads from 1980 onwards. This species appears to have declined generally in England apart from Northumberland and Cumberland, and it is widespread in the Southern Uplands. There are no modern records for the northern Scotland, Northern Ireland and the Isle of Man. This species has been found in a 400-year-old deposit in Warwickshire (Kelly & Osborne 1965), and in a Bronze Age deposit in Surrey (Robinson 1991).

Threats River regulation, pollution and siltation constitute general threats to this species. Nutrient enrichment appears to be largely responsible for its loss from many areas in England.

Management and conservation Legislation associated with the Water Framework Directive will enforce an improvement in the management of inland waters in the United Kingdom.

Published sources Angus (1964b), Balfour-Browne (1958), Boukal *et al.* (2007), Buczyński *et al.* (2008), Denton (2005), Eyre & Foster (1984), Eyre, Luff & Lott (1998), Foster, G.N. (1988b, 1990d), Foster & Eyre (1992), Foster & Sinclair (1980), Friday (1988a), García-Criado *et al*. (1999); Hammond & Merritt (2008), Hansen (1998), Jäch (1997), Jäch, Dietrich & Raunig (2005), Jackson (1973), Kelly & Osborne (1965), Löbl & Šmetana (2004), Osborne (1996), Queney (2008), Robinson (1991), Vorst *et al*. (2007).

HYDRAENA PALUSTRIS Near Threatened

Order COLEOPTERA Family HYDRAENIDAE

Hydraena palustris (Erichson, 1837).

Identification Friday (1988a) and Balfour-Browne (1958) key this species in the British fauna. Balfour-Browne (1958) reported a series of misidentifications, in most cases based on *H. testacea* Curtis, and errors of this kind continue to be made.

Distribution Records since 1980 are for West Suffolk, East and West Norfolk, Cambs, and South-east Yorks. Earlier records add only Mid-west Yorks from Askham Bog up to 1902. The most recent map (Foster 1990d) should be used in conjunction with that provided by Balfour-Browne (1958, map 62). This is a central European species, ranging to southern Fennoscandia, the central Russian steppe, and the northern Balkans, avoiding the Mediterranean coast, a record for Spain requiring confirmation.

Habitat and ecology *H. palustris* prefers temporary and semi-permanent, stagnant water, and is confined to areas with well-developed marginal vegetation, especially litter-generating species such as reeds and sedges. It can occur in partial shade in fen carr. Painter (pers. comm.) has noted that it occurs in managed ditches at Wicken Fen with a distinct "drawdown zone" below the marginal vegetation but that it does not occur in the shallowly flooded litter of the surrounding fen. In the Netherlands, it appears to have one generation a year with a peak of adult abundance and breeding in the spring.

Status In terms of extent of occurrence (ca 10,500 km²) and area of occupancy (17 locations in 14 hectads from 1980 onwards) *H. palustris* might qualify for the IUCN Vulnerable category but there is as yet no evidence of decline. Nevertheless the strong association with relict fenland indicates that this is a species potentially under threat. This species is abundant in Neolithic, Bronze Age, Iron Age and post-Iron Age deposits in the Somerset Levels, but it has not been reliably recorded alive in south-west England. It has also been found in deposits in North Lincs.

Threats Former losses of relict fenland stagnant water habitats have probably caused this species to become restricted to East Anglia and eastern Yorkshire.

Management and conservation This species occurs at Wicken Fen, a NNR, on Thompson Common and Foulden Common, two palsa scar ("pingo") fen areas managed by the Norfolk Wildlife Trust, and on Catfield Fen NNR. Hornsea Mere is a Local nature Reserve. The citation of the Lower Derwent Valley under the Ramsar Convention includes this species on the basis of its occurrence at Thornton Ellers. Piecemeal tree and scrub clearance, as at Foulden, may prove beneficial for this species. In the Broads it is important to maintain an open fen habitat as can be achieved by Reedcutting.

Published sources Allen (1959), Angus & Diaz Pazos (1991), Balfour-Browne (1958), Boukal *et al.* (2007), Cuppen (1993a), Dinnin (1997), Foster, G.N. (1977c, 1983c, 1984d, 1990d, 1993), Friday (1988a, 1990, 1997), Girling (1976, 1977, 1978, 1979a, 1979b, 1980, 1982a, 1984a), Hammond (2002), Hammond & Merritt (2008), Hansen (1987), Jäch, Dietrich & Raunig (2005), Jäch & Prokin (2005), Lohez (2007), Nobes (2001), Painter (1994, 1999), Palmer (1981a), Queney (2002b), Shirt (1987).

HYDRAENA PULCHELLA VULNERABLE

Order COLEOPTERA Family HYDRAENIDAE

Hydraena pulchella (Germar, 1824).

Identification Friday (1988a) and Balfour-Browne (1958) key this species in the British fauna.

Distribution Records since 1980 are for East Sussex, West Kent, Oxon, Worcester, North-east and Mid-west Yorks, Cumberland, Dumfries, Ayrshire, and Lanark. Earlier records add South Devon, Dorset, Hereford, Warks, Kirkcudbright, West Lothian, West Perth, and Moray. The most recent map (Foster (1990d) should be used in conjunction with that provided by Balfour-Browne (1958, map 65). There are no records for Wales. This is a northern and central European species extending to France, north-west Russia and Bulgaria.

Habitat and ecology *H. pulchella* occurs in pockets of stiller water at the edges of rivers and streams, usually among clean silt or mud, and sometimes among tree roots. It occasionally occurs in drains leading onto coastal levels.

Status *H. pulchella* is known from fourteen hectads in England and Scotland from 1980 onwards. *H. pulchella* occurred in one of the 614 sites sampled for RIVPACS III. This species appears to have become extinct in eight British vice-counties and in Ireland. It qualifies for the IUCN Vulnerable category on the basis of its area of occupancy, the severely fragmented distribution and evidence of losses from its former range. It is known from early Flandrian deposits in Warwickshire (Osborne 1974), and from 5,000 and 400 year old deposits, also from Warwickshire (Kelly & Osborne 1965), and in a Bronze Age deposit in Surrey (Robinson 1991).

Threats Enrichment of rivers associated with sewage outfalls and farm effluents will damage the river margin sites occupied by this species by encouraging the accumulation of algae and organic material.

Management and conservation Legislation associated with the Water Framework Directive will enforce an improvement in the management of inland waters in the United Kingdom.

Published sources Balfour-Browne (1958), Boukal *et al.* (2007), Buczyński *et al.* (2008), Carr (1983c, 1984a, 1985b), Carr & Philp (1988), Denton (2005), Foster, G.N. (1978a, 1990d), Foster & Eyre (1986, 1992), Friday (1988a), Hammond & Merritt (2008), Hansen (1987), Jäch, Dietrich & Raunig (2005), Kelly & Osborne (1965), Osborne (1974), Phillips (1985), Queney (2008), Robinson (1991), Wright *et al.* (1996).

HYDRAENA PYGMAEA VULNERABLE

Order COLEOPTERA Family HYDRAENIDAE

Hydraena pygmaea (Waterhouse, 1833).

Identification Friday (1988a) and Balfour-Browne (1958) key this species in the British fauna.

Distribution Records since 1980 are for West Cornwall, South and North Devon, East Sussex,

North-east, Mid-west and North-west Yorks, Cumberland, Kirkcudbright, Stirling, and Arran. Earlier records add South Somerset, East and West Gloucester, Hereford, Salop, Glamorgan, Caerfyrddyn, Caernarfon, Denbigh, Derbyshire, South Northumberland, Peebles, Mid Perth, Banff, and Moray. The most recent map (Foster 1990d) should be used in conjunction with that provided by Balfour-Browne (1958, map 66). This is probably a southern European montane species, ranging from Spain to Turkey and north to Scotland and Germany.

Habitat and ecology *H. pygmaea* occurs amongst mossy stones and on clay in shallow streams, often in steep sections. It appears to be mainly associated with base-rich water such as on the seam of ultrabasic rocks associated with the Highland Boundary Fault on Loch Lomond. This species is generally regarded on the Continent as being confined to the smallest streams. *H. pygmaea* is claimed to be brachypterous.

Status *H. pygmaea* has been recorded from eleven hectads in England and Scotland from 1980 onwards. The IUCN criteria for Vulnerable status that are satisfied are based on the area of occupancy with 14 locations in 11 hectads known in England and Scotland since 1980, combined with a severely fragmented distribution without any modern records for Wales or central England. This species has been found in 5,000 and 400 year old deposits in Warwickshire (Kelly & Osborne 1965).

Threats The loss of this species from much its English range is most probably associated with pollution of small streams from localised sewage outfalls, or possibly by afforestation of headwaters. The former is certainly the case for many former sites in Devon, and the latter is relevant for the species' survival in what would otherwise appear to be a stronghold in Arran. The isolated Sussex site appears to be threatened by coastal erosion.

Management and conservation Legislation associated with the Water Framework Directive will enforce an improvement in the management of inland waters in the United Kingdom. The Conic Hill site by Loch Lomond is part of an SSSI and lies within the Loch Lomond and Trossachs National Park. The Benlister Glen site lies just outside an SSSI on Arran. Protection of the Fairlight Glen site in Sussex is problematical owing to coastal erosion.

Published sources Anonymous (1986b), Balfour-Browne (1958), Bilton (1991), Boukal *et al.* (2007), Cuppen (1993a), Foster, G.N. (1979, 1983d, 1988b, 1990d), Friday (1988a), Hammond (in press), Hammond & Merritt (2008), Hancock (1998), Jäch, Dietrich & Raunig (2005), Jackson (1973), Kelly & Osborne (1965), Queney (2008).

HYDROCHARA CARABOIDES Near Threatened
Lesser Silver Water Beetle Schedule 5 of the Wildlife & Countryside Act

Order COLEOPTERA Family HYDROPHILIDAE

Hydrochara caraboides (Linnaeus, 1758).

Identification This distinctive species is keyed as an adult by Balfour-Browne (1958), Hansen (1987) and by Friday (1988a). Bøving and Henriksen (1938) reviewed accounts of the egg-case, larva and pupa (described as a *Hydrophilus*). Sutton and Wilkins (2005) include this species in a review of larger water beetles.

Distribution The most recent map is provided by Sutton (2008). Records since 1980 are for North Somerset, Cheshire (from 1990) and Denbigh (from 2002). Earlier records add West Sussex, South and North Essex, Surrey, Middlesex, Cambs, Hunts, Glamorgan, Ceredigion, Derbyshire, South Lancs, and Mid-west Yorks. There are sub-fossil records for Worcestershire and North Lincs. A record for East Norfolk is incorrect (Foster 2002). *H. caraboides* is widely distributed in the Palaearctic, ranging from eastern Denmark and Fennoscandia to Catalonia, and east to Siberia (Šmetana 1980).

Habitat and ecology This species occupies a wide range of still water habitats in mainland Europe. In the Somerset Levels, it was claimed that this species was confined to the peat areas, being common only on the turbary peats of Tadham and Westhay Moors; however, recent investigations in Somerset demonstrate occurrence of adults in a wide range of ditch types, with egg cocoons and larvae tending to occur in very shallow or ephemeral aquatic habitats from which larger beetle predators are

absent. The Cheshire and Welsh sites include some relatively undisturbed ponds. The egg cocoon's construction necessitates the use of floating leaves (Maillard 1970) or debris. Eggs are laid in silken cocoons that are formed in shallow water, typically about 15 cm, and maximally at 30 cm in spring and summer, and larvae occur, often floating just below the surface. The cocoon is protected by a leaf or leaf fragment folded around the outside. The egg cocoons float in small pools of clear water amongst blades of floating grasses, or amongst taller vegetation, or around the edges of those floating mats of mixed swamp vegetation which occupy the centre of some long undisturbed ponds: the proximity of such vegetation appears critical to the subsequent survival of the larvae. A difference in phenology has been detected between the Somerset and Cheshire records, adult occurrence in the former being bimodal with peaks in April and August, with larval occurrences peaking in May. The Cheshire data for adults are unimodal, peaking in June/July, with larvae peaking in June and occurring until August, egg cocoons having been detected as late as July. It is assumed that adults emerge during the summer and disperse, overwintering in water according to one observation in February. To feed, the larvae grip surface vegetation and lever prey items clear of the water. They prefer soft-bodied arthropods to the snails often claimed in the literature. Adults are occasionally found attracted to light or to glass, and fly readily at dusk if kept in captivity.

Status This species, with an extent of occurrence of 9,100 km² and an area of occupancy based on sixteen hectads known to be occupied since 1980 in England and Wales in two discrete centres, might qualify for IUCN Vulnerable status. However, there is if anything evidence for expansion of range rather than decline and it would appear safer to list this species as Near Threatened on the basis that whatever it was that caused the major decline in the past might come back into operation. *H. caraboides* was more widely distributed in the 19th Century, being particularly well recorded from the Hammersmith Marshes, the Cambridgeshire Fens and Askham Bog. There is a single record from West Sussex in 1926, as well as some older Welsh records that need confirmation. Until recently it was thought to have become confined to the Somerset Levels, but discovery of individual adults in three ponds on the Cheshire Plain was followed, in May and June 1996, by the discovery of egg cocoons and larvae, in particular at one of the few remaining unenclosed commons of the area, and later by a series of finds over much of Cheshire and Denbigh. The steady accumulation of new site records on and around the Cheshire Plain might be interpreted as an extension or infilling of range, but the possibility exists that it represents a previous lack of detection. Beebee (2002) noted the occurrence of *H. caraboides* on the North Somerset Levels in 16 out of 19 years of survey, being particularly abundant in the early 1980s, and generally scarcer since.

Threats The loss of peatland through drainage and wastage has in the past been considered to pose the major threat to this species, though its occupancy of ponds on the Cheshire Plains demonstrates that it is by no means confined to peat. It may be surmised that disturbance of ditches or ponds when egg cocoons are present is likely to be deleterious. Injudicious conservation measures - however well-intentioned - could result in damage to habitat at this critical time in the year. *H. caraboides* features on many local action plans, and this too could prove counter-productive if there is insufficient national co-ordination of conservation activities. Colonisation of the "pondscapes" of the Cheshire Plain reduces the perceived vulnerability of this species in England. There its survival depends on the abundance of small, richly vegetated and fishless ponds rather than on either a cycle of ditch cleaning or the presence of peat.

Management and conservation The turbary peats of the Somerset Levels are protected in various ways. The Cheshire sites do not have statutory protection, but this should be considered for those with evidence of breeding. The possibility of reintroducing this species to Woodwalton Fen NNR and Wicken Fen NNR should be considered. Such introductions should be prefaced by genetic characterisation of the populations from which the recruits are drawn, or, at the very least, by preserving material in a form suitable for future genetic study. Survey work concerning this species must be conducted at the appropriate times of year, i.e. in the spring when adults and the egg cocoons can be detected, or in late summer, when the new generation of adults emerges; surveys in midsummer can be highly misleading. On the Somerset Levels it appears that this species

benefits from periodic ditch cleaning. Survey work should establish the optimal management of a ditch system, and the optimal type of pond. Scrapes were created at one Cheshire site in 1998. Guest (2001) has noted that nearly all Cheshire sites are poached by cattle, and livestock access is considered desirable as a means of reducing thick and shading vegetation. A Biodiversity Action Plan was prepared for this species but it does not appear in the latest priority list of invertebrates.

Published sources Allen (1958), Anonymous (2005a), Balfour-Browne (1958), Beebee (2002), Biggs *et al.* (1991), Boyce (2004), Bøving & Henriksen (1938), Denton (2004, 2007a), Department of the Environment (1995), Duff (1993), Foster, A.P. (1984b), Foster, G.N. (1987a, 2000b, 2001b, 2002), Friday (1988a), Gibbs (1857), Guest (1996, 1997, 2001), Hansen (1987), HMSO (1992), Key (1998), Lohez (2007), Maillard (1970), Palmer (1980), Shirt (1987), Šmetana (1980), Sutton (2008), Sutton & Wilkins (2005), UK Biodiversity Group (1999), Valladares & Ribera (1993), Whitehead (1989).

HYDROCHUS BREVIS Near Threatened

Order COLEOPTERA Family HYDROCHIDAE

Hydrochus brevis (Herbst, 1793).

Identification The treatment by Angus (1977a) could not take into account the existence of *H. megaphallus* van Berge Henegouwen, but Friday (1988a) mentions this species.

Distribution The most recent map is provided by Foster (1987a); it should be used in conjunction with the vice-county map of Balfour-Browne (1958, map 41). Both maps were prepared before recognition of the existence of *H. megaphallus*, and the former map has been reappraised (Anonymous 1988, 1991). Records since 1980 are for West Suffolk, East and West Norfolk, Salop, Anglesey, South-east and Mid-west Yorks, Durham, Cumberland, Kirkcudbright, Wigtown, Roxburgh, Angus, Moray, and East Inverness. Earlier records are for West Kent, West Suffolk, West Norfolk, Hunts, West Gloucester, North Lincs, South Northumberland, Renfrew, Berwick, Midlothian, and Mid Perth. *H. brevis* is a northern species, reaching the French Pyrenees (Queney 2004) and northern Italy in the south, recently new for Bohemia, and occurring over much of southern Fennoscandia and ranging to Eastern Siberia and Turkey.

Habitat and ecology *H. brevis* occurs in well established weedy pools and fens with thick emergent vegetation, often in partial shade and usually with a soft bottom of mud or peat. It has been detected by sifting litter and by the use of Berlese funnels. *Hydrochus* species are aquatic as adults and larvae, but do not swim. They are slow in their movements, and feign death when disturbed. Adults feed on algae according to Archangelsky (1998) but the larval diet is unknown.

Status There are records for 24 hectads in Britain from 1980 onwards. Angus (1977a) drew attention to the persistence of colonies of this species, citing finds widely separated in time near Loch Vaa, Moray and at Thurstonfield Lough, Cumberland. The species no longer exists at many of its former sites in northern Britain, but is still common in many relict sites in the Breckland and Broadland. Sub-fossil material, which has been reported from Warks, Salop, North Lincs and South-west Yorks, should be checked for *H. megaphallus*, possibly the commoner species of open habitats in the past.

Threats Loss of relict fenland habitats across Britain has resulted in an extremely fragmented distributed, within which localised extinctions place this species at risk of extinction in all but the Breckland and Broadland of Norfolk.

Management and conservation Maintenance of wet carpets of rich fenland vegetation and large areas of mossy edge in fluctuating ponds is essential for the survival of this species. Most of the sites in which it occurs receive some form of statutory protection, e.g. the Malltraeth Marshes and Loch Vaa SSSI, Fonah Bog, part of the Balgavies Loch reserve owned by the Scottish Wildlife Trust, the Whitlaw Mosses NNR (part of the Natura 2000 Whitlaw & Branxholme SAC), Biglands Bog, a reserve of the Cumbria Wildlife Trust, and the Norfolk palsa scar ("pingo") fens such as Thompson Common, a reserve of the Norfolk Wildlife Trust, and Weston Fen, a reserve of the Suffolk Wildlife Trust. *H. brevis* often occurs in small water bodies associated with a larger one, and there is a risk that protection of the lake may not result in protection of surrounding wet areas. This

appears to have been the case at Thurstonfield Lough, and should be prevented from occurring at other SSSI, e.g. Loch Vaa.

Published sources Angus (1964b, 1965, 1977a), Anonymous (1988, 1991), Archangelsky (1998), van Berge Henegouwen (1988), Boukal *et al.* (2007), Darilmaz & Kiyak (2008), Foster, G.N. (1977c, 1981a, 1983c, 1984d, 1987a, 1993, 2005b), Hammond & Merritt (2008), Hancock (1998, 2002), Hodge & Jones (1995), Morgan (1991), Nobes (2001), Queney (2004), Ryndevich (2003); Silfverberg (2004, 2006).

HYDROCHUS CRENATUS Near Threatened

Order COLEOPTERA Family HYDROCHIDAE

Hydrochus crenatus (Fabricius, 1792). This was formerly known as *H. carinatus* Germar.

Identification Angus (1977a) illustrated and keyed this species among some European species. It is keyed in the British fauna by Friday (1988a). The Scandinavian key (Hansen 1987) should be used with caution as it does not include all British species.

Distribution The most recent published map is provided by Foster (1987a). Records since 1980 are for East Kent, East and West Norfolk, Cambs, Hunts, Northamptonshire, South and North Lincs, and, as a single specimen, in South-west Yorks. Earlier records are East and West Suffolk, with sub-fossil material known from North Somerset. Although *H. crenatus* reaches the Mediterranean on Corsica and Sardinia, and in northern Italy and the Balkans, it is mainly a northern European species. There is a recent record for Asian Russia.

Habitat and ecology *H. crenatus* occurs mainly in mossy edges of fluctuating ponds and in rich fens. The life-cycle of this species is unknown but adults are commonest in the spring and autumn. *Hydrochus* species are aquatic as adults and larvae, but do not swim. They are slow in their movements, and feign death when disturbed. Adults feed on algae according to Archangelsky (1998) but the larval diet is unknown.

Status There are records for 25 hectads in England from 1980 onwards. *H. crenatus* has strong centres in the Woodwalton Fen area and in Breckland. This species is known from Neolithic, Bronze Age and Iron Age deposits in the Somerset Levels but is not extant in south-west England.

Threats Loss of fenland habitats have reduced the distribution of this species but excessive abstraction of groundwater in Breckland poses the greatest threat, as this will alter the hydrology of the fluctuating water bodies.

Management and conservation Restriction on water abstraction in Breckland is desirable to protect the wetlands there, which, however, do receive direct statutory protection in some cases. Some of the Breckland sites are reserves of the Norfolk Wildlife Trust (Foulden Common and Thompson Common) and the Lincolnshire Wildlife Trust (Burton Gravel Pits), and some meres and ponds on the Stanford Training Area of the Ministry of Defence, Norfolk (which is part of the Brecklands Special Area of Conservation) support this species. This species occurs on Woodwalton NNR and Monks Wood NNR. The genetic relationships of what appears to be a recently established population in East Kent with the East Anglian populations should be explored.

Published sources Angus (1977a, 1977b), Anonymous (1998a), Archangelsky (1998), Balfour-Browne (1958), Bilton (1987), Booth (2001), Foster, G.N. (1973a, 1977c, 1980b, 1983c, 1987a, 1993), Friday (1988a), Girling (1979a, 1979b, 1984a), Gurney & Cadbury (2001), Hansen (1987), Key (1994), Kirby (1998), Lohez (2007), Merritt (2006), Painter (1994), Palmer (1977, 1981a), Perry (1998), Prokin *et al*. (2008), Sinclair (1982), Welch (1973).

HYDROCHUS ELONGATUS Near Threatened

Order COLEOPTERA Family HYDROCHIDAE

Hydrochus elongatus (Schaller, 1783)

Identification Angus (1977a) illustrated and keyed this species among some European species. It is keyed in the British fauna by Friday (1988a). The Scandinavian key (Hansen 1987) should be used with caution as it does not include all British species.

Distribution Records since 1980 are for North Hants, East Sussex, Surrey, South Essex, Berks,

East Suffolk, East and West Norfolk, Cambs, Hunts, Northamptonshire, Hereford, Worcester, Warks, South and North Lincs, Leics, Derbyshire, South-east and South-west Yorks. Earlier records, mainly verified by Angus (1997a), are for South Somerset, North Wilts, East and West Kent, Middlesex, Oxon, Bucks, Beds, Glamorgan, Notts, and North-east Yorks. Several old records for Scotland and north-east England possibly refer to *elongatus* as opposed to *ignicollis* Motschulsky. The most recent map is provided by Foster (1987a). *H. elongatus* is mainly a central European species, ranging to Britain, Denmark, Sweden, east Siberia, Italy, former Yugoslavia, and Turkey.

Habitat and ecology This species occurs in shallow, well vegetated, still water, often in reedbeds and other areas with rich emergent vegetation over clay, in low-lying areas. *Hydrochus* species are aquatic as adults and larvae, but do not swim. They are slow in their movements, and feign death when disturbed. Adults feed on algae according to Archangelsky (1998) but the larval diet is unknown.

Status There are records for 38 hectads in England from 1980 onwards. This species has contracted in range, owing to loss of sites in Scotland, north-east England, the London area, south-west England, and possibly Wales. The only recent records for the East Anglian coast are from the Halvergate Marshes and Redgrave and Lopham Fens, but not from the Norfolk Broads. Its occurrence includes some man-made habitats unlike its sibling species *H. ignicollis*, which is almost entirely associated with ancient fenland. This species is known from Neolithic deposits in the Somerset Levels but is not extant there.

Threats Loss of fenland habitats, particularly reedbeds, will be detrimental to this species.

Management and conservation Restoration of old clay ponds should take into account the need to retain reedbeds. This species can colonise man-made ponds once they are well established. *H. elongatus* is found in several sites under protection, e.g. Woodwalton Fen NNR, Thorne Moors NNR and Wicken Fen NNR.

Published sources Angus (1977a), Archangelsky (1998), Balfour-Browne (1958), Carr (1985b), Darby (2009), Darilmaz & Kiyak (2008), Denton (2005, 2007a), Foster, A.P. (1986), Foster, G.N. (1980b, 1987a), Foster & Watson (2006), Friday (1988a), Girling (1977, 1980, 1984a), Hammond & Merritt (2008), Hansen (1987), Kirby (1998), Kirk-Spriggs & Mann (2000), Lane, Wright & Forsythe (2002), Lohez (2007), Lott (1995), Merritt (1995, 2006), Painter (1994), Palmer (1980), Sinclair (1982), Skidmore, Limbert & Eversham (1985), Watson & Foster (2006).

HYDROCHUS IGNICOLLIS Near Threatened

Order COLEOPTERA

Hydrochus ignicollis (Motschulsky, 1860).

Identification Angus (1977a) illustrated and keyed this species among some European species, recognising for the first time its status as a species distinct from *elongatus*. It is keyed in the British fauna by Friday (1988a). The Scandinavian key (Hansen 1987) should be used with caution as it does not include all British species.

Distribution Angus (1977a) gave the following distribution based largely on museum material: South and North Somerset, East Sussex, East Kent, Cambs, Oxon, East Norfolk, Beds, and Wales. The Irish status of *ignicollis* suggests that some old Scottish records for *elongatus* may refer to this species. The most recent map is provided by Foster (1987a). There are modern records for North Somerset, East and West Kent, East Sussex, East and West Norfolk, Cambs, Northamptonshire, Anglesey, and South Lincs. *H. ignicollis* is a northern European species, not reaching the Mediterranean, and being rather more widely distributed in north-west Europe than *H. elongatus*, reaching Asian Russia and Turkey.

Habitat and ecology This species occurs in stagnant, well vegetated pools, often in association with mosses in the margins of pools that dry out. Unlike *H. elongatus*, this species is exclusively associated with areas of ancient fenland, for example in the Breckland palsa scar ("pingo") fens. *Hydrochus* species are aquatic as adults and larvae, but do not swim. They are slow in their movements, and feign death when disturbed. Adults feed on algae according to Archangelsky (1998) but the larval diet is unknown.

Status With records for eighteen hectads in England and Wales from 1980 onwards this species might just qualify for the IUCN Vulnerable status on the basis of its area of occupancy. However, despite its primary association with relict fen, it cannot be claimed to be in decline and it is safer to regard it as Near Threatened.

Threats Loss of fenland habitats has resulted in a contraction in the range of this species. This species is most at risk from excessive water abstraction in Breckland.

Management and conservation *H. ignicollis* occurs on many sites subject to statutory protection, e.g. SSSI in the East Norfolk palsa scar ("pingo") fens, Old Buckenham Fen, the Somerset Levels and the Pevensey Levels, and Catfield Fen NNR.

Published sources Archangelsky (1998), Bilton (1987), Cadbury, Shardlow & Gurney (2002), Carr (1985b), Carr & Philp (1988), Darilmaz & Kiyak (2008), Duff (1993), Foster, A.P. (1983), Foster, G.N. (1983c, 1987a, 1993), Foster & Foster (1984), Friday (1988a), Hansen (1987), Hodge (2006), Hodge & Jones (1995), Kirby (1998), Lohez (2007), Painter (1994), Phillips (1985), Prokin *et al*. (2008), Telnov & Kalninš (2000).

HYDROCHUS MEGAPHALLUS
VULNERABLE

Order COLEOPTERA Family HYDROCHIDAE

Hydrochus megaphallus (van Berge Henegouwen, 1988).

Identification Friday (1988a) mentions the recent discovery of this species when keying *H. brevis* (Herbst). This species is compared with *H. brevis* in the original description, but the value of the pronotal characters has been questioned. The value of the fifth abdominal sternite was recognised by van Berge Henegouwen (1990). The discovery of *H. megaphallus* post-dates the standard keys to the British and to the Scandinavian faunas.

Distribution Records since 1980 are for East Suffolk and East Norfolk. Museum material indicates that this species was possibly as common as or commoner than *H. brevis* in the Broads at the turn of the Century, and also that *H. megaphallus* occurred in Leics in the 19th Century. Specimens from the 1960s survey of Lopham Fen, East Suffolk by staff of the (then) British Museum (Natural History) are *H. megaphallus*, and Geoff Nobes has found this species again there in 2004 and 2005. The full extent of the distribution of this recently described species is uncertain, but it appears to be northern European, being recorded from Belarus, Denmark, France, the Netherlands, Sweden, the Czech Republic as well as Turkey, from where it was first detected.

Habitat and ecology This species coexists with *H. brevis* in East Norfolk. In the Netherlands, it occupies more flood-plain habitats than *H. brevis*, being found at the edges of exposed, muddy ditches with reed litter. *Hydrochus* species are aquatic as adults and larvae, but do not swim. They are slow in their movements, and feign death when disturbed. Adults feed on algae according to Archangelsky (1998) but the larval diet is unknown.

Status *H. megaphallus* has been recorded from five hectads in the Broads area from 1980 onwards. This species is clearly rarer than the other British species of *Hydrochus*, except *H. nitidicollis*. The IUCN criteria for Vulnerable status that are satisfied are based on an extent of occurrence of ca 8,000 km² and an area of occupancy of five hectads in ten areas of the Broads from 1980 onwards. The fens it occupies are still quite extensive, rather more than 20 km², so the D2 criterion is inappropriate, but *H. megaphallus* appears to have become more restricted than *H. brevis* in even the most natural fens, indicating the fragility of the precise conditions that it requires.

Threats Loss of relict fen conditions, particularly fragmentation of larger fen systems, would appear to be detrimental. Extraction of groundwater might affect some fenland sites.

Management and conservation The two sites with modern records are Lopham Fen, a reserve of the Suffolk Wildlife Trust, and Catfield Fen NNR, managed by Butterfly Conservation. This species therefore receives site protection. Management objectives of the sites must include retention of the open fen conditions that have favoured the population of this species on Mrs Myhill's Marsh in the Hickling catchment. Sites

where *H. brevis* has been reported should be reinvestigated to check for the occurrence of *H. megaphallus*, as should museum material of *H. brevis.*

Published sources Anonymous (1988, 1991), Archangelsky (1998), van Berge Henegouwen (1988, 1990), Boukal *et al.* (2007), Darilmaz & Kiyak (2008), Friday (1988a), Hodge & Jones (1995), Nilsson (1988b), Pope (1969), Queney (2006, 2009).

HYDROCHUS NITIDICOLLIS
VULNERABLE

Order COLEOPTERA Family HYDROCHIDAE

Hydrochus nitidicollis (Mulsant, 1844). *H. interruptus* Heyden, usually regarded as a synonym, is a distinct species (A. van Berge Henegouwen, pers. comm.).

Identification Angus (1977a) illustrated and keyed this species among some European species. It is keyed in the British fauna by Friday (1988a) but there are a surprising number of misidentifications of *H. angustatus* Germar as this species in England, possibly through failure to recognise the importance of colour characters. The Scandinavian key (Hansen 1987) should be used with caution as it does not include all British species. The representation of the male genitalia by van Berge Henegouwen (1992) was corrected by Cuppen (1993b).

Distribution The most recent map is provided by Foster (1987a). Records are for West and East Cornwall, and South Devon, as are all previous authenticated records. A record for Bookham Common (Kett & Kirk 1994) should be referred to *H. angustatus*. *H. nitidicollis* is largely a western European species, known from western France and Iberia, Belgium, the Netherlands, the Rhineland, and Italy.

Habitat and ecology The typical habitat of this species is in pockets of still water among coarse gravel in shingle beds at the edges of rivers and open water bodies, some of them man-made. Booth (1990) reported a specimen swept from low vegetation at the edge of a reservoir. *Hydrochus* species are aquatic as adults and larvae, but do not swim. They are slow in their movements, and feign death when disturbed. Adults feed on algae according to Archangelsky (1998) but the larval diet is unknown.

Status With an extent of occupancy of ca 2,300 km² and an area of occupancy of five sites in five English hectads from 1980 onwards *H. nitidicollis* meets the IUCN criteria for the Vulnerable status. Site loss is also evident in Devon.

Threats Regulation of river systems will be detrimental to this species. The narrow distribution in England indicates a strong dependency on a warm Atlantic climate rather than on a particular management practice or habitat.

Management and conservation The running water sites supporting this species has been recorded are not directly protected for conservation purposes. Red Moor, where the species has been found in a former quarry pool, is a wildlife reserve of the Cornwall Wildlife Trust. *H. nitidicollis* has also been found at several sites in the Dartmoor National Park. Breney Common is an SSSI and part of the Breney Common and Goss and Tregoss Moors SAC. *H. nitidicollis* is a UK Biodiversity Action Plan priority species and features in the Exposed Riverine Sediment Habitat Action Plan.

Published sources Angus (1977a), Archangelsky (1998), Balfour-Browne (1958), van Berge Henegouwen (1992), Booth (1990), Cuppen (1993b), Department of the Environment (1995), Foster, G.N. (1973b, 1987a, 2001c), Friday (1988a), Hansen (1987), Kett & Kirk (1994), Mitchell (1917), Sadler *et al*. (2004).

HYDROCYPHON DEFLEXICOLLIS Near Threatened
The rockhopper beetle

Order COLEOPTERA Family SCIRTIDAE

Hydrocyphon deflexicollis (Müller).

Identification This species is not treated in British identification keys specifically for water beetles, but it is covered by the usual, very dated, Coleoptera keys.

Distribution Records since 1980 are for South and North Devon, South Somerset, East Norfolk,

Salop, Radnor, Ceredigion, Caernarfon, Mid-west and North-west Yorks, Durham, Westmorland, Cumberland, Kirkcudbright, Wigtown, Selkirk, Roxburgh, East and West Inverness, and West Ross. Earlier records add South Essex, Montgomery, Meirionydd, North-east Yorks, Westmorland, Dumfries, Stirling, Mid Perth, Moray, East Ross, and Mull. *H. deflexicollis* is known from Austria, Belgium, Croatia, the Czech Republic, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, the Netherlands, Poland, Romania, Russia, Slovakia, Slovenia, Switzerland, and Turkey.

Habitat and ecology This species lives in small hill streams and occasionally in larger rivers. In Wales it is also known from upland streams but most records are from shingle bars on gravel bed rivers. The larvae pupate underwater and the adults are also found, usually in July and August, under water as well as being found at the edges of a stream or making short flights from exposed rock to exposed rock.

Status Hyman & Parsons (1992) listed this species as Notable B based on its widespread distribution.
H. deflexicollis has been recorded from 29 hectads in Scotland, Wales and England since 1980. Recent surveys of exposed riverine sediment have generated records, mainly on the Spey and Afon Rheidol. This species appears to have been lost from North-east Yorkshire and from South Devon. Dramatic losses indicated by analysis of data from Ireland have caused it to be categorised as Endangered there. Records in the Czech Republic also indicate losses.

Threats Any river engineering activity that reduces the movement of shingle banks is likely to detrimental to this species. Afforestation of uplands will have reduced the availability of suitable headwaters. The spread of alien weeds, such as Himalayan balsam (*Impatiens glandulifera* Royle) on riverbanks and Japanese Knotweed (*Fallopia japonica* (Houtt)) on shingle, has been identified as likely to reduce the available habitat, given that adults are found in vegetation around the breeding sites. Enrichment, in encouraging such aliens, is also bound to be damaging even if it does not result in obvious loss of water quality.

Management and conservation Livestock access was previously (Hyman & Parsons 1992) identified as detrimental in that it might damage shingle structure and disturb vegetation communities. Here, livestock access is considered to be potentially beneficial in maintaining an open structure to stream edges, although the extent and timing of access should be limited.

Published sources Boukal *et al.* (2007), Foster, Nelson & O Connor (2009), Hyman & Parsons (1992), Löbl & Šmetana (2006), Lott (2006).

HYDROPHILUS PICEUS Near Threatened
Great Silver Water Beetle

Order COLEOPTERA Family HYDROPHILIDAE

Hydrophilus piceus (Linnaeus, 1758). This is sometimes incorrectly referred to as *Hydrous* (see Pope 1985).

Identification Adult, larval and pupal stages of *H. piceus* are illustrated in many popular accounts of beetles. The possibility that other *Hydrophilus* species, *H. aterrimus* Eschscholtz and *H. pistaceus* Castelnau, might occasionally be detected in Britain as migrants appears to have been ignored in the past. The latter two species lack the sutural spine at the tip of the elytra, a character easily seen in live *H. piceus* before returning them to the wild.

Distribution The most recent map is provided by Sutton (2008). Records since 1980 are for South and North Somerset, East Sussex, East and West Kent, South and North Essex, East Suffolk, East Norfolk, and Monmouth. Earlier records add Dorset (1821 only), Isle of Wight (1931), Cambs (1820s-1938), Hunts (1820s), Glamorgan (1820s), and Leicestershire (1860s, 1930s). There are no certain records from Surrey where it was introduced into a pond at Haslemere Museum in the 1960s by John Clegg (Denton 2007a). One record for the Isle of Wight is incorrect (Knill-Jones 1995) and an older one lacks locality data. *H. piceus* ranges from southern Scandinavia to Catalonia, known from northern Africa only in Egypt, and east to northern India in Kashmir and to Siberia.

Habitat and ecology In Britain, *H. piceus* is largely confined to drains in coastal levels. Those specially favoured are choked with vegetation such as ivy-leaved duckweed (*Lemna*

trisulca L.) and fringed by common reed (*Phragmites australis* (Cav.)). *H. piceus* is a summer breeder (larvae reported from mid-May to the beginning of August in the Netherlands). The larvae feed on water snails, and the presence of *Hydrophilus* may be implied from the characteristic biting marks to be seen on empty snail shells. A photographic sequence of pupation has been provided by Walsh & Dibb (1954). The life-cycle has also been described by Leadley Brown (1971) and Balfour-Browne (1958). The construction of the egg cocoon was described by Maillard (1970). In the Somerset Levels, adults are found mainly in rhynes that have been recently cleared, whereas larvae occur in ditches thickly choked with vegetation. Adults have often been caught in light traps, and may occasionally be seen below street lamps, or on greenhouse roofs. An adult *H. piceus* has also been found on an offshore oil platform (Young 1995).

Status *H. piceus* has been recorded from 50 hectads in England and Wales from 1980 onwards. It appears to have contracted in range in that there are no modern records for the English Midlands, the Cambridgeshire Fens, Glamorgan and the immediate vicinity of London. It is, however, well established in the Somerset Levels, the Broads, and coastal levels in Kent, Essex and Sussex. It is known from Neolithic, Bronze Age and post-Iron Age deposits in the Somerset Levels, where it still occurs, though apparently in decreasing numbers. It is also known from Roman remains at Alchester, Oxon (Robinson 1979) and post-medieval remains in South-west Yorks (Dinnin 1991).

H. piceus is considered to be extinct in Luxemburg (Gerend 2003) and Norway (Ødegaard *et al.* 2006), Critically Endangered in the Czech Republic (Trávníček *et al.* 2005), Vulnerable in Slovakia (Holecová & Franc 2001), Near Threatened in Poland (Pawłowski *et al*. 2002) and Sweden (Gärdenfors 2005).

Threats Loss of traditional grazing fen may result in loss of this species, particularly if drains are destroyed or become overgrown. Drainage of the Cambridgeshire Fens and the London Marshes in the 19th Century must have resulted in the greatest reductions in this species in Britain, indicating the potential for further decline.

Management and conservation Conditions favouring an abundance of large molluscs are essential for breeding by this species; piecemeal clearance of drains using hand shovels is better than large scale clearance using heavy plant in that larger invertebrates can escape. Much of the area where *H. piceus* occurs in the Broads and on levels in Gwent, Somerset, Kent and Sussex is protected by scheduling as SSSI, and smaller areas are protected as NNR and wildlife reserves. The possibility of reintroducing *H. piceus* to a Cambridgeshire fen, or its introduction to Woodwalton Fen, should be considered.

Published sources Anonymous (1998b), Balfour-Browne (1958), Beebee (1991, 2002), Boukal *et al.* (2007), Boyce (2004), Bøving & Henriksen (1938), Cadbury, Shardlow & Gurney (2002), Carr (1985a, 1985b), Carr & Philp (1988), Charman, Palmer & Philp (1985), Cuppen (1992), Department of the Environment (1995), Dinnin (1991), Denton (2007a), Drake (1988), Driscoll (1978), Duff (1993), Foster, A.P. (1983, 1984b), Foster, G.N. (1966, 1972, 1987a), Foster & Eyre (1992), Gärdenfors (2005), Gerend (2003), Girling (1976, 1978, 1982a, 1984a), Hebauer & Ryndevich (2005), Holecová & Franc (2001), Knill-Jones (1985, 1991, 1994, 1995), Leadley Brown (1971), Leech (1975), Leeming & England (2005), Lohez (2007), Lott (2009), Maillard (1970, 1971), Murray (1977), O'Neil & Beebee (2005), Painter (1994), Palmer (1980, 1981b), Pawłowski *et al*. (2002), Philp (2002), Pope (1985), Robinson (1979), Sutton (2002, 2008), Sutton & Wilkins (2005), Trávníček *et al.* 2005, Valladares & Ribera (1993), Walsh & Dibb (1954), Young (1995), Ødegaard *et al.* 2006.

HYDROPORUS ELONGATULUS

VULNERABLE
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Hydroporus elongatulus (Sturm, 1835).

Identification The adult is keyed by Friday (1988a). The larva is unknown.

Distribution The most recent map is provided by Foster (1984b). Records since 1980 are for West Suffolk, West Norfolk, Dumfries, Peebles,

Roxburgh, and Berwick in a site running into East Lothian, and from Ayrshire in 1976. *H. elongatulus* is a northern European species rare throughout its range, which includes France, the Netherlands, Belgium, Germany, Denmark, Fennoscandia, Estonia, Lithuania, Poland, Mongolia and European Russia. In the Czech Republic it is known from Bohemia but recorded in error from Moravia.

Habitat and ecology *H. elongatulus* occurs in temporary areas of stagnant, base-rich fen, for example in palsa scar ("pingo") fens in West Norfolk and in small valley mires and in fens at the edges of lochs in southern Scotland. In a study of Bavarian moorland pools, Schmidl (1999) considered *H. elongatulus* to be specially associated with sedge litter. *H. elongatulus* does not take readily to flight, and may generally be flightless.

Status At 23,000 km² the extent of occurrence of *H. elongatulus* is too high to meet the appropriate criterion for the IUCN status of Vulnerable. However, with ten areas in nine hectads in Scotland and England from 1980 onwards, and evidence of site loss, this species can be regarded as Vulnerable. *H. elongatulus* appears to have become extinct at the Ayrshire site but is still often abundant at the more eastern Scottish sites and in the palsa scar ("pingo") fen pools on Thompson Common. *H. elongatulus* was detected in Bronze Age peat deposits on Thorne Moors by Whitehouse (1997).

Threats The Ayrshire locality may have become unsuitable owing to enrichment from water originating in the settling pools of an opencast site. In the Breckland sites, the greatest threat is posed by excessive abstraction of artesian water. One site in Scotland was threatened by its proximity to the M74 when that was being planned, but this risk was averted. This rare beetle can, however, survive in small, isolated areas of fen subject to some enrichment, and it has also survived in fens at Lochmaben subject to considerable disruption and drying out episodes.

Management and conservation The hydrological status of Thompson Common, a reserve of the Norfolk Wildlife Trust, must be maintained by prevention of further water abstraction in its vicinity. The maintenance of natural, fluctuating water tables on managed nature reserves is vital. Recognition of the need to conserve sites on the basis of their fauna rather than their magnitude is also desirable as many sites are small. Most of the sites for *H. elongatulus* are SSSI, and some are Wildlife Trust reserves. One site lies within the Ministry of Defence Stanford Training Area, Norfolk.

Published sources Anonymous (1986a, 1990), Boukal *et al.* (2007), Foster, G.N. (1977a, 1983c, 1984a, 1984b, 1984d, 1993), Friday (1988a), Hájek & Šťastný (2005), Hodge & Jones (1995), Lohez (2007), Nilsson & Holmen (1995), Schmidl (1999), Shaverdo, Short & Davaadorj (2008), Sinclair (1991), Whitehouse (1997).

HYDROPORUS GLABRIUSCULUS

VULNERABLE
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Hydroporus glabriusculus (Aubé, 1838).

Identification The adult is keyed by Friday (1988a). The third instar larva is keyed with 16 other British species by Nilsson (1989).

Distribution The most recent map is provided by Bilton (1993b). Recent published records are for East and West Norfolk, Roxburgh, and Berwick, and for Selkirk up to 1975. The only early record is from Mid-west Yorks in 1906. *H. glabriusculus* is a northern Palaearctic species, the range of which includes Ireland, the Netherlands, Denmark, Norway, Sweden, Finland, Lithuania, Poland, European Russia, and Siberia.

Habitat and ecology *H. glabriusculus* is confined to undisturbed, relict fen and bog systems. *H. glabriusculus* has been the subject of detailed morphological studies and differentiation of subpopulations by the use of allozyme profiles. The latter approach gave results consistent with geographical isolation, and indicated that populations occupying each fen are divided into small demes between which there is limited gene flow. These demes occupy small pockets of wet moss in shallow bogs, the largest sites having the greatest genetic diversity. Some individuals from a Swedish population have been shown to make short hopping glides. Flight tests with British material have proved negative but it has been concluded that flight is

possible as the skeletal apparatus is unmodified and the flight muscles are occasionally present.

Status The extent of occurrence of *H. glabriusculus* is 19,300 km², which combined with evidence of loss from at least three of the fourteen locations in fourteen hectads in England and Scotland from 1980 onwards is sufficient to justify the IUCN Vulnerable category. The Norfolk palsa scar ("pingo") fen populations show the least variation, suggesting that "bottlenecking" of these populations took place during the Late Glacial.

Threats Loss of habitat in the Norfolk palsa scar ("pingo") fens is most likely to come about because of extraction of groundwater; this is particularly the case at East Harling Common. Damming of protected land to retain water could also prove detrimental if smaller ephemeral water bodies are lost in the process. Whilst the extinction of the species from Askham Bog might be explained on the basis of pollution from a pig farm, the loss of open fen habitat at the beginning of the 20th Century is also likely to have been important. However some Irish and Borders sites are partly shaded.

Management and conservation Most of the sites in which *H. glabriusculus* occurs receive statutory protection, e.g. the Whitlaw Mosses NNR (part of the composite Natura 2000 Whitlaw & Branxholme SAC) and the palsa scar ("pingo") fens of West Norfolk scheduled as SSSI, of which Thompson Common is a reserve of the Norfolk Wildlife Trust. This is the only water beetle classified as "conservation dependent" using IUCN criteria; this is because its survival largely depends on the correct management of ephemeral water bodies to provide a series of small fen pools.

Published sources Bameul (1984), Bilton (1992, 1993a, 1993b, 1994a, 1994b, 1999), Buczyński & Przewoźny (2009), Fitter & Smith (1979), Foster, G.N. (1982b, 1983c, 1984a, 1984b, 1993, 1998), Foster *et al.* (2007), Foster & Sinclair (1982), Friday (1988a), Hammond & Merritt (2008), Hodge & Jones (1995), Nilsson (1989), Nilsson & Holmen (1995), Nobes (2001), Sinclair (1976a, 1987), Telnov & Kalniņš (2003).

HYDROPORUS LONGICORNIS Near Threatened
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Hydroporus longicornis (Sharp, 1871). The species was first described as *H. parallelus* Sharp, 1869.

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). Methods of distinguishing this species from *H. melanarius* Sturm have been detailed by Foster (1969). The third instar larva is keyed with sixteen other British species by Nilsson (1989).

Distribution The most recent map is provided by Foster (1984b). Records since 1980 are for East Cornwall, South and North Devon, South Somerset, Dorset, South Hants, East Sussex, East Kent, Bucks, East and West Norfolk, Caerfyrddyn, Pembroke, Ceredigion, Montgomery, Meirionydd, Caernarfon, Derbyshire, North-east, South-west, Mid-west, and North-west Yorks, South Lancs, Westmorland, Cumberland, South and North Northumberland, Dumfries, Kirkcudbright, Wigtown, Ayrshire, Renfrew, Lanark, Peebles, Selkirk, Roxburgh, Berwick, Midlothian, Stirling, Mid Perth, Kincardine, North Aberdeenshire, Argyll, Kintyre, East and West Inverness, West Sutherland, Caithness, Arran, the Holy Isle off of Arran, Islay, Jura, Skye and Rum. In addition there are older records for Durham and South Northumberland. *H. longicornis* is a northern and central European species, scarce in Ireland and ranging to European Russia, northern Italy, the Czech Republic, Austria and, in France, the Alps.

Habitat and ecology *H. longicornis* is confined to habitats associated with seepages on a peaty substratum, usually associated with base-poor water. In the south of its range in Britain, e.g. on Ashdown Forest and at Burnham Beeches, it is found in shaded habitats, but it occurs in more exposed habitats in the north and west, particularly in watershed mires. In Wales, it occurs in several valley mires, including some associated with former palsa scar ("pingo") systems. Flight tests with this species have been negative.

Status Balfour-Browne (1940) noted this as "The rarest British species of the subgenus [now treated as the genus *Hydroporus* s.s.] and, so far as I can find, not more than eight specimens have been taken in these Islands since Sharp first named it." *H. longicornis* has been recorded from 172 hectads since 1966, when it was discovered in East Sussex and its habitat requirements were first recognised in Britain. It was found in four samples of the British Countryside Survey in 1990. Its scarcity or threat status might be considered in doubt, since it appears to provide an excellent example of failure to recognise the importance of a relatively common habitat. However, within England, lowland Wales and lowland Scotland, the habitat is under threat, being easily lost through drainage and because of increased groundwater usage. *H. longicornis* is confined to natural habitats of this type, and has never been found in severely modified or recreated habitats. This species therefore remains of great value as a habitat indicator, particularly where it occurs in isolated sites in England and on low ground elsewhere. *H. longicornis* has been detected in Flandrian peat deposits in North Lincs (Dinnin 1997).

Threats The isolation of many English colonies places them at great risk of extinction, particularly if climatic change increases the probability of drought in areas where groundwater is in demand. Elsewhere, the greatest risk lies in drainage and modification of seepage areas, particularly in association with pasture improvement and afforestation. The site where *H. longicornis* was first discovered in East Sussex, based on a single spring, was destroyed by drainage before the site could be scheduled.

Management and conservation *H. longicornis* is found in many SSSI, e.g. Butterburn Flow and Sillyhole Moss, and NNR throughout Britain. Managers of such sites should be aware of the special importance of maintaining seepage areas, particularly in valley and watershed mires. The conservation of discrete, springfed areas such as those at Burnham Beeches NNR and the Whitlaw Mosses NNR (part of the composite Natura 2000 Whitlaw & Branxholme SAC), requires special consideration.

Published sources Andrews (1994), Angus (1987), Balfour-Browne (1940), Bilton (1990b), Boukal *et al.* (2007), Boyce (1989, 2001), Boyce & Fowles (1988), Buckton & Ormerod (1997), Clemons (1993), Cuppen (1984), Dinnin (1997), Dunn (1990), Dunn & Merritt (1989), Eyre & Foster (1984), Eyre, Foster & Carr (1992), Foster, G.N. (1969, 1970, 1972, 1976, 1983d, 1984b, 1988b, 1990c, 1992, 2009b), Foster & Eyre (1988, 1992), Foster & Young (1987), Friday (1988a), Hájek & Šťastný (2005), Hammond (in press), Hancock (1992, 1996, 1997, 2002), Hodge (1978a), Hodge & Jones (1995), Merritt (2006), Morgan (1989), Nilsson (1989), Nilsson & Holmen (1995), Owen (1952), Queney (1999), Read (1987, 1990), Shirt (1980), Sinclair (1976c, 1977, 1991).

HYDROPORUS NECOPINATUS

ENDANGERED

Ron's diving beetle

Order COLEOPTERA Family DYTISCIDAE

Hydroporus necopinatus (Fery, 1999). This was known as *H. cantabricus* Sharp until Fery (1999) recognised that as a distinct species of the Cantabrian Mountains, necessitating a renaming of the Lusitanian species.

Identification The adult is keyed by Friday (1988a) as *H. cantabricus*. The larva is unknown.

Distribution The most recent map is provided by Foster (1999). Recent published records are for Dorset and Jersey. *H. necopinatus* is a Palaearctic "Atlantic" or Lusitanian species, being known from western France, Belgium, northern Spain and Portugal. Eastern European records refer to *H. hebaueri* Hendrich (1990). The Dorset population of the species has been described as ssp. *roni* Fery 1999, distinct from ssp. *robertorum* Fery 1999 in Jersey and France, and the nominate form, *H. necopinatus necopinatus*, in northern Spain and in Portugal. A Cornish record (Nicolet 2001) of *cantabricus* refers to *melanarius* Sturm, or at least is referable to that taxon on the basis of morphology.

Habitat and ecology In Britain, *H. necopinatus* occurs in small pools on peat on exposed heathland. Ponds occupied are typically small and ephemeral, and occur on the fringe of acid valley mires, although the species is typically absent from the mire complexes themselves. The closely related *H. melanarius* occurs in similar

habitats in the New Forest and elsewhere in Britain. In northern France *H. necopinatus* occurs in wooded bogs and in southern France and northern Spain, it occurs in a range of habitats, including high-altitude ephemeral peat pools, and temporary base-rich fens. *H. necopinatus* has been found as teneral adults in pitfall traps in June, supporting the idea that it breeds in spring in temporary pools.

Status This species is known in England from three adjacent hectads on the Isle of Purbeck and in neighbouring heathland south of the River Frome, Dorset. It has been recorded from all three since 2005. Recognition of subspecific status for the Dorset form has resulted in genetic studies to explore its claimed endemic status: these endorse the special nature of the UK populations, and suggest recent introgression between the taxon *necopinatus roni* and *melanarius* along the south coast of England, echoed by similar interrelationships in northern France. Whatever its status *H. necopinatus roni* has a narrow distribution, with an extent of occurrence of about 200 km² and an area of occupancy considerably less than the full extent of the three heaths on which it occurs.

Threats Further loss of wet heathland in Dorset could result in extinction of this species in Britain. The marginal pools occupied by this species are more easily damaged that the main part of the wetland and are particularly prone to loss associated with climate change including heightened temperatures and lower rainfall

Management and conservation This is a priority species of the Biodiversity Action Plan. Studland Heath is a NNR. This species is often found in ruts created by vehicles and in small pools associated with artillery practice.

Published sources Department of the Environment (1995), Fery (1999), Foster, A.P. (1984a), Foster, G.N. (1984b, 1985a, 1999, 2005a), Friday (1988a), Hendrich (1990), Hodge & Jones (1995), Nicolet (2001), Queney (2009), Service (1968), Sutton (2005), Warne (1987).

HYDROPORUS RUFIFRONS

ENDANGERED

The oxbow diving beetle

Order COLEOPTERA Family DYTISCIDAE

Hydroporus rufifrons (Müller, 1776). The name *piceus* is often used on the Continent for *H. gyllenhalii* Schiødte but *piceus* Stephens is a synonym of *rufifrons*. Nilsson & Holmen (1995) explain why the correct authority is O.F. Müller, not Duftschmid.

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). The third instar larva is keyed with 16 other British species by Nilsson (1989). Shaverdo (2000) redescribed the larva. Conservation effort concerning this species is hampered by frequent misidentifications of other *Hydroporus* species.

Distribution The most recent map is provided by Foster *et al*. (2008). Records since 1980 are for Ceredigion, North Lincs, Mid-west Yorks, Westmorland, North Northumberland, Kirkcudbright, Dumfries, Stirling, Mid Perth, and Argyll. Earlier records are for Surrey, South Essex, Berkshire, East and West Suffolk, West Norfolk, Cambs, Caerfyrddyn, South Lancs, North-east and Mid-west Yorks, Durham, South Northumberland, Cumberland, Renfrew, Dumbarton, West Perth, and East Ross. A record for Raasay for 1937 (Heslop Harrison 1938) is considered unlikely even though the specimen exists, and that for North Wales (Brown 1948) is based on *H. erythrocephalus* (L.), as are several other records, e.g. for Savernake Forest (Darby 2009). *H. rufifrons* is generally regarded as a rare species, scattered through north and central Europe from France to western Siberia.

Habitat and ecology *H. rufifrons* occurs in shallow and temporary or fluctuating pools in unimproved pasture, often in old oxbow systems, usually in association with rushes and submerged vegetation such as mosses. In the south of the Lake District *H. rufifrons* also occurs in isolated pools on the fells up to 235 metres above sea level, and, at the very centre of its distribution around Windermere, it can be found in small permanent dam-ponds as single individuals. Some records are for seasonal fens associating with the fluctuating margins of larger lakes, including Windermere. Key features of the sites known to support large populations are

water level fluctuation, marginal sedge or rush tussocks and abundant pleurocarpous mosses and fine grasses. In Belarus (Shaverdo 2000), adults were collected in April and laid eggs the day after captivity. Hatching was first observed after six days, and the larvae reached their 2nd instar on 1 May, three days after hatching. Third instar larvae were found in June and August. This species would thus appear to breed in the spring and early summer, with adults overwintering. Flight tests have proved negative, although the species occurrence in isolated pools suggests that at least some individuals are capable of flight at some point during the life cycle: some records in the southern Lake District are based on single specimens in manmade sites, again indicating flight capability.

Status *H. rufifrons* has been recorded from 15 hectads in Britain from 1980 onwards. However, almost all former sites for this species have been investigated since 2000, and the species has only been found in seven hectads, all in the Lake District, south-west Scotland and in the southern Highlands, specimens having last been found in the latter area in 2001. Earlier, this species became extinct in many former habitats on the east side of England from Boldon Flats, County Durham to East Anglia, where it was known from Wicken Fen to the Brecks, also in some northern sites, e.g. Thurstonfield Lough. The records of living beetles indicate a marked historical contraction in range with a 70% reduction in known distribution up to 1980. Foster *et al*. (2008) concluded that *H. rufifrons* should be considered to be endangered in the UK, based on recent rates of decline, and ongoing threats to its remaining habitats. From 2001 onwards the extent of occurrence was ca 4,500 km², only 8% of 56,000 km² from 1980 onwards. The 14 locations currently known in six hectads are insufficient for the Endangered status and would even be marginal to the Vulnerable status. It is necessary to invoke criterion A2, which allows for "an observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years … where the reduction or its causes may not have ceased or may not be understood or may not be reversible", based in this case on the extent of occurrence. This can be justified on the basis of the survey work to which this particular species has been subject, demonstrating a 92% reduction in extent of occurrence over 21 years. Sites such as Gwaun Garthenor continue to retain suitable habitat, and others, such as Wretham Heath, have improved in apparent quality following clearance of scrub. There are three sub-fossil records – for North Devon, North Somerset and South-west Yorks.

Threats The habitat for *H. rufifrons* is extremely fragile, being easily destroyed by drainage of flood plain areas and other activities associated with agricultural intensification (e.g. fertilizer or manure application leading to eutrophication of occupied ponds, cultivation associated with reseeding, *etc*.). It has possibly become extinct at the Lincolnshire site (Epworth Turbary, a reserve of the Lincolnshire Wildlife Trust) following drainage of the periphery and resultant loss of temporary pools. Sites might also be destroyed by inundation; it is suspected that some former sites have been lost through construction of reservoirs for hydroelectric schemes and public drinking water supplies in the flatter expanses of valleys. One site in Scotland is on the edge of a golf course, raising the possibility of habitat damage by eutrophication and "manicuring"; the latter has caused the loss of the Kidwelly Castle site. Lack of grazing, leading to overgrowth by scrub, has also destroyed some habitats.

Management and conservation The conservation of *H. rufifrons* is made difficult by its elusiveness, perhaps a result of a brief adult activity in the autumn and spring. *H. rufifrons* has apparently been lost from several sites receiving protection for their insect fauna, e.g. Wicken Fen NNR, but it occurs in others receiving statutory protection for quite different reasons, e.g. the Kenmure Holms SSSI, scheduled for wildfowl. It has also been found in others, e.g. the Black Wood of Rannoch NNR, that might not at first be considered important for their aquatic fauna. Recognition of the importance of relict temporary pool systems is essential, in particular the value of isolated oxbow systems in agricultural land. The East Wretham site has recently been cleared of scrub, and appears once again suitable for this species. Reintroduction work is in progress (Foster 2009a).

A Biodiversity Action Plan has been prepared for this species. The species has been strongly linked to another species with an action plan, the mud snail (*Omphiscola glabra* (L.)) with the two co-occurring in several sites in the southern Lake District.

Published sources Andrews (1994), Angus (1964a), Balfour-Browne (1940), Bilton (1987), Boukal *et al.* (2007), Brown (1948), Buckland (1979), Darby (2009), Denton (2005, 2007a), Department of the Environment (1995), Drost & Cuppen (2006), Eyre (1985, 1989), Fitter & Smith (1979), Foster, G.N. (1984b, 1988b, 1989b, 2000b), 2001b, 2001c, 2002, 2005a, 2007a, 2009a), Foster & Angus (1985), Foster, Bilton & Routledge (2007), Foster *et al.* (2008), Foster & Eyre (1992), Friday (1988a), Garside (1990), Hájek & Šťastný (2005), Hammond & Merritt (2008), Hancock (2002), Heslop Harrison (1938), Hess & Heckes (1996), Key (1996b), Lohez (2007), Maitland (1966), Nilsson (1989), Painter (1994), Shaverdo (2000), Shirt (1987), UK Biodiversity Group (1999), Welch (1983).

HYDROPORUS SCALESIANUS

VULNERABLE

Mr. Scales' diving beetle

Order COLEOPTERA Family DYTISCIDAE

Hydroporus scalesianus (Stephens, 1828).

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). The third instar larva is keyed with 16 other British species by Nilsson (1989).

Distribution The most recent published map is by Foster (2004b). Records since 1980 are for Dorset, East and West Norfolk, Anglesey, South-east Yorks, Durham, Cumberland, and Angus, the last in the only site known in Scotland. Earlier, additional vice-county records are for South Hants, Herts, South-west and Mid-west Yorks. There are vice-county sub-fossil records for North Somerset, Monmouth, Montgomery, Cheshire, Salop, and South-west Yorks.

A claim (Foster 1982b) that the distribution was associated with the edge of the Weichselian ice advance was disproved by the discovery of *H. scalesianus* in Cumberland and Scotland, but the species is principally associated with pool systems in former periglacial areas in England. *H. scalesianus* occurs in north and central Europe, ranging from Ireland and Les Landes in south-west France to northern Italy, former Czechoslovakia, much of Denmark, Fennoscandia, Latvia, and Siberia.

Habitat and ecology This species is most typical of floating vegetation mats or tussocky areas with much moss. A detailed study in the Netherlands caused Cuppen (1986b) to classify *H. scalesianus* as an acidophilous species, i.e. one tolerant of non-acidic conditions but preferring habitats, in this particular case, from pH 4.1 to 6.5. *H. scalesianus* is not confined to such habitats in Britain and Ireland, more often being found in base-enriched waters of neutral or high pH, such as the West Norfolk palsa scar ("pingo") fens and marlpits on the Breckland. A constant of such habitats is fine grasses or moss. Flight tests have proved negative but a single specimen has been caught in a window trap in Sweden (Lundkvist, Landin & Karlsson 2000).

Status *H. scalesianus* has been recorded from sixteen hectads in Britain from 1980 onwards, six sites being scattered in sites near the coast, the other 17 being spread across the Brecks and Broads. Despite further discoveries of this species, including recognition that it is widespread in Ireland (Foster, Nelson & O Connor 2009), there is evidence of losses from sites where it was formerly found. For example, Fitter & Smith (1979) note that the last record for Askham Bog, Mid-west Yorks was in 1887. The 19th Century and sub-fossil record indicate that it was once widespread in England. Studies of sub-fossils in monoliths from the Somerset Levels (Girling 1976, 1977, 1978, 1979b, 1980) indicate the ability of this species to persist through major hydroseral changes over a long period of time and the likelihood that the species might come to have a highly fragmented relict structure. The area of occupancy is just low enough to allow this species to be classified as Vulnerable, the most appropriate category for a species confined to relict habitats.

Threats Eutrophication and land infill are the major threats to this beetle's habitats. Sites where the entire water body can be affected by a single pollution source, such as Biglands Bog SSSI, are most at risk. The Dorset site is on the edge of a golf course, and receives grass cuttings.

Management and conservation The relict status of the sites that support *H. scalesianus* points to the key to its survival. Substantial changes to the habitat, such as bog development, scrub encroachment - or its clearance - and some enrichment, do not eliminate this species, but *H. scalesianus* appears to be incapable of colonising

new habitats unaided in Britain. This is in contrast to experience in Ireland, where it is widely distributed in lakes and fens, but also in cutover bog and other manmade habitats. Many of the British sites occupied receive protection, simply as SSSI (Hart Bog, Co. Durham), or as reserves (e.g. Biglands Bog, a reserve of the Cumbria Wildlife Trust, Thompson Common, a reserve of the Norfolk Wildlife Trust, several Norfolk Broadland NNR, and Balgavies Loch, a reserve of the Scottish Wildlife Trust). However, there are a few very small sites that are not protected by designation or by sympathetic ownership.

Published sources Balfour-Browne (1940), Bameul (1984), Bilton (1984), Boukal *et al.* (2007), Buckland (1979), Claassen (1987), Cuppen (1986b), Eyre & Foster (1984), Fitter & Smith (1979), Foster, G.N. (1977c, 1982b, 1983c, 1984a, 1984b, 1990a, 1993, 1998, 2005b), Foster & Carr (2004), Foster & Eyre (1992), Friday (1988a, 1988b), Girling (1976, 1977, 1978, 1979a, 1979b, 1980, 1982a, 1982b, 1984a), Hájek & Šťastný (2005), Hammond (2002), Hammond & Merritt (2008), Hodge (1978c), Horsfield & Foster (1983), Key (1996b), Lundkvist, Landin & Karlsson (2000), Nelson & Anderson (1999), Nilsson (1989), Osborne (1972), Palmer (1981a), Petrov (2002), Queney (2002b), Shirt (1987), Vorst *et al*. (2007).

HYGROTUS NOVEMLINEATUS Near Threatened
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Hygrotus novemlineatus (Stephens, 1829). The name *Coelambus* has reverted to subgeneric usage (Nilsson 1995).

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). The three larval instars are described by Nilsson (1983), who also provides a key to this species together with three of the other four species of the subgenus *Coelambus*.

Distribution The map provided by Foster (1981b) should be used in conjunction with the vice-county map of Balfour-Browne (1940, map 42). Records since 1980 are for North-west Yorks, Durham, Cumberland, Kirkcudbright, Ayrshire, East, Mid and West Perth, Stirling, Moray, East Inverness, East and West Ross, East and West Sutherland, Caithness, Islay, Tiree, and Orkney Mainland. Earlier records add Dorset, North Hants, Berks, Cheshire, North-east Yorks, South and North Northumberland, Dumfries, Renfrew, Lanark, Fife, Angus, Kincardine, Argyll, Dumbarton, Kintyre, and Bute, Eigg, and Hoy. *H. novemlineatus* is a northern Holarctic species, known from Fennoscandia, Lithuania, northern Germany and Russia to west Siberia, and, as the subspecies *H. novemlineatus hudsonicus* (Fall) from Quebec to Alaska.

Habitat and ecology This species is associated with permanent water in exposed lakes, usually with light-coloured, finely particulate bottom substrata, usually either sand or silt, sometimes interspersed with peat. Such sites are often base-poor but the species also occurs on calcareous lake marl in Scandinavia (Nilsson 1983). The species is mainly flightless (Eriksson 1972), though thin, normal flight muscles have been found in some Scottish specimens (Jackson 1973). In Scandinavia, larval development takes place between June and August.

Status *H. novemlineatus* has been recorded from 38 hectads in Scotland and England from 1980 onwards. This species has become extinct in southern England and Cheshire, but it is still frequent in northern Scotland and present in southern Scotland, the Northumbrian Lakes and the Lake District. It is transferred to the near threatened category on the basis of loss of range.

Threats It might be assumed that this species has been lost from the southern part of its range because of eutrophication, but fragmentation of the distribution and localised extinctions may also be invoked.

Management and conservation The restoration of Woolmer Pond to its former status as a sandy lake might have made it once more suitable for *H. novemlineatus*, a species last recorded there by Curtis (1855). A controlled reintroduction into this pond would be a possibility, but the recent arrival of geese, and the associated eutrophication, may reduce the chances of success. Any attempt at reintroduction should be prefaced by genetic studies intended to characterise the new material. The fauna of Bassenthwaite Lake possibly benefits from exclusion of powerboats.

Published sources Angus (1966), Ansorge (1969), Balfour-Browne (1940), Curtis (1855), Eriksson (1972), Eyre & Foster (1984), Foster, A.P. (1995), Foster, G.N. (1981b), Foster & Eyre (1988, 1992), Friday (1988a), Hammond & Merritt (2008), Jackson (1973), McCann & Moran (1986), Nilsson (1983, 1995), Nilsson & Holmen (1995), Ratcliffe (1977), Sinclair (1984), Spirit (1986), Tamutis *et al*. (2008).

ILYBIUS WASASTJERNAE ENDANGERED
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Ilybius wasastjernae (C.R. Sahlberg, 1824). The name is occasionally spelt *wasastjernai*, an unjustified emendation of the original spelling. This species has been transferred from *Agabus* (Nilsson 2000).

Identification The adult of this species is not keyed in British treatments. It is keyed by Nilsson & Holmen (1995), and is described by Dettner (1974) and by Owen *et al*. (1992a, 1992b). The larva is keyed by Nilsson (1982a, 1982c), who also provides a description of all three instars (Nilsson 1982b).

Distribution This species is known from several sites in a north-facing valley in Abernethy Forest in East Inverness and Moray, having been discovered there in 1991. *I. wasastjernae* is known from Denmark, Norway, Sweden, Finland, Latvia, Poland, Germany, the Czech Republic and Russia to north-west Siberia, and it is transcontinental in North America, where it has been reviewed as a member of the *opacus*-group, perhaps requiring recognition of the subspecies *kenaienis* Fall (Larson 1996). Burmeister (1980) described a site on the Belgian-German border in association with palsa scar ("pingo") pools, and Dettner & Moos (2004) have reviewed all German records. It has recently been recorded from Austria by Schuh (2007).

Habitat and ecology *I. wasastjernae* is confined to temporary waters, usually stagnant, on a peat substratum in part shade. In Scotland, the typical habitat is in treeholes created by pine trees rocking in the wind in peat bogs. These should not be confused with treeholes formed within trees themselves, there occupied by a highly specialised phytotelmatic fauna. Abroad, the species has also been found in the larger treeholes associated with wind-thrown trees. Nilsson (1985, 1986b) described *I. wasastjernae* as a semivoltine spring breeder, first instars appearing mainly in late April and early May in northern Sweden, probably from overwintered eggs, the second winter being spent as an adult. No larvae have been found in visits to the Nethy Bridge sites in May and October. The adult population was dominated by teneral males in May 1994, suggesting that the life-cycle in Britain is the same as that in northern Sweden. Nilsson & Svensson (1995) noted that this species is capable of flight, as have Dvořák & Štastny (1998).

Status *I. wasastjernae* is known to be extant in three hectads. The IUCN criteria for Endangered status that are satisfied are based on an extent of occurrence of about 1 km² in three locations in Abernethy Forest, the potential area of occupancy being about 40 km². This is one of the few water beetle species for which the number of adults may be small enough to meet IUCN Criterion C, but it would be deleterious to undertake a population survey. *I. wasastjernae* is also known from a Flandrian deposit in Shropshire (Osborne 1972).

Threats This species may well be confined to its area of discovery, this being one of the few north-facing valleys to have retained tree cover north of the Grampians. The area is for the most part managed as a nature reserve, within which the potential threat of clear felling is unlikely, so the main threat that it probably faces is climate change.

Management and conservation Part of the area occupied is an RSPB reserve, and the managers are aware of the existence of this species. Windthrown trees may provide suitable additional habitats for this species, and their bases at least should be left *in situ*. Any changes in management of the area associated with its use as a nature reserve for birds must take into account the presence of this species. The same applies to neighbouring forest used mainly for timber and game.

Published sources Boukal *et al.* (2007), Burmeister (1980), Dettner (1974), Dettner & Moos (2004), Dvořák & Štastny (1998), Hájek & Šťastný (2005), Hodge & Jones (1995), Larson (1996), Nilsson (1982a, 1982b, 1982c, 1985,

1986b, 2000), Nilsson & Holmen (1995), Nilsson & Svensson (1995), Osborne (1972), Owen *et al.* (1992a, 1992b), Schuh (1997), Telnov *et al.* (2007, 2008).

LACCOPHILUS POECILUS CRITICALLY ENDANGERED
The Puzzled Skipper

Order COLEOPTERA Family DYTISCIDAE

Laccophilus poecilus (Klug, 1833). The name of this species has been subject to much change. It went under the name *Laccophilus variegatus* (Germar) for many years, but both that and the suggested replacement, *obsoletus* Westhoff, proved to be invalid (Nilsson 1988a). Subsequently the name *ponticus* Sharp has become more widely used but it has recently been recognised that this is a junior synonym of the species that Klug described based on the pale form of female in Egypt.

Identification The adult is keyed by Balfour-Browne (1940), as *variegatus* and by Friday (1988a), as *obsoletus*. The larva is illustrated and keyed (under the name *obsoletus*) by Nilsson (1982a); Biesiadka & Kazimierska (2004) provided a further description.

Distribution The most recent map is provided by the UK Biodiversity Group (1999). There are records since 1980 for East Sussex and South-west Yorks. There are older records for South Hants, West Sussex and East Kent. The claim (Ratcliffe 1977) that *L. poecilus* was, or ever had been, confined to the Pevensey Levels is incorrect. A record for the Spurn Peninsula (Hincks 1952) was corrected (Hincks & Shaw 1954). A recent report from the Dartford Marshes proved to be incorrect. Other *Laccophilus* species are regularly submitted to the national recording scheme as this species following publicity about it in the UK BAP. *L. poecilus* is a widely distributed Palaearctic species, probably commonest around the Mediterranean, and ranging north to southern Norway and Sweden, being known only as a sub-fossil in Denmark, and extending to Syria, Egypt, Uzbekistan, and Afghanistan.

Habitat and ecology *L. poecilus* occupies two quite distinct kinds of stagnant water habitat, lowland rich fen, often in grazing fen ditches near the coast but not in brackish water, and dystrophic waters. It is difficult to believe that sensitivity to fish predation can explain this difference as this species is found mainly in permanent waters. However, Galewski (1971) grouped it with *Agabus* species confined to temporary waters that have swimming larvae able to hunt in open water, the pelagic behaviour associated with temporary water pointing to the importance of avoiding fish. There is evidence of flight ability from south-west France (Bameul 1990).

Status *L. poecilus* has only ever been reliably recorded from twelve hectads in England, and is known from two hectads since 1980. Since 2002, there have been exhaustive, but unproductive surveys of all the most recently known sites and their vicinity. Hodge (2003) reviewed the known status of the beetle in Yorkshire, revealing an additional record from a pitfall trap in 1990 and some uncertainty about a 1977 record. The species has not been rediscovered in a recent comprehensive survey on the Thorne Moors (Merritt 2006). Merritt (2007) reviewed information concerning the single specimen found in June 1970 on Thorne Moors accessed "through a disused colliery leading off the Moorends road". The most recent record for Kent is an unpublished one based on a specimen taken at Canterbury by R.T. Bannister (A.P. Foster, pers. comm.) in 1958. *L. poecilus* was rediscovered in July 1996 on the Lewes Levels (Hodge 1998), the first record since 1983. It could not be found there in 2000 and 2001, but was again detected in September 2002, and has not been found in subsequent almost annual surveys. *L. poecilus* is known from Neolithic and Bronze Age deposits in the Somerset Levels (Girling 1976) but has not been reported alive in south-west England nearer than Dorset. This species must be regarded as Critically Endangered. The extent of occurrence is not measurable with only two locations since 1980 about 300 km apart. The main IUCN criteria met are based on extreme fragmentation and decline, but criteria C and D can be applied if the beetle really has become recently extinct.

Threats Ditch excavation on the Lewes Levels did not appear to be deleterious to this species but the species is clearly at risk from extinction through loss of habitat, possibly as a result of conversion of grazing fen to arable land. The species used to be common in parts of the Pevensey Levels, from where it has been lost

subsequent to deterioration in water quality and ditch structure associated mainly with arabilization. Fish farm escapes also pose a problem in grazing fen ditch systems. Excepting the Thorne Moors record, its absence from the eastern fenland and its restriction to southern coastal sites suggest that it has suffered mainly from post-glacial climatic deterioration, as opposed to habitat destruction, but then rather more recent climate change should have reversed this problem by now.

Castaldo *et al*. (2004) report *L. poecilus* (as *variegatus*) as a new host for the *Laccophilus* ectoparasitic fungus *Chitonomyces bakeri* Thaxter in Greece. One hundred and ten specimens, 89 of them English, have been checked in the collections of the Natural History Museum, London, and found free of laboulbenialian infection.

Management and conservation A Biodiversity Action Plan has been prepared for this species. Periodic monitoring has been undertaken on the Lewes Levels and the Thorne Moors, and should continue. The promising changes in the quality of the Pevensey Levels SSSI associated with the Higher Level Stewardship associated with the Environment Agency's work on raising water levels in ditches suggest that reintroduction might prove effective here. This species is often associated with abandoned manmade sites over much of western Europe. If more living material is found in Britain it may prove possible, using mitochondrial DNA, to establish if any differences exist between the northern and southern elements of the population: the striking differences in habitat preference seen abroad may be linked to genetic differences.

Published sources Ahmed & Angus (1998), Anonymous (2005b), Balfour-Browne (1940), Bameul (1990), Biesiadka & Kazimierska (2004), Boukal *et al.* (2007), Bunting (1955), Castaldo *et al.* (2004), Darby (2009), Department of the Environment (1995), Foster, G.N. (1972, 1981b, 2000b, 2001b, 2002, 2005a, 2007a, 2009a), Friday (1988a), Galewski (1971), Girling (1976, 1982a, 1984b), Hájek & Fery (2004), Hájek & Šťastný (2005), Hammond & Merritt (2008), Hincks (1952), Hincks & Shaw (1954), Hodge (1977b, 1978b, 1998, 2003), Merritt (2006, 2007), Nilsson (1982a, 1988a), Ratcliffe (1977), Shirt (1987), Skidmore, Limbert & Eversham (1985), UK Biodiversity Group (1999).

LACCORNIS OBLONGUS Near Threatened
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Laccornis oblongus (Stephens, 1835).

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). The three larval instars have been described by Cuppen & Dettner (1987).

Distribution The map provided by Foster (1983b) should be used in conjunction with the vice-county map of Balfour-Browne (1940, map 14). Records since 1980 are for North Somerset, East and West Suffolk, East and West Norfolk, Cambs, Hunts, Salop, Monmouth, South Lincs, Cheshire, North-east, South-east and Mid-west Yorks, Westmorland, Durham, Dumfries, Berwick, Peebles, Selkirk, Roxburgh, and East Inverness. Earlier records add Surrey, where it is considered extinct, and Herefordshire. The old Devon record is probably based on misidentified *Hydroporus obsoletus* detected by Dr D.T. Bilton (pers. comm.) in the collection of J.H. Keys. This species is circumboreal, being known from the North-west Territories of Canada (Wolfe & Spangler 1985). The Palaearctic range extends from Ireland and northern France to eastern Siberia.

Habitat and ecology This species is confined to shallow, mossy areas of temporary base-rich fens. Cuppen & Dettner (1987) and others have noted the occurrence of adults in the early spring and in the autumn. Larvae have been found in April and May, with eggs laid in captivity hatching very quickly. It is likely that the pupa or teneral adult rests in its pupal chamber until sites fill again after drying out in the summer. Unpublished flight tests have proved negative.

Status *L. oblongus* has been recorded from 46 hectads from 1980 onwards. This species has become extinct in the London area. The striking increases in the number of known sites in the British Isles and in the Netherlands owe to the expansion in recording rather than an extension in range by this species. For example, identification of the importance of former palsa scar ("pingo") sites as providers of relict fen in the Breckland led to its discovery in Shropshire in sites of similar origin.

Threats Contrary to notions based on metapopulation theory that underlie some recent developments in landscape conservation policy, some specialist species can persist in extremely small and isolated sites (Verberk *et al.* 2010), and it is important to continue to prioritise the protection of such small areas. *L. oblongus* clearly falls into the category of a relict species capable of surviving in small, isolated sites. Uncontrolled landfill, drainage and eutrophication of small ponds and fens are seen as the main threats; for example, the species appears to have been lost from Temple Sowerby Moss SSSI, where it was last found in 1983.

Management and conservation *L. oblongus* occurs in and around the Whitlaw Mosses NNR (part of the composite Natura 2000 Whitlaw & Branxholme SAC), Mount Bog SSSI in Peebles, Chippenham Fen NNR, and in several protected sites in Breckland and Broadland. Management measures on reserves should include recognition of the need to maintain shallow mossy swamps in partial shade.

Published sources Angus (1990), Anonymous (1986a, 1990, 1997), Balfour-Browne 1940), Boyce (2004), Cuppen & Dettner (1987), Denton (2007a), Duff (1993), Eyre & Foster (1984), Foster, A.P. (1984b), Foster, G.N. (1977a, 1977c, 1980a, 1983b, 1983c, 1984d, 1993, 1998), Foster & Eyre (1992), Foster & Sinclair (1977), Friday (1988a), Hájek & Šťastný (2005), Hammond (2002), Hammond & Merritt (2008), Horsfield & Foster (1983), Lohez (2007), Nilsson & Holmen (1995), Nobes (2001), Sinclair (1991), Verberk *et al*. (2010), Welch (1993), Wolfe & Spangler (1985).

LIMNEBIUS ALUTA Near Threatened

Order COLEOPTERA Family HYDRAENIDAE

Limnebius aluta (Bedel, 1881).

Identification Friday (1988a) and Balfour-Browne (1958) key this species in the British fauna. The Palaearctic members of the genus have been reviewed by Jäch (1993).

Distribution Records since 1980 are for South and North Somerset, West Suffolk, East and West Norfolk, Cambs, North-east Yorks, and Anglesey. Earlier records add West Kent, Surrey, East Suffolk, Warks, and Mid-west Yorks. The most recent map (Foster 1990d) should be used in conjunction with that provided by Balfour-Browne (1958, map 46). *L. aluta* is also known with certainty from France, the Netherlands, Denmark, Norway, Sweden, Finland, Latvia, Germany, Austria, Italy, the Czech and Slovak Republics, Poland, Hungary, and the central Russian steppe, and is absent from the Iberian Peninsula.

Habitat and ecology *L. aluta* is confined to relict lowland fen areas, living in the edges of pools and slow running ditches in association with mud, wet moss and litter beneath rich, emergent vegetation. Hansen (1987) notes an association with deciduous woodland in Denmark, but this is not the experience in England. Landin (1980) indicated that this was a species in which flight had rarely been observed, and one that did not engage in flight in the spring.

Status *L. aluta* is known from 21 hectads in England and Wales from 1980 onwards. *L. aluta* is probably extinct in Surrey, the only record being in 1829 from Wimbledon Common. Its scarcity might be explained in terms of its small size making it easily overlooked but it appears to be confined to relict fen areas. This species is common in Neolithic, Bronze Age, Iron Age and post-Iron Age deposits in the Somerset Levels, where it is still occurs; it has also been found in deposits in Surrey, Staffs, North Lincs and South-west Yorks.

Threats Loss of rich fenland habitats in relict areas must constitute the main threat.

Management and conservation *L. aluta* is largely confined to areas subject to statutory protection, e.g. SSSI on the Somerset Levels, the Bure Marshes, Catfield Fen, and Wicken Fen NNRs, and sites in Breckland such as Thompson Common, a reserve of the Norfolk Wildlife Trust. No special management prescription is possible other than to warn against injudicious wholesale pond or ditch cleaning.

Published sources Balfour-Browne (1958), Boukal *et al.* (2007), Bratton (1998), Denton (2005, 2007a), Duff (1993), Foster, A.P. (1984b), Foster, G.N. (1983c, 1990d, 1993), Friday (1988a), Girling (1976, 1977, 1978, 1979a, 1979b, 1980, 1982a, 1982b, 1984a), Hammond & Merritt (2008), Hansen (1987),

Hodge (1979b), Jäch (1993), Jäch, Dietrich & Raunig (2005), Jäch & Prokin (2005), Landin (1980), Lohez (2007), Painter (1994, 1999), Perry (1998), Pope (1969), Pope & Marshall (1980), Robinson (1991), Vorst *et al*. (2007).

LIMNEBIUS CRINIFER ENDANGERED

Order COLEOPTERA Family HYDRAENIDAE

Limnebius crinifer (Rey, 1884).

Identification Friday (1988a) keys this species in the British fauna. A detailed account of how to identify this species is given by Carr (1984b). The Palaearctic members of the genus have been reviewed by Jäch (1993).

Distribution There is no published map of the distribution of this species in Britain. It is known only from East Sussex in 1993, and East Kent, though not since 1983. *L. crinifer* is a northern and central European species, known from the Netherlands, Belgium, Germany, Denmark, Sweden, Finland, Latvia, Switzerland, Poland, Austria, the Czech and Slovak Republics, Hungary, Romania, Croatia, Ukraine, Russia, Kazakhstan, and Mongolia.

Habitat and ecology The original site in which *L. crinifer* was found was a man-made pond in an area of relict woodland and shallow pools, and this suggested that it had perhaps survived undetected in this refugium in south-east England. The second site was more typical of its occurrence in the Netherlands, being an open pond with rich vegetation. Holmen (1987a) stated that it lives mainly in running waters in Fennoscandinavia but this is an area where the closely related species, *L. nitidus* is rare. *L. crinifer* is possibly a pioneer species, occupying recently created pools with moss. Landin (1980) classified this as a species in which flight capacity was unknown.

Status *L. crinifer* is known from three English hectads. The IUCN criteria for Endangered status that are satisfied are the extent of occurrence of 103 km^2, a severely fragmented distribution based on three locations, none of which could be found to support the species in 2009.

Threats Loss of ponds in the Weald could result in the extinction of this species.

Management and conservation Longrope Wood is part of a reserve of the Kent Wildlife Trust. Creation of ponds in the Weald should be beneficial for this species.

Published sources Boukal *et al.* (2007), Carr (1983b, 1984b, 1985a), Carr & Philp (1988), Foster (1990d), Friday (1988a), Hodge (1994), Hodge & Jones (1995), Holmen (1987a), Jäch (1993), Jäch, Dietrich & Raunig (2005), Jäch & Prokin (2005), Landin (1980).

LIMNEBIUS PAPPOSUS Near Threatened

Order COLEOPTERA Family HYDRAENIDAE

Limnebius papposus (Mulsant, 1844).

Identification Friday (1988a) keys this species in the British fauna. Balfour-Browne (1958) did not differentiate it from *L. crinifer* Rey. The Palaearctic members of the genus have been reviewed by Jäch (1993). The supposed larva of this species was described by Bøving and Henriksen (1938).

Distribution Records since 1980 cover South and North Somerset, South Hants, East Kent, Surrey, South Essex, Herts, Oxon, Bucks, East and West Norfolk, Cambs, Beds, Hunts, Northamptonshire, South and North Lincs, Leics, and Notts. Earlier records add West Cornwall, South Devon, North Wilts, Dorset, the Isle of Wight, West Sussex, East Kent, North Essex, Middlesex, East and West Suffolk, Berks, East Gloucester, Hereford, Worcester, Warks, Caernarfon, Cheshire, South-west and Mid-west Yorks. The most recent map (Foster 1990d) should be used in conjunction with that provided by Balfour-Browne (1958, map 44). There are no reliable records from Britain north of Yorkshire. *L. papposus* ranges from Spain to Turkey and the central Russian steppe, with strong centres in East Anglia and south-east Europe.

Habitat and ecology *L. papposus* is largely confined to lowland fen areas in drains and ponds, usually with rich vegetation and detritus. It flies.

Status *L. papposus* is known from 79 hectads in England and Wales from 1980 onwards. This species was found in one sample of the British Countryside Survey in 1990. The distribution

map indicates a stronghold in the Somerset Levels and a major cluster of old records around another stronghold around the Wash. Some apparent losses elsewhere are likely to be associated with misidentified *L. truncatellus* (Thunberg) and occasional migrants. *L. papposus* appears to have declined or become extinct in the Netherlands, Denmark and Sweden.

L. papposus has been selected for Near Threatened status on the basis of (a) a 33% reduction in range size since 1989; (b) a significant year on year decline in the proportion of all records generated by the national recording scheme (P <0.001); (c) a significant year on year decline in the proportion of all surveyed hectads occupied (P <0.05).

Threats This species is not under threat from further loss of lowland peat.

Management and conservation The strong association of *L. papposus* with the Somerset Levels and the fens draining into the Wash indicates that this species benefits from a regular cycle of ditch clearing such as is provided by Internal Drainage Boards. Every opportunity should be taken to reappraise museum material to confirm that the distribution has contracted as much as is currently thought.

Published sources Balfour-Browne (1958), Ball (pers. comm.), Boukal *et al.* (2007), Bøving & Henriksen (1938), Carr (1985a), Carr & Philp (1988), Darby (2009), Denton (2005, 2007a), Driscoll (1978), Duff (1993), Eyre, Foster & Carr (1992), Foster, A.P. (1984b, 1986), Foster, G.N. (1980b, 1983c, 1990d, 1993), Foster & Eyre (1992), Friday (1988a), Hammond & Merritt (2008), Jäch (1993), Jäch, Dietrich & Raunig (2005), Jäch & Prokin (2005), Lane, Wright & Forsythe (2002), Leeming & England (2005), Lohez (2007), Lott (1995), Maitland (1966), Merritt (2006), Painter (1994), Palmer (1977, 1981a), Perry (1998), Pope (1969), Sinclair (1982, 1997), Welch (1968, 1973).

LIMNOXENUS NIGER Near Threatened

Order COLEOPTERA Family HYDROPHILIDAE

Limnoxenus niger (Zschach, 1788). Until recently, this species was known as *Hydrobius niger*.

Identification Friday (1988a) and Balfour-Browne (1958) key this in the British fauna, and Hansen (1987) keys it for Fennoscandinavia. The egg-case and larva have been described by van Berge Henegouwen (1975), who showed that the larva described by Bøving and Henriksen (1938) was not that species.

Distribution Records since 1980 are for South and North Somerset, the Isle of Wight, East Sussex, East and West Kent, South and North Essex, East and West Norfolk, Hunts, and Monmouth. Earlier records add Dorset, South Hants, Middlesex, East Suffolk, Cambs, Glamorgan, South Lincs, and Leics. The most recent distribution map (Foster (1987a) should be used in conjunction with the vice-county map provided by Balfour-Browne (1958, map 13). Within the Weald, this species is confined to drains and ponds in grazing fen. A relatively modern record for Leics (Evans 1979) is based on *Hydrobius fuscipes* (L.), leaving only a 19th Century record from Gumley by the Reverend A. Matthews. *L. niger* is a southern European species, being rare in Denmark, and ranging south to Spain, becoming widespread in the Mediterranean, and extending to Siberia.

Habitat and ecology *L. niger* occupies a range of exposed lowland fen habitats including peaty areas with rich vegetation and exposed clay in brackish ponds. The eggs are laid in a cocoon secured to foliage below the water's surface, but receiving an air supply through a 60 mm-long, spongy-tissued ribbon.

Status *L. niger* has been recorded from 44 hectads in England and Wales from 1980 onwards. It has declined in the north of its range, and it was identified as one of three species that had apparently become extinct in the Wash drainage system (Foster *et al.* 1989) following the loss of grazing fen. This species is known from an Iron Age deposit in the Somerset Levels, an area where it is still common.

Threats Arabilisation of former grazing fens most probably explains the decline of this species in the north, resulting in its largely being confined to coastal marshes and to the Somerset Levels.

Management and conservation Maintenance of a cycle of ditch management on grazing fen is apparently appropriate to the needs of this species, although it can also occur in coastal ponds with rich vegetation. It occurs in many statutorily protected coastal levels. In the north of its range, it appears to be largely confined to pools at Woodwalton NNR not connected to the main fen drainage system, and to the Broads. An isolated record from New Holkham on the north Norfolk coast by Bryan Sage in 1993 gives cause for hope that this species may recolonise the Cambridgeshire fens without the need for translocation.

Published sources Balfour-Browne (1958), van Berge Henegouwen (1975), Bøving & Henriksen (1938), Carr (1985b, 1986), Carr & Philp (1988), Charman, Palmer & Philp (1985), Drake (1988), Driscoll (1978), Duff (1993), Evans (1979), Foster, A.P. (1983), Foster, G.N. (1972, 1987a), Foster *et al.* (1989), Friday (1988a), Girling (1979a, 1984a), Goldie Smith (1985), Hansen (1987), Lohez (2007), Nasserzadeh & Hosseinie (2005), Palmer (1977, 1980, 1981b), Sage (1996), Service (1968), Sinclair (1982).

MACRONYCHUS QUADRITUBERCULATUS

Near Threatened
A riffle beetle

Order COLEOPTERA Family ELMIDAE

Macronychus quadrituberculatus (P.W.J. Müller, 1806).

Identification The adult, larva and pupa were described by Holland (1972). Friday (1988a) provides a key to the distinctive adult. The larva and pupa were also illustrated by Olmi (1976), who reproduced the classic plate by Perez (1863). A recent key to Central European elmids (Klausnitzer & Richoux 1996) includes *M. quadrituberculatus*.

Distribution Recent records for this species are for the River Taw, North Devon (G. Robinson, pers. comm.); East Stoke, Dorset; the River Medway (S. Wilson, pers. comm.); the Holy Brook, Berks (Denton 2009); the River Thames at Reading on the Berks/Oxon border; the River Teme and the River Severn, Worcester; the River Severn in Shropshire; the River Trent, Burton-on-Trent, Staffs; River Stour in Warwickshire; and the River Wye in Herefordshire, Monmouth, and West Gloucester. *M. quadrituberculatus* is a western European species reaching Morocco, the central Russian steppe and Hungary, absent from Denmark, Norway and Sweden, but found in Finland and the Baltic States.

Habitat and ecology *M. quadrituberculatus* is a lowland species, usually found clinging to submerged tree trunks in deep, permanent water in rivers. The larva is wireworm-like and burrows into wet wood, where it pupates. *M. quadrituberculatus* has been caught at light in Poland.

Status Holland's map (1980) included records from 1960 onwards for six hectads and earlier records from another three hectads. The species has been recorded from 18 hectads in England and Wales from 1980 onwards. *M. quadrituberculatus* occurred in two of the 614 sites sampled for RIVPACS III. There are records from the Flandrian and the Late Bronze Age, and M. Greenwood (pers. comm.) has found this species in a Mediaeval peat deposit in Leicestershire. This species is beginning to acquire a recent recording history amounting to a potential success story as an interesting species reoccupying large tracts of formerly polluted rivers. On this basis, although the area of occupancy would be low enough to justify the IUCN Vulnerable category, this cannot be coupled with evidence of decline – nor can the extent of occurrence of 37,900 km², well above the threshold of 20,000 km². The Near Threatened category is more appropriate on the basis that decline has been detected in this species in the past, and may reoccur.

Threats Because of the elmid method of plastron respiration, the major perceived threat to elmids is reduction in dissolved oxygen associated with pollution. This problem must be particularly acute in species living in deep, permanent water, but *M. quadrituberculatus* adults can be found on timber in oxygen-poor backwaters. Jaskuła *et al.* (2005) note that it can occur in polluted streams in Poland. Other threats to this species must come from

canalisation of rivers and associated loss of natural logjams. Smith (2000) has questioned the evidence for the proposal that elmid species, including the *Macronychus*, were affected by the siltation following on changes in farming practice in the Iron Age: association with woody debris is more important for this species than alluvium.

Management and conservation Rehabilitation of river systems should include provision of submerged timber. Legislation associated with the Water Framework Directive will enforce an improvement in the management of inland waters in the United Kingdom.

Published sources Atty (1983), Boukal *et al.* (2007), Denton (2005, 2009), Friday (1988a), Godfrey (2003), Holland (1972, 1977, 1980), Jäch & Prokin (2005), Jaskuła, Buczyński, Przewoźny & Wanat (2005), Klausnitzer & Richoux (1996), Lane, Wright & Forsythe (2002), Löbl & Šmetana (2006), Olmi (1976), Parpet & Chabrol (2007), Perez (1863), Robinson (1991), Smith (2000), Telnov & Kalninš (2000), Wallace (1973), Watson & Foster (2006), Wright *et al.* (1996).

NEBRIOPORUS DEPRESSUS Near Threatened
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Nebrioporus depressus (Fabricius, 1775). The species has been placed in the genera *Hydroporus*, *Deronectes* and *Potamonectes*. The nominate form is regarded as a taxon distinct from *N. elegans* (Panzer), but there is evidence of introgression, with the existence of stable intermediate forms. Toledo (2009) regards the question of the statuses of the two taxa as remaining open.

Identification This taxon is keyed by Friday (1988a) as *Potamonectes depressus depressus*. The larva of the *Nebrioporus depressus* complex is illustrated and keyed by Nilsson (1982a). Photographs by Balfour-Browne (1940) illustrate the range of appearance of larvae within the complex.

Distribution The most recent map of the distribution of *N. depressus* s. str. was provided by Shirt (1981). It was then shown to occur throughout Ireland, in mainland Scotland and in north-west England. Intermediates between *N. depressus* and *N. elegans* were shown as occurring in Scotland, north-west England and Wales. Recent records are for Meirionydd, Westmorland, Cumberland, Dumfries, Ayrshire, Mid Perth, Argyll, East and West Inverness, West Ross, East and West Sutherland, Caithness, and Islay. *N. depressus* is Holarctic, its range in the Palaearctic being mainly northern and central Europe, south to Italian and Slovenian mountains, and east to Siberia.

Habitat and ecology In Britain the true *N. depressus* is largely restricted to natural, non-montane lakes, living on fixed substrata with little vegetation, often in comparatively deep (>0.5 m) water. The more mobile *N. elegans* occurs on many islands and replaces *N. depressus* in running water and man-made, still water habitats throughout most of Britain, except in Caithness and North Sutherland, where *N. depressus* occupies rivers as it does in northern, continental Europe (Shirt 1981) and in Ireland. On this basis, it is probable that *N. elegans* is capable of flight and that the observations Jackson (1973) made concerning abnormal flight muscles and minute pleural discs related to *N. depressus* of the intermediate form.

Status Although the very limited number of English and historic Welsh sites remain occupied, there is evidence of major losses from Scotland, with this species largely confined to Loch Doon and Islay in the south and the Highlands and Caithness in the north. The original site where the complex was recognised, Talkin Tarn, used to support an extreme form of *depressus* seemingly confined now to Loch Doon and the neighbouring Bogton Loch. Talkin Tarn has been subject to algal blooms since the 1970s and the former clean sand and shingle bottom to the lake has been replaced by beds of Canadian pondweed (*Elodea canadensis* Michx.) over black mud. There are 34 hectads with records from 1980 onwards.

Threats The association of *N. depressus* with vegetation-free areas of base-poor lakes indicates that it must be at risk of eutrophication, with the consequent growth of marginal vegetation and the formation of algal blooms. Another potential threat comes from siltation associated with afforestation of catchments, and acidification may also pose a threat if it results in the rapid

growth of *Sphagnum* on the lake floor. Acidification might otherwise be considered beneficial in maintaining the *status quo*. *N. elegans* can occupy a wider range of habitats, including reservoirs subject to considerable fluctuations in water level, and must be considered a major competitor.

Management and conservation Many lakes are scheduled as SSSI including Loch Doon. Restrictions on catchment land use and on water storage are necessary to maintain vegetation-free, oligotrophic lakes with shores not subject to severe fluctuations. Legislation associated with the Water Framework Directive will enforce an improvement in the management of inland waters in the United Kingdom. The precise status of the introgressive populations should be reinvestigated by DNA analysis. A monitoring system should be set up to detect any changes in the distribution of the two forms.

Published sources Balfour-Browne (1940), Foster *et al.* (1991), Friday (1988a), Jackson (1973), Johnson (1991), Lott (1985), McCann & Moran (1986), Nilsson (1982a), Nilsson & Angus (1992), Shirt (1981), Shirt & Angus (1992), Spirit (1986), Toledo (2009).

NORMANDIA NITENS ENDANGERED
A riffle beetle

Order COLEOPTERA Family ELMIDAE

Normandia nitens (P.W.J. Müller, 1817). This species used to be referred to the genera *Riolus* and *Aptyktophallus.*

Identification Holland (1972) and Friday (1988a) provide keys to the adult. Palaearctic species of *Normandia* are reviewed by Berthélemy (1979). Berthélemy and Stragiotti (1965) described the larva of *N. nitens*, and it is included in keys by Olmi (1976) and Klausnitzer & Richoux (1996).

Distribution Records since 1980 are for Oxon, Monmouth, Hereford, and Worcester. Earlier records add South Hants, Durham, South Northumberland, and Cumberland. *N. nitens* is a widely distributed species, known from Austria, Belgium, Bosnia-Herzegovina, Byelorussia, Croatia, Estonia, Finland, France, Germany, Greece, Italy, Latvia, Lithuania, Macedonia, the Netherlands, Portugal, Russia, Slovenia, Spain, Sweden, and Switzerland in Europe, in Algeria and Morocco, and east to Turkey, Israel, and the Lebanon.

Habitat and ecology *N. nitens* is associated with the lower sections of rivers, principally amongst gravel in deep water, but also at the edge on rocks and amongst tree roots.

Status This species has been recorded from five hectads since 1980. Holland's map (1980) included records from 1960 onwards for two hectads (Rivers Wye and Teme) and earlier records from another five hectads. It occurred in three of the 614 sites sampled for RIVPACS III. Sub-fossil fragments of this genus are fairly easily recognised and assigned to this species, resulting in records from deposits in Surrey, Oxon, Monmouth, Worcester, Warks, Staffs, Salop, Caernarfon, North Lincs, and Mid-west Yorks. The conditions for the IUCN Endangered category are met on the basis of the extent of occurrence at 3,000 km², the four river sections occupied, and the evidence of considerable decline and contraction in range.

Threats Canalisation and pollution of rivers are detrimental to this species.

Management and conservation Rehabilitation of river system structures and flow should be beneficial for this species. Legislation associated with the Water Framework Directive will enforce an improvement in the management of inland waters in the United Kingdom.

Published sources Ashworth (1973), Berthélemy (1979), Berthélemy & Stragiotti (1965), Boukal *et al.* (2007), Coope & Brophy (1972), Denton (2005), Dinnin (1997), Drost (1992a), Friday (1988a), Hammond & Merritt (2008), Holland (1972, 1980), Klausnitzer & Richoux (1996), Kodada *et al.* (2003), Löbl & Šmetana (2006), Olmi (1976), Osborne (1972, 1974, 1988, 1997), Robinson (1991, 1993), Shirt (1987), Watson & Foster (2006), Wright *et al.* (1996).

OCHTHEBIUS AENEUS REGIONALLY EXTINCT

Order COLEOPTERA Family HYDRAENIDAE

Ochthebius aeneus (Stephens, 1835).

Identification Friday (1988a) and Balfour-Browne (1958) key this species in the British fauna. The aedeagophore is depicted by Jäch (1990) in a treatment of Palaearctic members of the subgenus *Asiobates*. It is now regarded as part of the *O. rugulosus* species complex (Jäch 1998).

Distribution A map is provided by Foster (1990d). The type locality for this species is Putney Heath, and it was known from other Surrey heaths. It is now confined to southern France, Portugal, Spain, the Balearics, the Alps, Morocco, Algeria, and Tunisia (Jäch 1990).

Habitat and ecology In the Mediterranean area this species occurs in exposed muddy and hard-bottomed ponds with little vegetation. In Britain it was probably confined to pools on lowland heath, but may also have occurred in saltmarshes.

Status *O. aeneus* has only ever been recorded from nine English hectads, the Welsh record being incorrect. The last confirmed record was from "The Salts, St Leonards" in 1913. That record was once assigned to St Leonards, Hastings, but it is more likely to relate to the area of St Leonard's Fleet, a dyke north-west of the site of St Leonard's Church, Winchelsea. The species was possibly once centred on heaths around London. *O. aeneus* is extinct in Britain.

Threats The loss of heathland sites may have been responsible for the disappearance of this species, but it more likely that the range of this thermophilic species has contracted following climatic deterioration.

Management and conservation This is not a suitable candidate for reintroduction to Britain, given its requirement for a hot climate, and no conservation measures are considered appropriate. Global warming may result in reinvasion by *O. aeneus*.

Published sources Balfour-Browne (1958), Denton (2007a), Foster, G.N. (1972, 1990d), Friday (1988a), Jäch (1990, 1998).

OCHTHEBIUS LENENSIS ENDANGERED

Order COLEOPTERA Family HYDRAENIDAE

Ochthebius lenensis (Poppius, 1907).

Identification The species is keyed by Friday (1988a) and Balfour-Browne (1958). The aedeagophore is depicted by Jäch (1991a) in a treatment of the Palaearctic members of the *marinus*-group. The larva is undescribed.

Distribution The most recent map is provided by Foster (1990d). This species is known from Moray, East Inverness and East Ross. *O. lenensis* is a northern Palaearctic species, known also from Norway and Siberia (Jäch 1991a).

Habitat and ecology *O. lenensis* is found on saltmarshes, usually walking on the bottom of hard-bottomed saltpans, with oligohaline to sea-strength water. Copulation and ovulation indicated breeding in July in a survey in 1986. Some specimens are capable of flight.

Status *O. lenensis* is known from eight localities covering six Scottish hectads, four of the latter from 1980 onwards. The IUCN criteria for Endangered status that are satisfied are based on an extent of occurrence of 22 km² based on four locations, with evidence of loss of sites and contraction in range.
O. lenensis is also known from late Glacial deposits in Warwickshire (Osborne 1973) and Lincolnshire (Buckland 1982).

Threats The saltmarshes suitable for *O. lenensis* at any one time undergo a natural process of degradation when deposition of mud changes tidal flow, leading to erosion and loss of saltpans, with accretion of mud and further saltpan formation elsewhere. If the appropriate habitat is available only during one part of the dynamic process of saltmarsh development and loss, preservation of one key area, even a large one, may provide insufficient protection for a species restricted to a narrow climatic zone within Britain. Developments largely related to exploitation of offshore deposits have reduced the amount of saltmarsh available for colonisation, not through pollution but because

road improvement schemes, rig-building yards and pipe-construction factories encroach on the coastal flats. The Scottish population is on the southern edge of the distribution of this species and must be considered at risk from climate change.

Management and conservation Periodic resurvey of the areas detailed by Foster (1988a) will provide guidance on the status of the species, so long as extra sites are sought to replace any lost by erosion. Construction of shallow saltmarsh pools, such as might occur when sea turf is cut, should provide appropriate conditions. It has been recommended that, when coastal SSSI are renotified in the area from Tain to Lossiemouth, the boundary should extend to the high water mark of high spring tides, as indicated by drift lines rather than by the line on Ordnance Survey maps, and that coastal water bodies just above high water mark should be included wherever possible. The other threat to this species comes from global warming.

Published sources Balfour-Browne (1958), Buckland (1982), Foster, G.N. (1988a, 1990d), Friday (1988a), Hodge & Jones (1995), Jäch (1991a), Osborne (1973), Shirt (1987), Telfer (2004).

OCHTHEBIUS POWERI Near Threatened

Order COLEOPTERA Family HYDRAENIDAE

Ochthebius poweri (Rye, 1869). Jäch (1989 and 1999a) treats *O. poweri* as a species distinct from *O. metallescens* Rosenhauer.

Identification Friday (1988a) and Balfour-Browne (1958) key this species in the British fauna. The aedeagophore is depicted by Jäch (1989) in a treatment of Palaearctic members of the *metallescens*-group.

Distribution A survey of suitable sites in western England and in Wales in 2008 indicated occupancy of West and East Cornwall, South Devon, Dorset, Glamorgan, and Pembroke (Bilton *et al*. 2009). *O. poweri* has a strikingly disjunct distribution, in southern England, Wales and Waterford in Ireland (Regan & McCormack 2008), and then from southern Portugal, Cueta, Algeria, Morocco and Tunisia. Löbl & Šmetana (2004) do not list earlier records for Italy and Greece, Jäch (1999a) noting that the Greek form is a different species.

Habitat and ecology *O. poweri* has a specialised habitat in crumbly mud at the edge of seepage on sea cliffs. Recent survey work indicates that the geology of the cliff face is relatively unimportant so long as it provides the right conditions surrounding small aquifers. Thus the species occurs on, for example, clay, limestone, breccia, slate, shales, sandstones, limestone, and serpentine rock. Of the sites where water parameters were recorded 83% were neutral in pH or alkaline. Almost half of 34 sites had conductivities of 0.3 mS/cm or less, i.e. the resolving capacity of the measuring equipment, the other 18 sites having conductivities 0.5 – 7.9 mS/cm, with a mean of 2.87 mS/cm. The key requirement is for freshwater seepages to receive salt spray.

Status *O. poweri* has been recorded from 21 hectads in England and Wales in 2007 and 2008, with records from 26 since its discovery. The continued occupancy of its range, plus extensions into Dorset and Waterford, indicate that this species is not under threat of extinction. However, applying the IUCN requirement to consider the importance of the population under evaluation in relation to the global population, the importance of this narrowly defined occupancy becomes apparent. This species is therefore raised from least concern to near threatened, and should remain so until the rest of the species' range can be investigated, including the possibility that the Mediterranean and Atlantic populations are linked along the Atlantic coast of France. Retention of the near threat category can cease if the genetic characterisation establishes a continuum to Iberia and northern Africa.

Threats The major threat to this species appears to be the lateral sprawl of coastal resorts, resulting in cesspit and septic tank outfall pollution from cliff top housing not connected to the main sewage system. Being on a major route for oil shipping, the Pembroke site has been considered at risk from coastal pollution in the past. Future climate change may also present a threat to this species since increases in sea level and the frequency of extreme rainfall events may lead to cliff erosion rates which are too rapid for the establishment of suitable habitat.

Management and conservation Orcombe Rocks at Exmouth are owned by the National Trust and it is likely that other, as yet undiscovered, cliff sites for this species in south-west England and Wales will be on NT land. Several sites are notified as SSSI. A Species Statement was published under the original UK Biodiversity Action Plan, and the species has been added to the list of priority species. It is mentioned in the Habitat Action Plan for Maritime Cliff and Slopes. Genetic characterisation should be carried out alongside material from Iberia or northern Africa, and a search made for sites in France.

Published sources Balfour-Browne (1958), Bilton, Bratton, McCormack & Foster (2009), Boyce (2002), Denton (1997), Department of the Environment (1995), Foster, G.N. (1988b, 1990d, 1990e, 1999, 2009a), Friday (1988a), Jäch (1989, 1999a), Löbl & Šmetana (2004), Owen (1976b), Regan & McCormack (2008), UK Biodiversity Group (2000a, 2000b).

OREODYTES ALPINUS VULNERABLE
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Oreodytes alpinus (Paykull, 1798). This species was described as *Hyphydrus borealis* Gyllenhal in Sahlberg, 1826 (see Nilsson 1987), but the name *borealis* has been misapplied to *O. davisii*. The British race is generally smaller and paler than counterparts in Scandinavia.

Identification The adult is keyed by Friday (1988a). The larva is illustrated and keyed by Nilsson (1982a, 1987), but these treatments do not include *O. davisii*.

Distribution The distribution of this species is mapped in Ratcliffe & Oswald (1988). *O. alpinus* is known from eleven lochs in Caithness and East Sutherland. The extent of occurrence is ca 660 km². The question of synonymy of this species with the Nearctic *O. laevis* (Kirby) was avoided by Zimmerman (1985), but it seems likely that there is a single, Holarctic taxon (Alarie 1997, Nilsson 1987). In the Palaearctic region, *O. alpinus* is confined to Scotland, Norway, northern Sweden, and from Lapland to north-west Siberia. It is not found in Mongolia as previously reported, the species concerned being almost certainly *O. mongolicus* (Brinck) (Shaverdo, Short & Davaadorj 2008).

Habitat and ecology *O. alpinus* is confined to larger lochs, generally exceeding 100 hectares apart from occasional specimens found in connecting rivers. The lochs lie between 100 and 170 metres O.D. in the catchments of the Forss Water and the Rivers Helmsdale and Thurso, Loch Brora being an outlying site in Sutherland. Typically the pH of these sites exceeds 7.2. The species is further restricted to sandy bays, usually at the northern and southern ends of the lochs. Even on calm days, these large lakes have considerable wave action and the areas occupied by *O. alpinus* are usually devoid of vegetation, though with constantly agitated masses of loose, dead plant material. The most likely explanation of this association with wave-washed edges is a need for a high oxygen content free from the risks associated with attempting to live in the inflows and outflows of lochs. In Norway, *O. alpinus*, although found in large lowland lakes, is commonest in lakes that have ice through most of the summer. In the absence of photosynthesising plants, the amount of oxygen dissolved in water increases with wave action and with lowered temperatures, such as might be maintained by the presence of ice floes. The biomass productivity of this species has been studied, as *Deronectes alpinus* by Brittain (1978). Nilsson (1987) concluded that this species must have a univoltine life-cycle with overwintering adults and larval development in the summer. The same appears to apply in Caithness, when larvae occur with non-teneral adults in July, females then bearing spermatophores. Flight tests have proved negative.

Status *O. alpinus* has been recorded from eight hectads in Scotland since it was discovered in 1985, having been overlooked in the past despite the intensity of water beetle recording in Scotland. The extent of occurrence is 1,050 km², ranging across eleven lochs where the species is found in numbers and two running water sites where individual specimens have been found: this species qualifies for the IUCN Vulnerable status since these sites may be considered under threat from climate change. It is known from a Mid-Weichselian deposit in Warwickshire and from several interglacial and glacial deposits in Britain. In a profile through the Devensian Late Glacial provided by the Gransmoor kettlehole

deposit, this species occurred only in the middle of the Loch Lomond Stadial. The present distribution coincides with the only low-lying area of mainland Britain not known to have been fully afforested following the retreat of the Ice Cap, as evidenced from a pollen diagram (Peglar 1979) and peat profiles (Ratcliffe & Oswald 1988).

Threats The former large-scale afforestation of the catchments of the larger lochs in the Flow Country may yet adversely affect this species through the effects of peat deposition into lochs, and also through localised increases in shelter, with reduction in wave action. Another threat identified by planting of alien trees is associated with outbreaks of pests, such as pine beauty moth (*Panolis flammea* Denis & Schiffermüller) on lodgepole pine (*Pinus contorta* Douglas ex Loudon). The resulting use of insecticides that are stable in water may cause aquatic macroinvertebrate mortality (Hurd, Perry & Perry 1996). *O. alpinus*, being a species tolerant of, or requiring low temperatures, and being confined to relatively low-lying situations, is the key British species threatened by global climatic change. Finally, the proximity of most sites to the rail route occasionally used for nuclear waste to Dounreay has attracted comment in the past.

Management and conservation The location and extent of sandy, wave-washed shores in lochs in the Flow Country should be surveyed in order to identify the full extent of the present day distribution of this species. Scottish *O. alpinus* should be subject to a morphometric and genetic study in order to identify the extent to which each loch has its own race and should also be compared with Scandinavian material. The range of genetic diversity between sites may dictate conservation measures for *O. alpinus* in Scotland; it is likely that the Scottish population has suffered "bottlenecking" during the postglacial optimum. Few of the sites receive full statutory protection but most are remote and inaccessible on private land used for hunting. Broubster Leans, the site where *O. alpinus* was first detected in the Forss water, is an RSPB reserve, but it is not a breeding site for this species.

Published sources Alarie (1997), Allen (1999), Brittain (1978), Coope (1968, 1981), Foster, G.N. (2009, unpublished observations), Foster & Spirit (1986), Friday (1988a), Hancock (2002), Hodge & Jones (1995), Hurd, Perry & Perry (1996), McCann & Moran (1986), Nilsson (1982a, 1987), Peglar (1979), Ratcliffe & Oswald (1988), Shaverdo, Short & Davaadorj (2008), Spirit & Ryrie (1991), Walker *et al.* (1993), Zimmerman (1985).

OREODYTES DAVISII Near Threatened
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Oreodytes davisii (Curtis, 1831). *O. borealis* Gyllenhal has been used for this species, but the true *O. borealis* does not occur in Britain. The misspelling "*davisi*" is also in use. The nominate subspecies, *O. davisii davisii* occurs in Britain.

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). Larval descriptions are possibly of limited value according to Balfour-Browne (1940).

Distribution A map provided by Foster (1983b) should be used in conjunction with the vice-county map of Balfour-Browne (as *O. borealis*, 1940, map 49). Records since 1980 are for Monmouth, Hereford, Radnor, Brecon, Pembroke, Ceredigion, Montgomery, Caernarfon, Denbigh, Derbyshire, South and West Lancs, North-east, South-west, Mid-west and North-west Yorks, Durham, South and North Northumberland, Westmorland, Cumberland, Dumfries, Kirkcudbright, Ayrshire, Lanark, Peebles, Selkirk, Roxburgh, Angus, Argyll, Midlothian, East Lothian, East and Mid Perth, South Aberdeenshire, Banff, Moray, East Ross, East and West Inverness, West Ross, East and West Sutherland, Caithness, and Rum. Earlier records add Glamorgan, Worcester, Caerfyrddyn, Berwick, Fife, Stirling, Moray, and Skye. The distribution is primarily associated with upland areas. It occurs in Ireland and has the North Ebudes but is otherwise unknown from islands. Contrary to Franciscolo (1979), this species does not occur in Scandinavia (Nilsson 1979). It is primarily a southern European montane species, recently reported as new from the Apennines in Italy and from Turkey.

Habitat and ecology *O. davisii* is typical of shallow water on silt or rock substrata in the edges of fast running water. It is also occasionally found on exposed lake shores. In

the north-east of England Eyre *et al*. (2005) found *O. davisii* equally distributed between two of the five assemblages associated with headwater streams, those of the most fast sections. Such habitats are most common at intermediate altitudes but *O. davisii* can live near to the coast in the northern part of its range. Balfour-Browne (1940) reported teneral adults from June to September and large larvae in July. An adult recorded in a funnel trap suspended in a tree (Owen 1984) confirms the flight capacity suggested by observations on flight musculature made by Jackson (1973).

Status *O. davisii* has been recorded from 135 hectads from 1980 onwards. An apparent decline in the English Midlands and East Anglia may be associated with misidentifications in the past. The species continues to occupy much of its former range, the exceptions being the Central Belt of Scotland and the coast of north-east England. *O. davisii* occurred in five of the 614 sites sampled for RIVPACS III. Statistical analysis of records held by the national recording scheme has shown that the range of distribution of *O. davisii* has declined by 31% since 1989. Furthermore its proportion of all water beetle records and of all hectads recorded has significantly declined year on year. *O. davisii* is one of five running water species, whose ranges have significantly declined in this way. All are free-swimming species of running water margins as opposed to the common riffle beetles that normally occupy the main river channel and that did not show any significant decline. This is taken to indicate the importance of loss of riparian structure. *O. davisii* is selected for the Near Threatened status as the least common of this suite of running water species.

Threats Pollution of running water, especially nutrient enrichment, presents a potential threat, but damage to riparian and marginal habitat by river regulation and, in particular, bankside engineering are more likely to be responsible for this species' recent decline. Regulated water systems associated with reservoirs may be harmful in that small, marginal water pockets this species inhabits may be lost or inundated too frequently.

Management and conservation Occurrence in many montane areas guarantees some measure of protection within Environmentally Sensitive Areas and areas such as the Peak District National Park. The introduction of Statutory Water Quality Objectives should help to prevent nutrient enrichment, which must be considered detrimental to this species. More important would be sympathetic re-engineering of waterways to generate more nearly natural riparian structure.

Published sources Angus (1964b), Balfour-Browne (1940), Ball (pers. comm.), Bertrand (1927, 1928), Boukal *et al.* (2007), Carr (2001), Erman & Erman (2002), Erman *et al.* (2005), Eyre (1987), Eyre, Luff & Lott (1998), Eyre *et al.* (2005), Foster, G.N. (1983b, 1988b), Foster *et al.* (1991), Fowles (1987), Franciscolo (1979), Friday (1988a), Hájek & Šťastný (2005), Jackson (1973), McCann & Moran (1986), Merritt (1993, 1995, 2006), Nilsson (1979), Owen (1984), Rocchi (2007), Sinclair (1977), Spirit (1986), Wright *et al.* (1996).

PARACYMUS AENEUS ENDANGERED
Schedule 5 of the Wildlife & Countryside Act

Order COLEOPTERA Family HYDROPHILIDAE

Paracymus aeneus (Germar, 1824).

Identification This species has been keyed by Friday (1988a) and by Balfour-Browne (1958) in the British fauna. It is the only species of *Paracymus* occurring in Fennoscandinavia and it is therefore not distinguished by Hansen (1987) from *P. scutellaris* (Rosenhauer). Woolridge (1978) keys the Palaearctic members of the genus. The larva was described by Bøving and Henriksen (1938), but Archangelsky (1999) calls their identification into doubt.

Distribution The most recent map is provided by the UK Biodiversity Group (1999). There are recent published records for the Isle of Wight, and the species has been rediscovered in South Essex. The record for Hampshire (Key 1996a) refers to the Isle of Wight. *P. aeneus* is common along the Mediterranean coasts and at saline localities inland as far as Eastern Siberia; in northern Europe it reaches southern Norway, Denmark, and the southern tip of Sweden.

Habitat and ecology *P. aeneus* lives amongst vegetation at the edge of saline pools above the high water mark. Greenwood & Wood (2003) noted *P. aeneus* in the salinity range 9 to 23 parts per thousand organic matter, or 25-66 %

seawater. According to Archangelsky (1998), *Paracymus* adults lay their eggs among algae or vegetation. Larvae hatch after 4-6 days, and live semiaquatically in the same habitat as the adults, feeding on small invertebrates. Larval development takes 30-40 days and pupation takes place in shallowly placed cells near the water's edge.

Status *P. aeneus* is confined to five localities in four hectads in England, having only ever been known extant from six. As such it qualifies for IUCN Endangered status. The extent of occurrence cannot be measured as the Essex sites are in a line running directly to the Isle of Wight site. The history of this beetle indicates that numbers have fluctuated considerably on the Essex saltmarshes. *P. aeneus* is known from a deposit beneath a Bronze Age boat in the Humber estuary (Buckland, Beal & Heal 1990).

Threats Loss of habitat by coastal development, including rubbish infill, poses the greatest threat to the continuing presence of this species in England. An SSSI on the Isle of Wight has been extended to include a key area of land that supports this species. The extent to which abandonment of coastal defences will affect this species is unclear and could be favourable or deleterious.

Management and conservation Coastal SSSI in Essex and on the Isle of Wight support this species. A Biodiversity Action Plan was prepared for this species but *P. aeneus* was dropped from the new list of BAP priority species, possibly because of its rediscovery in Essex.

Published sources Appleton (1975, 2004), Archangelsky (1998, 1999), Balfour-Browne (1958), Bøving & Henriksen (1938), Buckland, Beal & Heal (1990), Department of the Environment (1995), Foster, G.N. (1987a, 2001c, 2002, 2005a), Friday (1988a), Greenwood & Wood (2003), Hansen (1987), Hebauer & Ryndevich (2005), HMSO (1992), Key (1996a), Shirt (1987), UK Biodiversity Group (1999), Woolridge (1978).

POMATINUS SUBSTRIATUS
VULNERABLE

Order COLEOPTERA Family DRYOPIDAE

Pomatinus substriatus (Müller, 1806). This was formerly known as *Helichus substriatus*.

Identification This species is easily distinguished from *Dryops* by the general form and the recumbent covering of hair. Early keys (Fowler 1899, as *Potaminus substriatus*; Joy 1932) are sufficient. Olmi (1976, Fig. 18) illustrated the adult.

Distribution Records since 1980 are for South and North Devon, South Somerset, East Sussex, Monmouth, Hereford, Worcester, Caerfyrddyn, Ceredigion, and Cumberland. Earlier records add Surrey, East Suffolk, Glamorgan, and North-east Yorks. It is probably extinct in Surrey, having been recorded around 1900 at Chiddingfold. *P. substriatus* is a southern and central European species, known north to Lithuania and Sweden, south to Algeria and Morocco, and east to Turkey, Israel, the Lebanon, and Syria.

Habitat and ecology *P. substriatus* is found submerged in lowland streams, usually on logs or under stones, clods of earth or in masses of exposed tree roots at the edge. Olmi (1976) described the eggs, which are inserted into rotting tree branches under water. The wireworm-like larvae, which feed on wet, rotting wood, and may occur in damp soil, have been described by Olmi (1976). Adults and larvae of this species were found to occupy different faunal groups in a synthesis of the coleopteran fauna of the Upper Rhône catchment (Richoux 1994), adults being associated with side streams and larvae with temporarily flooded banks. This species is capable of flight.

Status *P. substriatus* has been recorded from fifteen hectads in England and Wales from 1980 onwards. It occurred at three of the 614 sites sampled for RIVPACS III. It qualifies for the IUCN Vulnerable status on the basis of its area of occupancy and the fragmentation of the distribution but the extent of occurrence is over 70,000 km². This species has been found in sub-fossil deposits in East Suffolk (Coope 2006), Warwickshire (Kelly & Osborne 1965), North Lincs (Smith 2000), and East Suffolk (Coope 2006).

Threats Canalisation of rivers must constitute the greatest threat in that submerged timber will be removed and tree roots destroyed.

Management and conservation This is one of the few species to benefit from partial shading of streams. Log accumulations in water should be retained wherever possible. The Upper Rhône study demonstrates the importance of maintaining the complete suite of riverine habitats in order to conserve individual species such as *P. substriatus*, as well as sustaining biodiversity overall. Legislation associated with the Water Framework Directive will enforce an improvement in the management of inland waters in the United Kingdom.

Published sources Bates & Sadler (2004), Boukal *et al*. (2007), Boyce (1991), Coope (2006), Denton (2005, 2007a), Duff (1993), Foster, G.N. (1988b, 1995b), Foster & Eyre (1992), Fowler (1989), Godfrey (2003), Hammond & Merritt (2008), Hodge (1977a), Joy (1932), Kelly & Osborne (1965), Löbl & Šmetana (2006), Nash (1973), Nelson (1990), Olmi (1976), Richoux (1994), Smith (2000), Watson & Foster (2006), Wright *et al.* (1996).

RHANTUS BISTRIATUS REGIONALLY EXTINCT
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Rhantus bistriatus (Bergsträsser, 1778). The name for this species remains controversial, and usage here complies with Nilsson & Holmen (1995) in an effort to ensure full recognition of the conservation needs of this species. In Britain it has been known as *adspersus* Fabricius in the past and has more recently as *aberratus* Gemminger & Harold. The name *bistriatus* Bergsträsser needs to be established by designation of a neotype. If that is unsuccessful, the name would need to be suppressed, and then the first available name for this species would be *nigropunctatus* Motschulsky. The common peatland species, *R. suturellus* (Harris) was until recently known as *R. bistriatus* Brit. auctt. Recent material of *R. bistriatus* from the Netherlands had been misidentified as *R. suturellus*.

Identification The adult is keyed by Balfour-Browne (1950) as *adspersus* and by Friday (1988a) as *aberratus*. The larva is illustrated and keyed by Nilsson (1982a) under the name *R. bistriatus* (Bergsträsser).

Distribution The map provided by Foster (1985b) under the name *aberratus* should be used in conjunction with the vice-county map of Balfour-Browne (1950, map 33) under the name *adspersus*. The most recent record is for a ditch at Potter Heigham, East Norfolk, in September 1904. There are 19th Century records for South Essex, Norfolk, Cambs and Hunts. A record for Gloucestershire is considered unreliable and the Scottish report (Sivell & Phillips 1999) and some records accessible on the worldwide web are based on confusion with *R. suturellus*. This is a rare Palaearctic species, known from France, Netherlands, Germany, Italy, Denmark, Sweden, Finland, the Baltic States, Poland, Austria, the Balkans, and east to Mongolia.

Habitat and ecology Nilsson & Holmen (1995) describe the main habitat as temporary, grassy ponds in open land. Galewski (1963) obtained larvae from May to September in Poland, and indicated that adults overwintered out of the water.

Status In addition to the surveys mentioned in Shirt (1987), further surveys of fenland drains (e.g. Foster *et al.* 1989) have failed to detect this species, which should be regarded as extinct. It is rated as extinct or endangered in many European Red Lists.

Threats The most likely cause of extinction of this species began with drainage of the natural fens of East Anglia, as described by Godwin (1978).

Management and conservation The possibility that this species has continued to survive undetected in East Anglia, plus the confusion associated with its name, dictates that it should remain a low priority candidate for reintroduction. Museum material of East Anglian *R. suturellus* should be checked for this species.

Published sources Balfour-Browne (1950), Foster, G.N. (1985b), Foster *et al.* (1989), Friday (1988a), Galewski (1963), Godwin (1978), Hodge & Jones (1995), van Nieuwenhuyzen (1999), Nilsson (1982a), Nilsson & Holmen (1995), Shirt (1987), Sivell & Phillips (1999), Telnov *et al.* (2007).

SPERCHEUS EMARGINATUS
REGIONALLY EXTINCT

Order COLEOPTERA Family SPERCHEIDAE

Spercheus emarginatus (Schaller, 1783).

Identification The adult is keyed by Balfour-Browne (1958), Friday (1988a) and Hansen (1987). The larva was illustrated by Bøving and Henriksen (1938), the main illustration being repeated by Balfour-Browne (1958) and others.

Distribution Balfour-Browne (1958, map 27) provided a map indicating occurrence in South Essex, Herts, Berks, East Suffolk, Cambs, Hunts, and Mid-west Yorks. *S. emarginatus* is mainly a central European species, ranging to northern France, the Netherlands, Denmark, Sweden, Siberia, northern Italy and the Balkans.

Habitat and ecology *S. emarginatus* typically occurs in lowland ponds with marginal vegetation over mud. The last known site in Britain was described as a marsh drain with much floating duckweed, the beetles being found by working a net among marginal vegetation. *Spercheus* adults are unusual among Coleoptera in that they are filter-feeders (Rothmeier & Jäch 1986), hanging upside down just below the water surface. The life-cycle has been described by Balfour-Browne (1958) and others. Like *Helochares*, *Spercheus* females carry their egg cocoons on their abdomen. The black predaceous larvae, which float, are easily found when the pond's edge is disturbed. They take about a month to complete their develop-ment according to Leblanc (1988); Hansen (1987) comments that their development is sufficiently rapid for full grown larvae to occur at the same time as egg-carrying adults.

Status *S. emarginatus* has been recorded from seven English hectads. The only 20th Century record is by Forster (1956) for Beccles, East Suffolk. The precise locality has not been identified. *S. emarginatus* would appear to be extinct in Britain.

Threats Loss of fenland habitats, in particular the drained Cambridgeshire Fens and the built-up areas around and in London, have contributed to the loss of this species. It is still common in Eastern Europe, and it has been suggested that climatic deterioration since the postglacial optimum has also contributed to its decline in the west of its range, where it features on many Red Lists.

Management and conservation This species is a candidate for reintroduction into a rich fen in East Anglia. This should be prefaced by genetic characterisation of imported material, plus long-term storage of material suitable for further genetic studies. This could be used to determine whether newly established populations have originated from the introduction as opposed to previously undetected native populations.

Published sources Balfour-Browne (1958), Bøving & Henriksen (1938), Forster (1956), Friday (1988a), Hansen (1987), Leblanc (1988), Lohez (2007), Hammond & Merritt (2008), Painter (1994), Rothmeier & Jäch (1986), Shirt (1987).

SPHAERIUS ACAROIDES ENDANGERED

Order COLEOPTERA Family SPHAERIUSIDAE

Sphaerius acaroides (Waltl, 1838). The names *Sphaerius* and Sphaeriidae were suppressed in 1985, the names being replaced by *Microsporus* and Microsporidae. *Sphaerius* was reinstated with the newly created family name Sphaeriusidae (International Committee of Zoological Nomenclature 2000), following an appeal by Jäch (1999b). This is referred to as *Microsporus obsidianus* Kolenati by Hodge & Jones (1995); the epithet *acaroides* has priority.

Identification The British fauna includes only one species of *Sphaerius*, which, being 0.7 mm long and globular, is very distinctive. It is keyed as *Sphaerius acaroides* Matthews by Joy (1932). The larva of *Sphaerius* has not been described sufficiently to differentiate it from the larvae of other genera of Myxophaga by Beutel *et al.* (1998). Darby (2009) notes that a record for Wiltshire may stem from a small seed pod identified as this beetle in Marlborough College.

Distribution There is no published map of the British distribution. Early records are for Oxfordshire, Cambridgeshire and Leicestershire (Fowler 1889). The 20th Century records for Dorset, Oxfordshire (Weston Fen), Cambridgeshire (Wicken, Quy and Chippenham

Fens), and Westmorland were reviewed by Duff (1992). The most recent record for Eype's Mouth, Dorset in 2007, and there is one other recent record, in 2008, for Hunts (pers. comm. Peter Kirby). The Palaearctic species of Sphaeriusidae are in need of revision. It seems likely that the species occurring in Britain has a wide distribution in Europe, ranging to the Caucasus but absent from the Iberian Peninsula.

Habitat and ecology What little is known of the life of these microscopic animals is reviewed in Beutel & Leschen (2005). Both adults and larvae would appear to be algivorous, with both living in the moist zone of the banks of watercourses. The adult can be found under stones but is frequently detected, on sunny days, when its slight movement attract attention. Duff (1992) described the best known site as a shallow freshwater pool with coarse grasses at the base of a cliff at Eype's Mouth, Dorset. Other British records are largely for fens.

Status The fossil record for this species is good because it is more likely to be detected by microscopic examination of fossil fragments than by orthodox sampling methods for live insects. For example, Osborne (1980) examined a transition between Late Devensian and Flandrian deposits at the junction of the M5 and the M6, and found *S. acaroides* in the Late Devensian fauna, about 12,000 years old from a cool temperate period prior to a brief return to severe arctic conditions. It is possible that the species is still widely distributed in England, but is overlooked because of its small size and resemblance, with the unaided eye, to an oribatid mite. Against this the considerable interest in the fauna of exposed riverine sediments in recent years, including trapping that might be expected to yield this species, has failed to bring forward more records, and *S. acaroides* should be regarded as associated with relatively few, fragile habitats. It qualifies for IUCN Endangered status, with only two modern hectads, the extent of occurrence not being measurable.

Threats Loss of fenland and wet cliff habitats are possible causes of reduction in the number of sites for this species.

Management and conservation Eype's Mouth is part of the West Dorset Coast SSSI. The Orton Pit is an SAC and SSSI. Management must primarily be directed to maintaining exposed, moist silt and mud banks.

Published sources Beutel & Leschen (2005), Beutel *et al.* (1998), Carron (2008), Darby (2009), Duff (1992), Girling (1979a, 1980, 1982a), Hess & Heckes (1996), Hodge & Jones (1995), ICZN (2000), Jäch (1999b), Joy (1932), Osborne (1980), Telfer (2003).

STENELMIS CANALICULATA
VULNERABLE
A riffle beetle

Order COLEOPTERA Family ELMIDAE

Stenelmis canaliculata (Gyllenhal, 1808).

Identification The adult and larva were described by Claridge & Staddon (1961). In addition, Holland (1972) described the pupa. Friday (1988a) keys the adult.

Distribution This species was first recorded from Britain in Lake Windermere (Claridge & Staddon 1961). Holland's (1980) map included new sites in the River Lymn, South Lincs, and in the River Nene (Water Newton, given as the modern Cambridgeshire by Shirt (1987), and as the vice-county of Hunts by Ormerod (1985)). Ormerod (1985) provided the first Welsh record, from the River Wye in Brecon, and there are more recent published records from the Wye in Herefordshire by Lee Knight (Watson & Foster 2006) and in Radnorshire by Denton (2007c), who also found it in the Afon Llynfi in Breconshire. Hinton (Holland 1972) recognised this species from Devon about twenty years earlier but could not trace the details of the record; there are recent, unpublished records for the River Taw, North Devon, and for River Avon in South Hants. A record for Lairds Loch, Angus (Sivell & Phillips, 1999) appears to be in error (Adam Garside, pers. comm.). *S. canaliculata* is mainly a southern and central European species, ranging north to Norway, Sweden and Finland, and south to Portugal and the Black Sea.

Habitat and ecology This is a lowland species found in deep water with gravel and stones in lakes and rivers. Unlike other British elmids, it is a truly benthic organism. An association with the riverine habitats occupied by barbel, *Barbus barbus* L., has been noted in central Europe (Claridge & Staddon 1961). In Italy, Saraceni

(1969) noted that adults occurred at peak densities in August and November, whilst mature larvae were most numerous in October. However, all stages of the life-cycle could always be found together, indicating that both larvae and adults are long-lived. The adults are flightless.

Status *S. canaliculata* has been recorded from fourteen hectads in England and Wales from 1980 onwards. It was last reported from Lake Windermere in 1963. The IUCN criteria for Vulnerable status are satisfied in terms of the area of occupancy but the extent of occurrence is too large at 36,000 km². The fragmentation of the population and the loss of range offset its improved status in the Thames catchment. A recent survey of records for Germany indicates a retraction in range to the south-west and westernmost parts of the country. This species is known as a sub-fossil from Surrey (Robinson 1991), East Suffolk (Coope 2006), and Warwickshire (Osborne 1974, 1976). Malcolm Greenwood (pers. comm.) has found this species in a Mediaeval peat deposit in Leicestershire.

Threats Eutrophication of Lake Windermere may have resulted in the localised extinction of this species. Pollution of large rivers resulting in eutrophication will result in further habitat loss. Smith (2000) has questioned the evidence for the proposal that elmid species, including the *Stenelmis*, were affected by the siltation following on changes in farming practice in the Iron Age: it seems more likely that this species was lost from parts of lowland Britain more recently.

Management and conservation Legislation associated with the Water Framework Directive will enforce an improvement in the management of inland waters in the United Kingdom.

Published sources Allen, A.J.W. (1999), Angus (1964a), Boukal *et al*. (2007), Claridge & Staddon (1961), Coope (2006), Denton (2007c), Drost (1992a), Foster, A.P. (1987), Friday (1988a), Garside (pers. comm.), Hess & Heckes (1996), Hodge & Jones (1995), Holland (1972, 1977, 1980), Klausnitzer & Richoux (1996), Löbl & Šmetana (2006), Olmi (1976), Ormerod (1985), Osborne (1974, 1976), J. Robinson (pers. comm.), Robinson (1991), Saraceni (1969), Shirt (1987), Sivell & Phillips (1999), Smith (2000); Watson & Foster (2006).

STICTONECTES LEPIDUS Near Threatened
A diving beetle

Order COLEOPTERA Family DYTISCIDAE

Stictonectes lepidus (Olivier, 1795).

Identification The adult is keyed by Balfour-Browne (1940) and Friday (1988a). The larva was originally described by Bertrand (1928 - as a *Graptodytes*) and has been keyed by Richoux (1982).

Distribution The map provided by Foster (1983b) should be used in conjunction with the vice-county map of Balfour-Browne (1940, map 54). Records since 1980 are for West and East Cornwall, South and North Devon, South Somerset, Dorset, South Hants, East Sussex, East Norfolk, Cambs, Hunts, West Suffolk, West Norfolk, Monmouth, Staffs, Glamorgan, Salop, Brecon, Caerfyrddyn, Ceredigion, Meirionydd, Caernarfon, Denbigh, Anglesey, South and North Lincs, Leics, Notts, Derbyshire, South-east, South-west and Mid-west Yorks, Cheshire, South Lancs, Durham, Westmorland, Cumberland, Kirkcudbright, Wigtown, Ayrshire, Midlothian, Argyll, Caithness, Arran, and Islay. Earlier records add North Somerset, North Hants, East Kent, South Essex, Herts, East Gloucester, Warks, North-west and North-east Yorks, South and North Northumberland, Dumfries, Renfrew, East Lothian, Stirling, Fife, Kintyre, West Perth, South Aberdeenshire, East Ross, Cumbrae, Coll and Skye, and Hoy in the Orkneys. This species is extinct in Surrey. The full range of *S. lepidus* is uncertain abroad, as many southern and eastern records may refer to closely related species, some not yet described; it is primarily a western European species, occurring from Ireland and Scotland to Portugal.

Habitat and ecology *S. lepidus* occupies a wide range of habitats in Britain, being found on exposed, peaty substrata in lochs and river margins, as well as on clay in recently cleared fenland ditches. Its most characteristic habitat is in "stream pools", natural backwaters or deeper pockets of water left in otherwise dried-out streambeds. Abundance in Pennine streams on Millstone Grit suggests a preference for base-poor waters, but *S. lepidus* also occurs in waters of high conductivity such as old limestone quarry pools on the Northumbrian coast. The

unifying feature of these habitats is their exposed substratum at low to moderate altitude. *S. lepidus* can fly (Jackson 1973). Its frequent occurrence in highly acidic streams and in isolated coastal ones might be explained by a need to avoid fish predation or less mobile competitors.

Status *S. lepidus* has been recorded from 128 hectads in Britain from 1980 onwards. It was found in one sample of the British Countryside Survey in 1990. *S. lepidus* occurred in one of the 614 sites sampled for RIVPACS III. There is considerable evidence of decline, particularly over much of eastern Scotland and England, and in parts of the English Midlands, in Surrey, and most recently in East Anglia. However, the species remains widespread in western Galloway, in the Lake and Peak Districts, the New Forest, and in the south-west of England. This species is transferred to the Near Threatened category as a result of its loss from many parts of lowland Britain.

Threats Loss of habitat for this species has come about mainly through habitat destruction, including invasion by vegetation in enriched sites.

Management and conservation In Broadland, the habitat for this species was maintained by routine clearance of small ditches in grazing fen, though there have been no records since 1977, and few from East Anglia as a whole. This species is easily lost from manmade sites that generate suitable habitat, such as small reservoirs in former industrial areas, if they are allowed to become overgrown. Fish stocking might also be considered deleterious.

Published sources Angus (1964a), Atty (1983, 1996), Balfour-Browne (1940), Bertrand (1928), Boyce (1990), Cuppen (1984), Denton (2002c, 2005, 2007a), Driscoll (1978), Duff (1993), Evans (1979), Eyre, Foster & Carr (1992), Foster, G.N. (1972, 1983b, 1988b), Foster & Eyre (1988), Friday (1988a), Hammond (2001), Hancock (2001), Jackson (1973), Johnson (1991), Key (1994), Lane, Wright & Forsythe (2002), Lee (1981, 1986), Lott (1995), McCann & Moran (1986), Merritt (1993, 1995), Morgan (1989), Richoux (1982), Sinclair (1982), Wright *et al.* (1996).

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12. Index

APPENDIX 1. The IUCN Red List Categories and Criteria as set out in Version 3.1 of the guidance (IUCN 2001).

CRITICALLY ENDANGERED (CR)
A taxon is Critically Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing an extremely high risk of extinction in the wild:

A. Reduction in population size based on any of the following:
1. An observed, estimated, inferred or suspected population size reduction of ≥90% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
a direct observation
b an index of abundance appropriate to the taxon
c a decline in area of occupancy, extent of occurrence and/or quality of habitat
d actual or potential levels of exploitation
e the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥80% over the last 10 years or three generations, whichever is the longer**,** where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible**,** based on (and specifying) any of a to e under A1.

3. A population size reduction of ≥80%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥80% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:
1. Extent of occurrence estimated to be less than 100 km^2, and estimates indicating at least two of a–c:

a. Severely fragmented or known to exist at only a single location.

b. Continuing decline, observed, inferred or projected, in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 10 km^2, and estimates indicating at least two of a–c:

a. Severely fragmented or known to exist at only a single location.

b. Continuing decline, observed, inferred or projected, in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

C. Population size estimated to number fewer than 250 mature individuals and either:
1. An estimated continuing decline of at least 25% within three years or one generation, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):

a. Population structure in the form of one of the following:
(i) no subpopulation estimated to contain more than 50 mature individuals, OR
(ii) at least 90% of mature individuals in one subpopulation.
b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 50 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 50% within 10 years or three generations, whichever is the longer (up to a maximum of 100 years).

ENDANGERED (EN)
A taxon is Endangered when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a very high risk of extinction in the wild:

A. Reduction in population size based on any of the following:
1. An observed, estimated, inferred or suspected population size reduction of ≥70% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
(a) direct observation
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer**,** where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥50%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥50% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:
1. Extent of occurrence estimated to be less than 5000 km^2, and estimates indicating at least two of a–c:

a. Severely fragmented or known to exist at no more than five locations.

b. Continuing decline, observed, inferred or projected, in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat

(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

2. Area of occupancy estimated to be less than 500 km^2, and estimates indicating at least two of a–c:

a. Severely fragmented or known to exist at no more than five locations.

b. Continuing decline, observed, inferred or projected, in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) area, extent and/or quality of habitat
(iv) number of locations or subpopulations
(v) number of mature individuals.

c. Extreme fluctuations in any of the following:
(i) extent of occurrence
(ii) area of occupancy
(iii) number of locations or subpopulations
(iv) number of mature individuals.

C. Population size estimated to number fewer than 2500 mature individuals and either:
1. An estimated continuing decline of at least 20% within five years or two generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):

a. Population structure in the form of one of the following:
(i) no subpopulation estimated to contain more than 250 mature individuals, OR
(ii) at least 95% of mature individuals in one subpopulation.

b. Extreme fluctuations in number of mature individuals.

D. Population size estimated to number fewer than 250 mature individuals.

E. Quantitative analysis showing the probability of extinction in the wild is at least 20% within 20 years or five generations, whichever is the longer (up to a maximum of 100 years).

VULNERABLE (VU)
A taxon is Vulnerable when the best available evidence indicates that it meets any of the following criteria (A to E), and it is therefore considered to be facing a high risk of extinction in the wild:

A. Reduction in population size based on any of the following:
1. An observed, estimated, inferred or suspected population size reduction of ≥50% over the last 10 years or three generations, whichever is the longer, where the causes of the reduction are: clearly reversible AND understood AND ceased, based on (and specifying) any of the following:
(a) direct observation
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

2. An observed, estimated, inferred or suspected population size reduction of ≥30% over the last 10 years or three generations, whichever is the longer**,** where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible**,** based on (and specifying) any of (a) to (e) under A1.

3. A population size reduction of ≥30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on (and specifying) any of (b) to (e) under A1.

4. An observed, estimated, inferred, projected or suspected population size reduction of ≥30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on (and specifying) any of (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) OR B2 (area of occupancy) OR both:

1. Extent of occurrence estimated to be less than 20,000 km^2, and estimates indicating at least two of a–c:

   a. Severely fragmented or known to exist at no more than 10 locations.

   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.

   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

2. Area of occupancy estimated to be less than 2000 km^2, and estimates indicating at least two of a–c:

   a. Severely fragmented or known to exist at no more than 10 locations.

   b. Continuing decline, observed, inferred or projected, in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) area, extent and/or quality of habitat
      (iv) number of locations or subpopulations
      (v) number of mature individuals.

   c. Extreme fluctuations in any of the following:
      (i) extent of occurrence
      (ii) area of occupancy
      (iii) number of locations or subpopulations
      (iv) number of mature individuals.

C. Population size estimated to number fewer than 10,000 mature individuals and either:

1. An estimated continuing decline of at least 10% within 10 years or three generations, whichever is longer, (up to a maximum of 100 years in the future) OR

2. A continuing decline, observed, projected, or inferred, in numbers of mature individuals AND at least one of the following (a–b):

   a. Population structure in the form of one of the following:
      (i) no subpopulation estimated to contain more than 1000 mature individuals, OR
      (ii) all mature individuals are in one subpopulation.

   b. Extreme fluctuations in number of mature individuals.

D. Population very small or restricted in the form of either of the following:
   1. Population size estimated to number fewer than 1000 mature individuals.

   2. Population with a very restricted area of occupancy (typically less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period.

E. Quantitative analysis showing the probability of extinction in the wild is at least 10% within 100 years.

DEFINITIONS

Extent of occurrence (Criteria A and B)

Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary which can be drawn to encompass all the known, inferred or projected sites of present occurrence of a taxon, excluding cases of vagrancy. This measure may exclude discontinuities or disjunctions within the overall distributions of taxa (*e.g.* large areas of obviously unsuitable habitat) (but see 'area of occupancy'). Extent of occurrence can often be measured by a minimum convex polygon (the smallest polygon in which no internal angle exceeds 180 degrees and which contains all the sites of occurrence).

Area of occupancy (Criteria A, B and D)

Area of occupancy is defined as the area within its 'extent of occurrence' which is occupied by a taxon, excluding cases of vagrancy. The measure reflects the fact that a taxon will not usually occur throughout the area of its extent of occurrence, which may, for example, contain unsuitable habitats. In some cases the area of occupancy is the smallest area essential at any stage to the survival of existing populations of a taxon. The size of the area of occupancy will be a function of the scale at which it is measured, and should be at a scale appropriate to relevant biological aspects of the taxon, the nature of threats and the available data.

Location (Criteria B and D)

The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a taxon is affected by more than one threatening event, location should be defined by considering the most serious plausible threat.

Quantitative analysis(Criterion E)

A quantitative analysis is defined here as any form of analysis which estimates the extinction probability of a taxon based on known life history, habitat requirements, threats and any specified management options. Population viability analysis (PVA) is one such technique. Quantitative analysis should make full use of all relevant available data. In a situation in which there is limited information, such data as are available can be used to provide an estimate (for instance, estimating the impact of stochastic events on habitat). In presenting the result of quantitative analysis. The assumptions (which must be appropriate and defensible), the data used and the uncertainty in the data or quantitative model must be documented.