Natural England Commissioned Report NECR224

A review of the status of the beetles of Great Britain

The stag beetles, dor beetles, dung beetles, chafers and their allies - Lucanidae, Geotrupidae, Trogidae and Scarabaeidae

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

Decisions about the priority to be attached to the conservation of species should be based upon objective assessments of the degree of threat to species. The internationally-recognised approach to undertaking this is by assigning species to one of the IUCN threat categories using the IUCN guidelines.

This report was commissioned to update the national threat status of beetles within the Lucanidae, Geotrupidae, Trogidae and Scarabaeidae. It covers all species in these groups, identifying those that are rare and/or under threat as well as non-threatened and non-native species. Reviews for other invertebrate groups will follow.

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Further information
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1.1 The Species Status project

The Species Status project is a recent initiative, providing up-to-date assessments of the threat status of taxa using the internationally accepted Red List guidelines developed by the International Union for Conservation of Nature (IUCN) IUCN Standards and Petitions Subcommittee, 2014); (IUCN, 2012a; 2012b). It is the successor to the Joint Nature Conservation Committee (JNCC) Species Status Assessment project (http://jncc.defra.gov.uk/page-3352) which ended in 2008. This publication is one in a series of reviews to be produced under the auspices of the new project.

Under the Species Status project, the UK's statutory nature conservation agencies, specialist societies and NGOs will initiate, resource and publish Red Lists and other status reviews of selected taxonomic groups for Great Britain which will then be submitted to JNCC for accreditation (http://jncc.defra.gov.uk/page-1773). This means that the UK's statutory nature conservation agencies and JNCC will be able to publish red lists. All publications will explain the rationale for the assessments made. The approved threat statuses will be entered into the JNCC spreadsheet of species conservation designations (http://jncc.defra.gov.uk/page-3408).

1.2 The status assessments

This review adopts the procedures recommended for the regional application of the IUCN threat assessment guidelines which can be viewed at IUCN (2012b). http://cmsdocs.s3.amazonaws.com/keydocuments/Reg_Guidelines_en_web%2Bcover%2Bbackcover.pdf Section 3 and Appendix 1 provide further details. This is a two-step process, the first identifying the taxa threatened in the region of interest using information on the status of the taxa of interest in that region (IUCN, 2014), the second amending the assessments where necessary to take into account interaction with populations of the taxon in neighbouring regions (IUCN Standards and Petitions Subcommittee, 2014; http://cmsdocs.s3.amazonaws.com/RedListGuidelines.pdf). In addition, but as a separate exercise, the standard GB system of assessing rarity, based solely on distribution, is used alongside the IUCN system.

1.3 Species status and conservation action

Sound decisions about the priority to attach to conservation action for any species should primarily be based upon objective assessments of the degree of threat to the survival of a species. This is conventionally done by assigning the species to one of the IUCN threat categories although the IUCN (2014) point out that a category of threat is often not sufficient to determine priorities for conservation action. However, the 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.

2 Introduction to the Beetle Reviews

Many beetles are important ecological indicators (much more refined than most plants) due to their dependency on complex factors such as vegetation structure, microclimate and substrate. They are also found in a much wider range of habitats than some of the more popular groups of insects such as butterflies, dragonflies and bumblebees. Monitoring their status and abundance can provide a very useful indication of ecological 'health', in a way that monitoring plants, birds, bats or other insect groups, for example, may not.

The Scarabaeiodea are a well-defined and easily recognisable group of beetles. The superfamily contains some of the best known British beetles, such as the stag beetle, cockchafer and Minotaur beetle. In addition, they are an important source of prey for some birds (e.g. chough) and mammals (e.g. greater horseshoe bat) and provide essential ecosystem services. An overview of the British fauna was provided by Mann (2006).

Dung beetles are also an economically important group with Beynon *et al*. (2015) suggesting that they are currently saving the U.K. cattle industry ca. £367 million each year. Beynon *et al*. (2015) also highlight the potential for the DEFRA ecosystem services framework to be utilised in an entomological context, as dung beetles should be considered key ecosystem service providers within the UK cattle industry.

2.1 Taxa selected for this review

Table 1 summarises the taxa included in this review. Nomenclature follows Mann (2012). These taxa have been the subject of a British national recording scheme, coordinated by the Biological Records Centre. The work of this scheme includes the collation of information from the following data sources:

- National Recording Scheme for Scarabaeoidea:
- historic records published in local and national journals;
- published county reviews;
- voucher specimens in local and national museums;
- records arising from the activity of the biological recording community.

Table 1. Distribution across higher taxonomic groupings of the taxa selected for review.

Order	Family	Species
Coleoptera	Lucanidae	*Dorcus parallelipipedus* (Linnaeus, 1758)
		Lucanus cervus (Linnaeus, 1758)
		Platycerus caraboides (Linnaeus, 1758)
		Sinodendron cylindricum (Linnaeus, 1758)
	Trogidae	*Trox perlatus* (Goeze, 1777)
		Trox sabulosus (Linnaeus, 1758)
		Trox scaber (Linnaeus, 1767)
	Geotrupidae	*Anoplotrupes stercorosus* (Scriba, 1791)
		Geotrupes mutator (Marsham, 1802)
		Geotrupes spiniger (Marsham, 1802)
		Geotrupes stercorarius (Linnaeus, 1758)
		Odonteus armiger (Scopoli, 1772)
		Trypocopris pyrenaeus (Charpentier, 1825)
		Trypocopris vernalis (Linnaeus, 1758)
		Typhaeus typhoeus (Linnaeus, 1758)
	Scarabaeidae	*Aegialia arenaria* (Fabricius, 1787)
		Aegialia rufa (Fabricius, 1792)
		Aegialia insularis Pittino, 2006
		Amphimallon fallenii (Gyllenhal, 1817)
		Amphimallon solstitialis (Linnaeus, 1758)
		Anomala dubia (Scopoli, 1763)
		Aphodius arenarius (Olivier, 1789)
		Aphodius ater (Degeer, 1774)
		Aphodius borealis Gyllenhal, 1827
		Aphodius brevis Erichson, 1848
		Aphodius coenosus (Panzer, 1798)
		Aphodius conspurcatus (Linnaeus, 1758)
		Aphodius consputus Creutzer, 1799

		Aphodius constans Duftschmid, 1805
		Aphodius contaminatus (Herbst, 1783)
		Aphodius depressus (Kugelann, 1792)
		Aphodius distinctus (Müller, 1776)
		Aphodius erraticus (Linnaeus, 1758)
		Aphodius fasciatus (Olivier, 1789)
		Aphodius fimetarius (Linnaeus, 1758)
		Aphodius foetens (Fabricius, 1787)
		Aphodius foetidus (Herbst, 1783)
		Aphodius fossor (Linnaeus, 1758)
		Aphodius granarius (Linnaeus, 1767)
		Aphodius haemorrhoidalis (Linnaeus, 1758)
		Aphodius ictericus (Laicharting, 1781)
		Aphodius lapponum Gyllenhal, 1806
		Aphodius lividus (Olivier, 1789)
		Aphodius luridus (Fabricius, 1775)
		Aphodius merdarius (Fabricius, 1775)
		Aphodius nemoralis Erichson, 1848
		Aphodius niger (Illiger, 1798)
		Aphodius obliteratus Panzer, 1823
		Aphodius paykulli Bedel, 1908
		Aphodius pedellus (De Geer, 1774)
		Aphodius plagiatus (Linnaeus, 1767)
		Aphodius porcus (Fabricius, 1792)
		Aphodius prodromus (Brahm, 1790)
		Aphodius punctatosulcatus Sturm, 1805
		Aphodius pusillus (Herbst, 1789)
		Aphodius quadrimaculatus (Linnaeus, 1761)
		Aphodius rufipes (Linnaeus, 1758)
		Aphodius rufus (Moll, 1782)

		Aphodius scrofa (Fabricius, 1787)
		Aphodius sordidus (Fabricius, 1775)
		Aphodius sphacelatus (Panzer, 1798)
		Aphodius sticticus (Panzer, 1798)
		Aphodius subterraneus (Linnaeus, 1758)
		Aphodius varians Duftschmidt, 1805
		Aphodius zenkeri Germar, 1813
		Brindalus porcicollis (Illiger, 1803)
		Cetonia aurata (Linnaeus, 1758)
		Copris lunaris (Linnaeus, 1758)
		Diastictus vulneratus (Sturm, 1805)
		Euheptaulacus sus (Herbst, 1783)
		Euheptaulacus villosus (Gyllenhal in Schönherr, 1806)
		Gnorimus nobilis (Linnaeus, 1758)
		Gnorimus variabilis (Linnaeus, 1758)
		Heptaulacus testudinarius (Fabricius, 1775)
		Hoplia philanthus (Fuessly, 1775)
		Melolontha hippocastani Fabricius, 1801
		Melolontha melolontha (Linnaeus, 1758)
		Omaloplia ruricola (Fabricius, 1775)
		Onthophagus coenobita (Herbst, 1783)
		Onthophagus fracticornis (Preyssler, 1790)
		Onthophagus joannae Goljan, 1953
		Onthophagus medius (Kugelann, 1792)
		Onthophagus nuchicornis (Linnaeus, 1758)
		Onthophagus similis (Scriba, 1790)
		Onthophagus taurus (Schreber, 1759)
		Onthophagus verticicornis (Laicharting, 1781)
		Oxyomus sylvestris (Scopoli, 1763)
		Oxythyrea funesta (Poda, 1761)

		Phyllopertha horticola (Linnaeus, 1758)
		Pleurophorus caesus (Creutzer in Panzer, 1796)
		Polyphylla fullo (Linnaeus, 1758)
		Protaetia metallica (Herbst, 1782)
		Psammodius asper (Fabricius, 1775)
		Rhyssemus germanus (Linnaeus, 1767)
		Saprosites mendax (Blackburn, 1892)
		Saprosites natalensis (Peringuy, 1901)
		Serica brunnea (Linnaeus, 1758)
		Tesarius caelatus (LeConte, 1857)
		Tesarius mcclayi (Cartwright, 1955)
		Trichius fasciatus (Linnaeus, 1758)
		Trichius gallicus Dejean, 1821

The area covered in this review is Great Britain (i.e. England, Scotland and Wales only). While Northern Ireland forms part of the United Kingdom, the recent trend has been for that area to work with the Irish Republic to cover whole Ireland reviews. The Channel Islands and the Isle of Man are not included.

2.2 Previous reviews

2.2.1 British Red Data Books: 2. Insects (1987)

The first account of threatened British Coleoptera was included in the British Red Data Books: 2. Insects (Shirt, 1987). This listed 546 of the total British beetle fauna of some 3900 species, which equates to 14% having a conservation status of threat. Shirt used 5 Categories (Endangered, Vulnerable, Rare, Out of Danger and Endemic) as well as 'Appendix' which concerned extinct species formerly native to Britain but not recorded since 1900. These categories were assigned by count data only. Magnitude of decline was not considered. Data sheets were only provided for each of the Category 1 (Endangered) and 2 (Vulnerable) species. The list of species covered in the present *Review* by category from Shirt (1987), allowing for taxonomic changes which have occurred since 1987 (see Mann, 2012 for changes) is provided in Table 2.

Table 2. Scarabaeoidea Red List assignments after Shirt (1987)

FAMILY	SPECIES	CATEGORY
Lucanidae	*Platycerus caraboides* (Linnaeus, 1758)	APPENDIX: Extinct
Trogidae	*Trox perlatus* (Goeze, 1777)	RDB1: Endangered
Geotrupidae	*Odonteus armiger* (Scopoli, 1772)	RDB3: Rare
Scarabaeidae	*Aegialia rufa* (Fabricius, 1792)	RDB1: Endangered
	Aphodius brevis Erichson, 1848	RDB1: Endangered
	Aphodius lividus (Olivier, 1789)	RDB3: Rare
	Aphodius niger (Illiger, 1798)	RDB1: Endangered
	Aphodius quadrimaculatus (Linnaeus, 1761)	RDB3: Rare
	Aphodius scrofa (Fabricius, 1787)	APPENDIX: Extinct
	Aphodius subterraneus (Linnaeus, 1758)	RDB3: Rare
	Brindalus porcicollis (Illiger, 1803)	RDB1+:Endangered, believed to be extinct
	Copris lunaris (Linnaeus, 1758)	RDB1: Endangered
	Diastictus vulneratus (Sturm, 1805)	RDB2: Vulnerable
	Euheptaulacus sus (Herbst, 1783)	RDB3: Rare
	Gnorimus nobilis (Linnaeus, 1758)	RDB3: Rare
	Gnorimus variabilis (Linnaeus, 1758)	RDB1: Endangered
	Heptaulacus testudinarius (Fabricius, 1775)	RDB3: Rare
	Onthophagus taurus (Schreber, 1759)	APPENDIX: Extinct
	Onthophagus verticicornis (Laicharting, 1781)	APPENDIX: Extinct
	Polyphylla fullo (Linnaeus, 1758)	APPENDIX: Extinct
	Pleurophorus caesus (Creutzer in Panzer, 1796)	APPENDIX: Extinct
	Rhyssemus germanus (Linnaeus, 1767)	APPENDIX: Extinct

The Category RDB1+ given to *Brindalus porcicollis* denotes a Category 1 species believed to be extinct. The Category APPENDIX is reserved for those taxa that were formerly native to Britain but had not been recorded since 1900.

2.2.2 A review of the scarce and threatened beetles of Great Britain (1992; 1994)

The British Red Data Book volume was followed by the publication of *A review of the scarce and threatened beetles of Great Britain Part 1* (Hyman, 1992) and Part 2 (Hyman, 1994) which reviewed the status for all British beetles and presented data sheets for all scarce and threatened terrestrial species. Hyman expanded on Shirt's Categories, but retained Categories 1, 2, 3 and 5 and 'Appendix' with their criteria. He also introduced additional categories, those for Red Data Book Indeterminate (RDBI), Red Data Book Insufficiently Known (RDBK), Nationally Scarce Category A (Notable A), Nationally Scarce Category B (Notable B) and Nationally Scarce (Notable). As with Shirt (1987), the magnitude of decline was not considered in the evaluation of status. Data sheets for aquatic beetles were not included, although these have been subsequently determined and data sheets provided by Foster (2010). The list of species covered in the present *Review* by category from Hyman (1992, 1994) allowing for taxonomic changes which have occurred since 1994 (see Mann, 2012 for changes) is provided in Table 3.

Table 3. Rarity and scarcity categories assigned by Hyman (1992, 1994) for species in the status review of Scarabaeoidea

FAMILY	SPECIES	CATEGORY
Lucanidae	*Lucanus cervus* (Linnaeus, 1758)	Nb
	Platycerus caraboides (Linnaeus, 1758)	EXTINCT
Trogidae	*Trox perlatus* (Goeze, 1777)	RDB1: Endangered
	Trox sabulosus (Linnaeus, 1758)	Na
Geotrupidae	*Geotrupes mutator* (Marsham, 1802)	Nb
	Odonteus armiger (Scopoli, 1772)	Na
	Trypocopris pyrenaeus (Charpentier, 1825)	Na
	Trypocopris vernalis (Linnaeus, 1758)	Nb
Scarabaeidae	*Aegialia insularis* Pittino, 2006	Nb
	Aegialia rufa (Fabricius, 1792)	RDB1: Endangered
	Amphimallon fallenii (Gyllenhal, 1817)	Na
	Aphodius arenarius (Olivier, 1789)	Nb
	Aphodius brevis Erichson, 1848	RDB1: Endangered
	Aphodius coenosus (Panzer, 1798)	Nb
	Aphodius conspurcatus (Linnaeus, 1758)	Nb
	Aphodius consputus Creutzer, 1799	RDB3: Rare
	Aphodius distinctus (Müller, 1776)	Nb
	Aphodius fasciatus (Olivier, 1789)	Nb
	Aphodius lividus (Olivier, 1789)	RDB1: Endangered
	Aphodius nemoralis Erichson, 1848	Na
	Aphodius niger (Illiger, 1798)	RDB1: Endangered
	Aphodius paykulli Bedel, 1908	Nb
	Aphodius plagiatus (Linnaeus, 1767)	Nb
	Aphodius porcus (Fabricius, 1792)	Nb
	Aphodius quadrimaculatus (Linnaeus, 1761)	RDB1: Endangered
	Aphodius scrofa (Fabricius, 1787)	EXTINCT
	Aphodius sordidus (Fabricius, 1775)	Na
	Aphodius subterraneus (Linnaeus, 1758)	RDB1: Endangered

	Aphodius zenkeri Germar, 1813	Nb
	Brindalus porcicollis (Illiger, 1803)	EXTINCT
	Copris lunaris (Linnaeus, 1758)	RDB1: Endangered
	Diastictus vulneratus (Sturm, 1805)	RDB2: Vulnerable
	Euheptaulacus sus (Herbst, 1783)	RDB1: Endangered
	Euheptaulacus villosus (Gyllenhal in Schönherr, 1806)	Na
	Gnorimus nobilis (Linnaeus, 1758)	RDB2: Vulnerable
	Gnorimus variabilis (Linnaeus, 1758)	RDB1: Endangered
	Heptaulacus testudinarius (Fabricius, 1775)	RDB1: Endangered
	Melolontha hippocastani Fabricius, 1801	RDBK
	Omaloplia ruricola (Fabricius, 1775)	Nb
	Onthophagus fracticornis (Preyssler, 1790)	RDBK
	Onthophagus medius (Kugelann, 1792)	Nb
	Onthophagus nuchicornis (Linnaeus, 1758)	Na
	Onthophagus taurus (Schreber, 1759)	EXTINCT
	Onthophagus verticicornis (Laicharting, 1781)	RDB1: Endangered
	Pleurophorus caesus (Creutzer in Panzer, 1796)	EXTINCT
	Polyphylla fullo (Linnaeus, 1758)	EXTINCT
	Protaetia metallica (Herbst, 1782)	Nb
	Psammodius asper (Fabricius, 1775)	Na
	Rhyssemus germanus (Linnaeus, 1767)	EXTINCT

2.2.3 This review

The present review provides an up to date assessment of the status of the Scarabaeoidea beetle families in the format now almost universally adopted for the assessment of threat in any taxa. The IUCN Guidelines have been revised (IUCN, 1994) and subsequently updated (IUCN, 2012a): the criteria for threat categories concentrate on imminent danger of regional extinction whereas the older, non-IUCN criteria for Nationally Rare and Nationally Scarce relate to the restriction of geographic distribution within Great Britain without taking any account of trends, whether for increase or decline. Much new information on distribution and trends has become available since the publication of Shirt (1987) and Hyman (1992, 1994). This review revises the status assigned to many species in the earlier reviews and several nomenclatural changes have been incorporated in accordance with the latest checklist (Mann, 2012).

3 The IUCN threat categories and selection criteria as adapted for Invertebrates in Great Britain

3.1 Summary of the 2001 Threat Categories

It is necessary to have a good understanding of the rationale behind red listing and the definitions used in the red listing process. This is because these definitions may differ from standard ecological definitions e.g. "populations" or have very specific meanings e.g. "inferred". Details regarding methods and terminology are contained in the *Guidelines for Using the IUCN Red List Categories and Criteria* IUCN 2014; http://www.iucnredlist.org/documents/RedListGuidelines.pdf). This is summarised without any detail in *IUCN Red List Categories and Criteria: Version 3.1* (IUCN 2012a; http://cmsdocs.s3.amazonaws.com/keydocuments/Categories_and_Criteria_en_web%2Bcover%2Bbckcover.pdf). The procedure for assessing taxa at a regional level differs from that at a global level and is summarised in the *Guidelines for Application of IUCN Red List Criteria at Regional and National Levels IUCN* (2012b) http://cmsdocs.s3.amazonaws.com/keydocuments/Reg_Guidelines_en_web%2Bcover%2Bbackcover.pdf).

A brief outline of the revised IUCN criteria and their application is given below. The definitions of the categories are given in Table 4 and the hierarchical relationship of the categories in Figure 1.

Table 4. Definitions of IUCN threat categories (from IUCN, 2012b with a more specific definition for regional extinction)

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 (see Appendix 2).
ENDANGERED (EN) A taxon is Endangered when the best available evidence indicates that it meets any of the Criteria A to E for Endangered (see Appendix 2).
VULNERABLE (VU) A taxon is Vulnerable when the best available evidence indicates that it meets any of the Criteria A to E for Vulnerable (see Appendix 2).
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.
NOT APPLICABLE (NA) Taxa deemed to be ineligible for assessment at a regional level because they are not wild populations or not within their natural range in the region, or non-natives (whether this is the result of accidental or deliberate importation), or because they are vagrants. A taxon may also be NA because it occurs at very low numbers in the region (i.e. when the regional Red List authority has decided to use a "filter" to exclude taxa before the assessment procedure) or the taxon may be classified at a lower taxonomic level (e.g. below the level of species or subspecies) than considered eligible by the regional Red List authority.

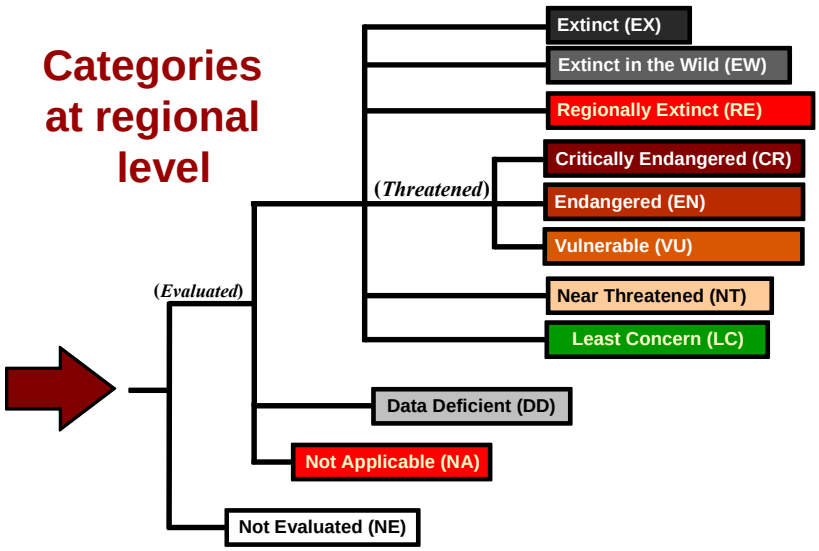

Figure 1. Hierarchical relationships of the categories adapted from IUCN (2001)

Taxa listed as *Critically Endangered*, *Endangered* or *Vulnerable* are defined as Threatened taxa. For each of these threat categories there is a set of five main criteria A-E, that reflect varying degrees of threat of extinction, 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. A taxon therefore need not meet all of the criteria A-E, but must be tested against all five criteria. The taxon should then be listed against the highest threat category for one or more of the five criteria. The qualifying thresholds within the criteria A-E are detailed in Appendix 2: IUCN Criteria and Categories.

Status evaluation procedure relies on an objective assessment of the available evidence. Understanding data uncertainty and data quality is essential when applying the criteria. However, it is not always possible to have detailed and relevant data for every taxon. For this reason, the Red List Criteria are designed to incorporate the use of inference and projection, to allow taxa to be assessed in the absence of complete data. Although the criteria are quantitative in nature, the absence of high-quality data should not deter attempts at applying the criteria. In addition to the quality and completeness of the data (or lack of), there may be uncertainty in the data itself, which needs to be considered in a Red List assessment (data uncertainty is discussed in section 3.2; IUCN 2014). The IUCN criteria use the terms Observed, Estimated, Projected, Inferred, and Suspected to refer to the quality of the information for specific criteria and the specific IUCN red list definitions of these terms was used (see section 3.2; IUCN 2014).

The guidelines stipulate/advise that a precautionary approach 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 judgment, and it should be particularly noted that it is not the worst-case scenario that will determine the threat category to which the taxon will be assigned.

3.1.2 The use of the Not Applicable category

A taxon may be Not Applicable (NA) when it occurs in a region but is not included in the regional assessment. See Table 4 for details.

3.1.3 The use of the Near Threatened category

The IUCN guidelines recognise a *Near Threatened* category to identify taxa that need to be kept under review to ensure that they do not further decline to become Threatened. This category would be best considered for those taxa that come close to qualifying as CR, EN or VU but not quite; i.e. meets many but not all of the criteria and sub-criteria and there is ongoing threat. For those criteria that are not quite met, there should be sufficient evidence to show that the taxon is close to the relevant threatened thresholds. As such, it is up to the reviewers to provide evidence and methods for discerning this.

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

The IUCN regional guidelines (IUCN, 2012b) indicate taxa should be assessed using a two-stage approach. Populations in the region under review should firstly be assessed using the global guidelines. That status should then be reassigned a higher or a lower category if their status within the region is likely to be affected by emigration or immigration (IUCN, 2012b).

3.2 Application of the Guidelines to the Scarabaeoidea

3.2.1 Use of criteria in this review

The IUCN process requires that each species is evaluated against all 5 criteria.

British invertebrate data have been collected since the 19th century in a presence absence form. Often there is only enough information to identify the median point in the numbers of records gathered and compare these two periods (pre- and post-median). Sometimes the data are better and can be grouped into several 10 year periods (e.g. 1985 – 1996 and so forth). Occasionally, there is a single record for a taxon (and therefore date) which makes calculation of decline over a given period easier (possibly Criterion A). Further, a few species do have sufficient data required for the use of Criterion A.

Criterion A was tested on all taxa, but was only found to be viable as an accurate measure of status for *Gnorimus nobilis*. This is because the data for this species concern repeat visits to assess habitat suitability and the data have been collated through extensive research.

It was not possible to use Criterion E as the current data do not allow for determining the probability of extinction using population modelling.

The Invertebrate Inter Agency Working Group has defined the following for the use of B2bii which is commonly used in reviews. Continuing decline has to be demonstrated, and proven that it isn't an artefact of under-recording. If decline is demonstrated then the reviewer needs to consider whether or not B2a (and B2c if the data are present) is met:

- If 10 or less current localities then *Critically Endangered*, *Endangered*, *Vulnerable* is applicable;
- If 11 or 12 current localities then *Near Threatened* applies;
- If 13-15 and the taxon can be shown to be vulnerable to a specific and realistic threat, then *Near Threatened* applies;
- If more than 15 locations then *Least Concern* applies.

3.2.2 Scale for calculating decline and area

The IUCN have recommended a scale of 4km^2 (a tetrad) as the reference scale (IUCN, 2014). This needs to be applied with caution and there will be instances where a different scaling may be more applicable, or where attempting to apply any scale is extremely difficult. It should be noted that, historically, invertebrate datasets used hectads (10km^2) as the default scale. Old records (e.g. pre 1950) have only been recorded at this scale. This means that, for some taxa, comparative declines can only be made at this scale. Hectads are also used to determine the Great Britain Rarity Status, and are therefore still usefully recorded. For rarer, more restricted, taxa the tetrad is more applicable, in particular those taxa which may occur on a few fragmented sites within the UK and/or whom are often restricted to certain, well-defined habitat types that are easily identified. Tetrads have therefore been recorded for taxa that qualify as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) and future reviews should make efforts to record all taxa at both the hectad and tetrad scale.

Rate of Decline is used in Criteria A, B & C to assess threat status. For Criterion A and C1 a decline threshold is related to a specific number of years. For Criterion A it is precisely ten years, and for Criterion C1 precisely 3, or 5 or 10 years (exceptionally up to 100 years for long-lived species such as *Margaritifera margaritifera*). [Criterion A is usually dependent on a pattern of decline in population size over the last 10-year period (unless quality data exist to prove significant former decline or projected future decline). Where data are poor or patchy, this

decline can be calculated from an estimate over a non-contemporary time interval providing, significantly, that the decline of the taxon is linear. Linear decline means that the gradient of decline is constant over a given period of time. This is easy to establish for taxa that have been the subject of repeated and regular population counts, where constant monitoring protocols or controlled sampling procedures have been adopted. Examples might be transect butterfly counts, MV-light trapping of moth species over a prolonged period at regular intervals at a specific location and regular bird count and nesting surveys. The Scarabaeoidea with the exception of *Gnorimus nobilis* have not been sampled with this degree of regularity or control and as a consequence, the data quality is too poor to establish whether a decline is linear. In many respects, the assumption that a decline is linear could be statistically suspect, particularly where poor-quality and patchy data are sampled from a non-contemporary time period to the present and any number of population dynamic models might be in force. Criterion C1 likewise utilises population size decline measured over specific time intervals but places more emphasis on population counts referring throughout to number of mature individuals.

Criterion B also relies on a pattern of continuing decline. The number of hectads (data quality is too poor for tetrad use) is calculated for several pre-determined periods. The degree of accuracy with which the location is recorded is variable and often poor. For example, *Aegialia rufa* is represented by 70 records in the National database, of which 52 (74%) are referenced by hectads only. If a decline is apparent in this initial main recording period analysis, reference to a later 'contemporary' time period may be used to reinforce or weaken the suggestion of a decline. The quality of the data in the contemporary time period is invariably better than that in the earlier date class and usually allows us to consider AoO (Area of Occupancy) to tetrad detail or better. In this latter date period, the number of locations is also calculated for taxa recorded from 15 or fewer hectads. The resulting figures are used for application of the spatial distribution Criteria under B.

For most invertebrate taxa, data are gathered by observation of presence in a particular location. The data are generated by field observation, the location and timing of which is at the random whim of collectors of varying skills. However, it is usually possible to ascribe some degree of decline whether observed, or inferred (i.e. the balance of probability suggests that a decline is present). The application of Criterion B is less susceptible to incorrect statistical conclusions compared to A as applied to taxa for which data quality is poor. There is no specific requirement for the decline to be within the last 10-year period nor the requirement to meet any threshold, although it makes sense to use this or a similar recent measure as a constant time period for each reviewed invertebrate group. The necessity to prove that a decline is linear is also absent, continuous decline being assessed by the observation of a reduction in the AoO between the prescribed contemporary time periods and not requiring a numerical percentage of magnitude. The number of contemporary locations is also a significant factor in the evaluation and is once more, relatively straightforward to appreciate and is reliable. The author's professional and field knowledge and intuition of a species can play an integral part in the application of this criteriona where the data are patchy.

3.2.3 Taxa applicable to this review

Taxa with wild populations inside their natural range and a long-term presence (since 1500 AD) in Britain were considered for review. All other taxa deemed to be ineligible for assessment at a

regional level, e.g. non-natives, were placed in the category of **'Not Applicable (NA)'** and included recent colonists (or attempted colonists) responding to the changing conditions available in Britain as a result of human activity and/or climate change.

3.2.4 Knowledge about immigration and emigration effects for this group

There has been very limited research on this subject within the Scarabaeoidea, both taxonomically and geographically (North Temperate region). There are only a few published studies (e.g. Roslin, 2000; Webb *et al*., 2010).

4 GB Rarity Status categories and criteria

At the national level, countries are permitted under the IUCN guidelines to refine the definitions for the non-threatened categories and to define additional ones of their own. The Nationally Rare and Nationally Scarce categories are unique to Britain. Broadly speaking, the Nationally Rare category is equivalent to the Red Data Book categories used by Bratton (1991), namely: Endangered (RDB1), Vulnerable (RDB2), Rare (RDB3), Insufficiently Known (RDBK) and Extinct. These are not used in this review. The Nationally Scarce category is directly equivalent to the combined Nationally Notable A (Na) and Nationally Notable B (Nb) categories used in the assessment of various taxonomic groups (e.g. by Hyman (1992) in assessing the status of beetles) but never used in a published format to assess the Scarabaeoidea.

For the purposes of this review, the following definitions of Nationally Rare and Nationally Scarce have been applied:

Great Britain Rarity Status	
Nationally Rare	A native species recorded from between 1- 15 hectads of the Ordnance Survey national grid in Great Britain since 1990 and: • There is reasonable confidence that exhaustive recording would not find them in more than 15 hectads. • Where it is believed to occur as a breeding species within each of these hectads (i.e. discount those that are known to contain only casual immigrants). • This category includes species that are possibly extinct, such as those in the CR(PE) category, but not those where there is confidence that they are regionally extinct (RE).
Nationally Scarce	A native species recorded from between 16 - 100 hectads of the Ordnance Survey national grid in Great Britain since 1990. • There is reasonable confidence that exhaustive recording would not find them in more than 100 hectads. • Where it is believed to occur as a breeding species within each of these hectads (i.e. discount those that are known to contain only casual immigrants).

The choice of the date class as the start of the modern recording period for the Scarabaeoidea is discussed in Section 6.

This national set of definitions is referred to as the GB Rarity Status within this document. Importantly, Nationally Rare and Nationally Scarce are not categories of threat.

5 Methods and sources of information

5.1 Introduction

The most recent published list of scarce and threatened beetles (Hyman, 1992, 1994) was based on the Red Data Book criteria used in the British Insects Red Data Book (Shirt, 1987) with the addition of the category RDB-K (Insufficiently Known) after Wells *et al*. (1983). The original IUCN criteria for assigning threat status used in these publications gave the categories Endangered, Vulnerable and Rare, which were defined rather loosely and without quantitative thresholds. The application of these categories was largely subjective, and it was not easy to apply consistently within a taxonomic group or to make comparisons between groups of different organisms.

5.2 Data sources

This *Review's* authors assessed the status of all 101 British species of chafers, dung beetles, stag beetles and their allies using the information sources described in this section and the system described in Sections 3 and 6. During this process, the views of a number of other specialists (listed in Acknowledgements) were sought. The bulk of the data however come from the National Recording Scheme for Scarabaeoidea supplemented by information provided directly by a number of entomologists with experience in particular species and/or locations. It is important to acknowledge the considerable contribution made by all of these recorders.

The key source is the dataset collated by the Biological Records Centre (BRC), including the National Recording Scheme for the Scarabaeoidea. The BRC is supported by the Joint Nature Conservation Committee and the Centre for Ecology and Hydrology. The work of the BRC is a major component of the National Biodiversity Network Gateway (NBN). This dataset contained approximately 16,300 records. This data set was interrogated for mistakes, and potentially erroneous records were highlighted and followed up. Data were then requested through the beetles-britishisles yahoo group. This group, founded by Andrew Duff in 1999 has 371 members, many of whom are Coleopterists active in the field. Historical data were also sourced from a small number of Museum Collections and from literature searches. The resulting dataset used in this *Review* contains approximately 43,000 records.

For species attaining IUCN or GB Rarity Status, data were more intensely scrutinized and records considered unreliable were discounted. However, a small number of these records are mentioned in the *Species Accounts* and elsewhere in this *Review* where informative.

6 The assessments

6.1 The data table

The key outcome of this Review is the generation of a table which lists all of the taxa in the beetle families covered. The full table has been produced as a spreadsheet which accompanies this text. Appendix 1 provides an extract of the key data. The columns completed in the full accompanying Excel table are as follows:

Species name
GB IUCN status (2015)
Qualifying criteria
Rationale
Distribution Overview
GB Rarity status (2015)
Presence in:
- England
- Scotland
- Wales

Area of occupancy:
- Total number of hectads occupied for period up to and including 1989
- Total number of hectads occupied from period from 1990-2015
- Total number of dual hectads where species have been recorded from within the hectad in both date classes (see 5.2 below)
- Total number of hectads occupied during sixteen year period 1985-1999
- Total number of hectads occupied during sixteen year period 2000-2015
- Tetrads 1990-2015, for species that qualify as NR (i.e. 15 or less hectads from 1990-2015)
- No. of locations, for species that qualify as NR (i.e. 15 or less hectads from 1990-2015)

Amber List (a category for species that appear to be declining and that are nearly Near Threatened)
BRC concept code
NBN taxon number
Status in Shirt (1987)
Status in Hyman (1986)
Status in Hyman (1992)
Ecological account
Popular synonyms

6.2 Category columns introduced in this review

6.2.1 Distribution overview.

Unlike a number of the invertebrate groups that have been the subject of IUCN reviews to date (e.g. Carabidae, Chrysomelidae), the Scarabaeoidea have not been the subject of a National Atlas publication. Whilst the NBN Gateway provides a representation of the National distribution, these data occasionally contain errors because the data have not been and cannot practically be

verified by specialists. The authors therefore include descriptions of the Regional distribution of each species in the review.

6.2.2 Recent date range for hectad counts.

The issue of 'continuing decline' is fundamental to the IUCN categorisation process. Much of the decline in the size and or range of species in this group occurred historically (e.g. before 1950). The prescribed recording periods for hectad counts are ≤ 1989 and 1990-2015 (hereto referred to as the main recording period). It is the author's opinion that to demonstrate if a species is undergoing 'continuing decline' necessitates evidence of present or recent decline and to achieve this, a more recent recording period is required. The choice of the years 2000-2015, and an equivalent, earlier period preceding, of 1984-1999 provides a 32 year block of data which allows for the determination of recent trends. Reference to the main recording period provides vital information about the species' historical distribution and decline. The use of both recording periods in the analysis will ensure that 'false positives' of continuing decline in the earlier data period can be measured against the recent recording period and discarded if necessary.

Habitat decline values can be used as a proxy for population declines for species that are strongly associated with specific habitat types. However, it should be acknowledged that evidence of habitat fidelity in most Scarabaeoidea is generally anecdotal. Even where such fidelity exists quantitative data on habitat declines are rarely available and the reviewer needs to work with very imperfect data. The exception here is the Noble Chafer *Gnorimus nobilis,* for which habitat fidelity is at least partially understood (Bunney, 2012; Schenke, 2012; Whitehead, 2003) and for which habitat decline is a certain threat factor for around 90% of the regional population. Even in this case, full quantitative data for habitat decline are not yet available across its British range.

A requirement of this Review is to assess whether any reduction in the Area of Occupancy represents a real decline or an apparent decline caused by a lower level of search effort (leading to a lack of data) in the later time period. Search effort (and hence data availability) is likely to vary considerably between taxonomic groups and for different species within taxonomic groups. Use of Criterion B2b for any taxon therefore demands a clear assessment of the available data in order for us to be confident in the scale or rate of any decline. The IUCN Guidelines state that: “A continuing decline is a recent, current or projected future decline (which may be smooth, irregular or sporadic) which is liable to continue unless remedial measures are taken.

Fluctuations will not normally count as continuing declines, but an observed decline should not be considered as a fluctuation unless there is evidence for this.” It is clear then that a full review of the evidence is not essential but that it can be projected, much as the ‘population reduction’ criterion may rely on ‘observed, estimated, inferred, projected or reduction. The objective is to achieve consensus amongst the appropriate experts on the level of evidence available and to apply it pragmatically.

7 Downgraded and excluded species

7.1 Downgraded species

Down-grading of species should not be seen necessarily as evidence that species status has improved. In many cases species were categorised too highly in the early Reviews (Hyman,

1992, 1994) due to limitations in the available data and to the omission of criteria such as decline, when evaluating the status of a taxon. The intervening period has seen an increase of recorder effort, targeting species with Nationally Scarce or RDB status. In particular, these earlier Reviews acted as a focus, stimulating new recording effort, and the revised statuses provided by the present Review more accurately reflect the status of those species. The Reviews (Hyman, 1992, 1994) should in many ways be regarded as a first draft and an initial attempt at assessing status. Some species have increased their abundances and/or ranges in the intervening period, but the reasons for some or all of these increases remain unclear. Nevertheless, other species, based on available data, appear to be declining, and the lack of records following publication of the Reviews (Hyman, 1992, 1994) is therefore all the more significant. Table 5 provides a list of species downgraded and the justification for downgrading since the publication of Shirt (1987) and Hyman (1992, 1994).

Table 5. Species included in Hyman (1992) but downgraded in this review

Scientific name	Shirt (1987)	Hyman (1992)	This Review	Rationale for downgrading
Aphodius consputus		RDB3	NS	21 post-1990 hectads; 9 from 2000-2015. Likely under recorded due to its winter activity period. Increased sampling effort on the south downs and generally in suitable habitat across Berkshire, Surrey, Sussex and Kent may result in new records.
Aphodius zenkeri		Nb	-	62 post-1990 hectads; 41 from 2000-2015. There has been a 25-30% increase in records from both recording periods. This increase may be due to recorder effort and a better understanding of the sampling method, or a genuine increase of the species. A large number of recent records originate from the English Midlands and it is likely that this area may have been under represented when criteria were applied for status designations in Hyman (1992).
Gnorimus nobilis	RDB3	VU	NS	34 post-1990 hectads; 33 from 2000-2015. This species is unusual in that it is only Nationally Scarce, yet it satisfies the criteria for IUCN category Vulnerable due to the significant recent loss and deterioration of its orchard habitat in our region.

7.2 Excluded species

The status of some species newly recorded in Britain or recorded after a protracted absence can be very difficult to ascertain. Most problematic are those species that could conceivably be on the edge of their natural range in Britain and only occur in a limited number of locations to which they may equally have been introduced. The geographical position of Britain makes it inevitable that our fauna includes Western European, Northern European and even Central European species some of which are considered native, but others which are demonstrably present through introduction. It is important to recognise that lack of clear evidence of native status is not automatically taken to mean that a species has been introduced.

Where the presence of a species results from natural colonisation from the continent, they may be expected to continue to expand their distribution and records may occur from more than 50 hectads over the next few decades. Their natural range, or 'Extent of Occurrence' under the IUCN

Guidelines expands with them, but they are not considered long-term residents in Britain and are therefore excluded from the IUCN categorisation. The precautionary principle suggests that they should not be afforded a regional conservation status unless the source population itself is threatened, which would seem unlikely in most cases, although climate change may impose such a threat.

Species excluded from assessment on the basis they are introduced non-natives, whether this is the result of accidental or deliberate importation, have been assigned to the category 'Not Applicable (NA)' as required under the IUCN Guidelines. Even where these species occur in 50 hectads or less, they have not been assessed for scarcity or rarity as they are not considered to be native to Britain. A list of the excluded species and the rationale for their exclusion is provided in Table 6.

Table 6. Species categorised as 'Not Applicable (NA)'

Scientific name	Post-1990 hectads	Rationale for exclusion
Oxythyrea funesta	6	Although the authors cannot validate all recent records, most can be assigned as 'adventives'. The recently established population in a post-industrial area of Portsmouth (Harrison, 2016), adjacent to the docks, provides strong evidence that this was a case of assisted importation. There is strong evidence that the species has been imported in the past (e.g. Allen, 1967). Barclay & Notton (2015) discuss the importation of plant and root-balls as a mechanism by which the regional population could be reinforced from the Continent. Consequently, the evidence is strongly supportive of assisted importation. Even if this species had not arrived through assisted importation, the recently proven establishment is too recent for its status to be evaluated.
Rhyssemus germanus	4	It is difficult to evaluate the true status of this species based on available data. For it to be an indigenous species that has remained undetected in our region between 'pre-1850' and 2011, a period of over 160 years and then to have been coincidentally found at four sites in the last five years seems incredible. The current populations could be the result of introductions and the historical populations either introduced themselves, or indigenous and historically wiped-out. The authors strongly believe this species to have been introduced, though the mechanism of such introduction is currently unknown.
Saprosites mendax	1	An Australian native accidentally introduced into England in the 1920s and restricted to one area of Sussex (Tottenham, 1930; Jones, 1999).
Saprosites natalensis	5	A South African species introduced into the London area in the l980's (Angus *et. al*., 2003).
Tesarius caelatus	3	A North American species, long-established in the west-coast dune systems in Lancashire (Johnson, 1976).
Tesarius mcclayi	2	A North American species first discovered at Crymlyn Burrows SSSI (Glamorgan) dune system in 1995 (Mann, 1998) and Merthy Mawr Warren SSSI (Glamorgan) in 2015 (Harrison, 2015).
Trichius gallicus	8	This species has been recorded in Britain on several occasions over the past 200 years, but with more records in the last few decades than historically. Some of the recent sites are some distance from likely sources of importation (e.g. ports, garden centres) and it is possible that recent importations (assisted or natural) have established small breeding populations. Regardless of the mechanism by which it is establishing in the region, even if it is in the early stages of unassisted colonisation, its appearance in England is too recent for an evaluation of status to be made.

8 Format of the species accounts

8.1 Information on the species accounts

Species accounts have been prepared for each of the Regionally Extinct, Critically Endangered (Possibly Extinct), Critically Endangered, Endangered, Vulnerable and Near Threatened species. These account for 32 of the 101 species on the British checklist; approximately 30% of our Scarabaeoidea fauna. Previous reviews have included species accounts for all Nationally Rare and Nationally Scarce taxa. It is beyond the scope of the current Review to include these for the Scarabaeoidea.

Information on each species is given in a standard format. The species accounts are in the form of data sheets designed to be largely self-contained in order to enable site managers to compile species-related information for site files; this accounts for some repetition between the species accounts. This section provides context for eight information sections provided for each species data sheet.

8.2 The species name

The nomenclature used in this *Review* follows the most recent checklist for the British fauna (Mann, 2012), unless otherwise stated. Under the *Species Accounts* where the name differs from that used by Shirt (1987) or Hyman (1992, 1994) the previous name is indicated.

8.3 Identification

The emphasis in the accounts, where possible, is on readily available English language publications covering the British Isles; work in other languages or from other/wider geographical areas is only referred to where no other options are available or where the non-English/wider work is more detailed or up-to-date. With experience, identification for most British species can be achieved in the field with a good hand lens. A microscope is required to identify and/or confirm the identitification for some species, particularly the aphodiines and psammodiines. On rare occasions dissection of the male aedeagus will be required as a confirmatory character.

Jessop (1986) is the standard work on the British fauna and although it contains some errors and imprecise identification features it does allow for the accurate identification of the majority of British species. Although Jessop (1986) is out of print, it can be downloaded for free from the Royal Entomological Society website at http://www.royensoc.co.uk/content/out-print-handbooks. This website also has the first edition this Handbook by Britton (1956). In addition, useful references and images are available from http://markgtelfer.co.uk/beetles/scarabaeoidea/.

The third in the series of '*Beetles of Britain and Ireland'* (Duff, A.G., in prep.) will include all of the species in our region (Duff, A.G. pers. comm.). Whilst not an identification key, Brock (2014), provides an excellent beginners guide to insects and around 50% of the British Scarabaeoidea fauna is covered with photographs and accompanying text. A limited number of larvae are keyed to species in Emden (1941) and Jessop (1986) provides a key to most genera. Larval identification is aided by reference to Klausnitzer & Krell (1996) and Krell (1997), but in many instances this will only facilitate identification to generic level. For some species, the larva is as yet undescribed.

A number of species have been added to the British list since the publication of Jessop (1986) and the identification resources required for these species are listed in Table 7. Wilson (2001) separated *Aphodius fimetarius* to two species *A. fimetarius* (Linnaeus) and *A. pedellus* (De Geer). Angus *et al*. (2003) noted that *Saprosites mendax* (Blackburn) from the London area were a second introduced species *Saprosites natalensis* (Peringuy). *Tesarius mcclayi,* introduced from California has established at two sites in Glamorgan. *Aphodius punctatosulcatus* and *A. varians* discovered in old collections in museums are now considered extinct in Britain.

Table 7. Species not covered in Jessop (1986)

Species	**Identification reference(s)**
Aphodius fimetarius	Miraldo *et al.*, 2014; Fery & Rössner, 2015
Aphodius pedellus	Miraldo *et al.*, 2014; Fery & Rössner, 2015
Aphodius punctatosulcatus	Baraud, 1992
Aphodius varians	Baraud, 1992
Saprosites natalensis	Angus *et al.*, 2003
Tesarius mcclayi	Cartwright, 1955

8.4 Distribution

Records held in the database of the national species recording schemes form the basis for determining the distribution of each species. In most cases these data can be accessed through the NBN Gateway (https://data.nbn.org.uk/) and therefore individual records have generally not been listed. The exceptions are those species known from only a relatively small number of sites and where site information is considered essential to understanding habitat, ecology, status, threats and conservation. The Watsonian vice-counties (Dandy, 1969) are included in the NBN database for many records and are referred to in this review. International distribution is referred to within the species accounts where a comment on biogeography is considered relevant and where the information is readily accessible but it has not influenced the assessment of status. For the Scarabaeoidea, the distribution section of the *Species Account* tends to focus on the currently known distribution with details of former distribution patterns discussed under the Status section (see 8.6 below). However, where a species is Regionally Extinct its known distribution history may be presented in the *Distribution* section of the account.

8.5 Habitat and ecology

This section aims to provide an overview of both the known habitat requirements for each species and the wider landscape context. However, for many species this information is inadequate or incomplete. Information on the life cycle and seasonal activity for Britain is included where known, or taken from the wider European literature. The understanding of species-level habitat preferences, even when there are well-known localities, can be difficult to ascertain. Several species are able to disperse over long distance and therefore the recorded capture site may not be the breeding site. For example, in instances where species are attracted to light traps (e.g. *Odonteus armiger, Amphimallon solstitialis, Aphodius rufus, Aphodius rufipes* and *Trox scaber*) and for those which may forage some distance from their breeding site (e.g. *Gnorimus nobilis*).

Habitat data, such as vegetation structure and substrate type, are well known to be of major importance to invertebrates. However, most published records, label data associated with

specimens in collections and data submitted to the various recording schemes and records centres lack this level of detail. Comments provided in the *Species Accounts* are based on a relatively few, and often *ad hoc* personal experiences or gathered from the wider scientific literature (e.g. from continental Europe based research).

Flight and dispersive ability are vital to understanding how beetles utilise habitat mosaics, how they move within the wider landscape and how habitat fragmentation will affect populations. However, there has been limited research (e.g. Roslin, 2000) and our understanding of this complex topic is incomplete. Local climatic factors are an important influence and will vary across the country. In many beetle species flight activity is directly correlated with conditions of relatively high temperatures, high relative humidity, and little or no air movement. Mobility will naturally be higher under the more continental climatic conditions of southern and eastern Britain than in the cooler north and west. Species on the edge of their European range in Britain may be less mobile than their continental equivalents.

Emphasis is placed in this *Review* on the importance of relict sites for supporting rare species. In such instances, this normally indicates that a species has limited dispersal ability or that they require a specific suite of environmental conditions only provided by such sites or in some cases a combination of both factors.

8.6 Status

Reference to former distribution by Vice-County has been a particularly useful tool for demonstrating decline from large regions of Britain. 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 1990 were used to establish whether or not a species might be considered scarce. The IUCN guidelines (see Section 3) were then used to decide whether such species might also be considered under threat, and to assign a category. Detailed survey data is rare but has has been used where available, to inform the designation process.

Only species which have been assessed as Regionally Extinct, Critically Endangered, Endangered, Vulnerable or Near Threatened are provided with species accounts. The status of these and all other species in this review is summarised in Appendix 1.

The IUCN criteria allow data of different quality to be used in the assessments as explained for 'estimated, inferred, projected or suspected' data. In addition, there is the problem of under-recording and one or two species currently known from fewer than fifteen hectads from 1990 onwards have been excluded from both Near Threatened categorisation and IUCN criteria because the authors have good reason to believe they are under recorded. An example is *Aphodius fasciatus* which is an under recorded northern species in our region. Assessments of status can only be based on current knowledge, which is very unlikely to be comprehensive in the majority of cases, being based on the experience of a limited number of active recorders in each generation. The likely national distribution of each species and trends in population size must, therefore, be extrapolated from the available information so as to arrive at the best estimate of the likely national status of each species.

Beetles lend themselves to preservation as sub-fossils by virtue of their hard body parts. Many studies of organic deposits that can be reliably dated to post-glacial times generate valuable information on the history of a particular species in what is now referred to as Britain. Those studies provide irrefutable evidence for long-term presence. The data have been collated and made available by Buckland & Buckland (2006).

8.7 Threats

It is those human activities that result in the loss of sites or degrade habitat quality that pose the greatest threat to invertebrate populations. Where specific threats are recognised they are included in the species accounts, otherwise the statements attempt to summarise in general terms those activities that are considered most likely to place populations at risk.

The reduction or cessation of more traditional land management has subsequently led to habitat loss and degradation through vegetational succession. For example, with calcareous grassland areas becoming scrubbed over and open areas within woodland reverting to a closed canopy. This neglect of habitat management can even be observed at sites with some conservation protection or designation where the required level of rotational disturbance (e.g. felling, coppicing, mowing, grazing) has not been implemented or maintained.

Coastal habitats are prime areas for development, such as holiday villages and homes, port facilities, marinas and golf courses.

In addition to the resulting habitat loss, further degradation can occur through factors such as pollutants from road run-off or oil spills, application of herbicides and pesticides to horticultural borders and lawns. Increased footfall and vehicle access may also be detrimental to the conservation value of coastal sites.

Not all threats to invertebrate populations are anthropogenic and coastal populations are especially vulnerable to episodes of extreme weather. Coastal erosion is often essential for maintaining the habitat of species associated with soft cliffs or mobile dunes, but could for example in extreme cases cause the local extinction of a species with a very restricted distribution if it destroys the site or the species population beyond recovery. The recent tidal surge in December 2013 that affected much of the eastern coastline of England causing significant loss of sand-hills and eroding dune systems is a phenomenon that may be seen more frequently as a consequence of future climate change. Species restricted to or predominantly occurring on shingle formations may be similarly vulnerable. Species inland can be threatened by severe flooding, such as was seen in western England in early 2014, especially if the species only occur at a very small number of sites.

The major threats for the coprophilous Scarabaeoidea are loss of permanent pasture, through conversion to other uses; degradation through pasture improvement; cessation of grazing and therefore dung supply; changes in grazing regimes and therefore dung continuity; use of endectocides as a prophylactic treatment for livestock.

The loss of permanent pasture has been linked to the decline of a number of dung beetles (e.g. *Copris lunaris*, *Geotrupes mutator*) which are sensitive to disturbance (i.e. ploughing, soil

aeration). Pasture improvement, such as re-seeding, soil aeration, conversion to grass mono-cultures and the application of fertilisers, will also negatively affect species (e.g. Hutton & Giller, 2003) Improved pasture and the resulting enrichment of grass will also lead to reduced dung quality through higher water content making it less suitable for most dung beetles.

The complete cessation of grazing will have significant negative impact, often with immediate effect since without a food supply adult beetles are unable to feed or provide food for their larvae. It is only when other source populations exist on sites within flight capacity that re-colonisation of sites becomes possible, and then only when livestock are reintroduced during the beetles activity period. If there are no local source populations, or grazing ceases simultaneously at a wider landscape level, this is likely to have extinction level impacts. In some cases, species with a very limited range (e.g. *Onthophagus fracticornis* in the Mendips) could feasibly be locally extirpated within a few years. Continuity of dung supply can be adversely affected by changes in grazing regimes, or in the use of intermittent grazing for conservation management of grasslands. The recent changes in livestock husbandry practices such as winter shedding of livestock, reduces or terminates the supply of dung for species active during this period (e.g. *Aphodius paykulli* and *A. consputus*) with a resulting negative impact on populations.

Endectocides are used in the treatment and control of internal and external parasites of livestock. There is now an incontrovertible body of evidence on the negative impact that endectocides have on the dung fauna (e.g. Beynon *et al*., 2012a; Beynon *et al*., 2012b; Liebig *et al*., 2010; Lumaret *et al*., 2012; O'Hea *et al*., 2010). Endectocides are usually macrocyclic lactones which are broad-spectrum parasiticides, which comprise three classes of chemicals, Avermectins (i.e. ivermectin, doramectin, abamectin), Milbemycins (i.e. moxidectin), and Spinosyns (i.e. spinosad) (Lumaret *et al*., 2012). Although there is some evidence that sensitivities to these chemicals may be species-specific, initial research suggests that the more sensitive species are also those currently undergoing decline (e.g. Beynon *et al*., 2012a). The link between high sensitivity and decline of species requires further research. Liebig *et al*. (2010) critically reviewed the existing *Risk Mitigation Measures* for veterinary medical products (including endectocides) and concluded that measures proposed thus far are not sufficiently helpful to protect the biodiversity and function of dung and soil organism communities (see also Adler *et al*., 2015 and references therein).

The non-dung feeding species (including *Trox*, the chafers and stag beetles and allies) are dependent on a variety of adult and larval food sources which include dead heartwood of standing trees, dry organic matter (carcases, skins, bones) in non-synanthropic settings such as birds' nests in trees, pollen/nectar rich flowering plants and detritus in hollows and at plant root level in sand dunes or on sandy soil. For these species the following threats are apparent:

- loss of habitat and degeneration of habitat (e.g. deterioration of orchards affecting *Gnorimus nobilis*)
- lack of regeneration of suitable habitat in mature woodland and parkland
- scrub encroachment on open areas through lack of grazing or decrease in rabbit populations
- increased countryside hygiene and 'tidying up' which results in the removal of animal carcases, dead wood and bird's nests etc.

- erosion of coastal dune systems

8.8 Management and conservation

Some of the oldest Nature Reserves in Britain were created to protect their invertebrate fauna (e.g. Wicken Fen), however beetles are rarely amongst the primary reasons for site designation and protection. Nevertheless, the value of beetles as indicators of habitat quality has been recognised when many SSSI's have been re-evaluated. Beetles also feature in designations for some Special Areas of Conservation (SAC).

Where known sites have the benefit of statutory protection as, for example, in the case of National Nature Reserves (NNRs) or Sites of Special Scientific Interest (SSSI), this is noted. Sites designated as SAC under the European Habitats Directive and SSSI have the potential to provide protection for beetles as long as the conservation interest associated with them is acknowledged, and as long as that interest is effectively translated into site conservation objectives.

Loss and degradation of suitable habitat continues in undesignated sites. The populations of many beetle species with fragmented distributions are relicts of previously widespread populations, surviving in small patches of relatively undisturbed habitats after loss of the interconnecting habitats. For these species it is critical to maintain connectivity 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.

It is very unusual for threatened scarabaeoids to have been the subject of detailed ecological research or even standardised monitoring, but these are referred to where such are known. More often the implementation of further survey, or monitoring or a specific line of research is recommended.

Preventative measures and positive action designed to maintain populations are suggested where these are understood 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. However, this general advice is retained in order to ensure that the species data sheets can be read as stand-alone documents. Fry & Lonsdale (1991) and Kirby (2001) both give excellent general accounts of the relevant conservation issues and habitat management measures which may be undertaken.

8.9 Published sources

Literature references specific to the taxon that have contributed information to the data sheet are cited here.

9 Acknowledgements

Jon Webb (Natural England) commissioned the current review and the report was quality assured by the Joint Nature Conservation Committee. The format and content is based closely on the recent water beetle review (Foster, 2010) and subsequent publications in this review series (Alexander, 2014; Alexander, Dodd & Denton, 2014; Hubble, 2014; Lee, 2015; Macadam, 2015); key sections of text have been adopted and adapted for the current review in order to maintain a consistent approach.

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10 Species listed by IUCN status category

In this list the species are given in taxonomic order within status categories (nomenclature follows Mann, 2012).

Regionally Extinct
Trox perlatus (Goeze, 1777)
Platycerus caraboides (Linnaeus, 1758)
Aphodius punctatosulcatus Sturm, 1805
Aphodius varians Duftschmidt, 1805
Aphodius scrofa (Fabricius, 1787)
Pleurophorus caesus (Creutzer in Panzer, 1796)
Onthophagus taurus (Schreber, 1759)
Onthophagus verticicornis (Laicharting, 1781)
Polyphylla fullo (Linnaeus, 1758)

Critically Endangered (Possibly Extinct)
Aphodius brevis Erichson, 1848
Aphodius subterraneus (Linnaeus, 1758)
Heptaulacus testudinarius (Fabricius, 1775)
Copris lunaris (Linnaeus, 1758)

Critically Endangered
Aphodius quadrimaculatus (Linnaeus, 1761)
Brindalus porcicollis (Illiger, 1803)

Endangered
Aegialia rufa (Fabricius, 1792)
Gnorimus variabilis (Linnaeus, 1758)

Vulnerable
Aphodius sordidus (Fabricius, 1775)
Aphodius lividus (Olivier, 1789)
Euheptaulacus sus (Herbst, 1783)
Diastictus vulneratus (Sturm, 1805)
Onthophagus fracticornis (Preyssler, 1790)
Onthophagus nuchicornis (Linnaeus, 1758)
Gnorimus nobilis (Linnaeus, 1758)

Near Threatened
Geotrupes mutator (Marsham, 1802)
Trox sabulosus (Linnaeus, 1758)
Aphodius paykulli Bedel, 1908
Aphodius arenarius (Olivier, 1789)
Aphodius porcus (Fabricius, 1792)

Psammodius asper (Fabricius, 1775)
Amphimallon fallenii (Gyllenhal, 1817)

Data Deficient
Aphodius nemoralis Erichson, 1848

11 Species listed by GB Rarity Status category

In this list the species are given in taxonomic order within status categories (nomenclature follows Mann, 2012).

Nationally Rare
Geotrupes mutator (Marsham, 1802)
Trox sabulosus (Linnaeus, 1758)
Aegialia rufa (Fabricius, 1792)
Aphodius sordidus (Fabricius, 1775)
Aphodius brevis Erichson, 1848
Aphodius paykulli Bedel, 1908
Aphodius subterraneus (Linnaeus, 1758)
Aphodius lividus (Olivier, 1789)
Aphodius niger (Illiger, 1798)
Aphodius quadrimaculatus (Linnaeus, 1761)
Aphodius arenarius (Olivier, 1789)
Aphodius porcus (Fabricius, 1792)
Euheptaulacus sus (Herbst, 1783)
Heptaulacus testudinarius (Fabricius, 1775)
Brindalus porcicollis (Illiger, 1803)
Diastictus vulneratus (Sturm, 1805)
Psammodius asper (Fabricius, 1775)
Copris lunaris (Linnaeus, 1758)
Onthophagus fracticornis (Preyssler, 1790)
Onthophagus nuchicornis (Linnaeus, 1758)
Melolontha hippocastani Fabricius, 1801
Amphimallon fallenii (Gyllenhal, 1817)
Gnorimus variabilis (Linnaeus, 1758)

Nationally Scarce
Odonteus armiger (Scopoli, 1772)
Trypocopris pyrenaeus (Charpentier, 1825)
Trypocopris vernalis (Linnaeus, 1758)
Lucanus cervus (Linnaeus, 1758)
Aegialia insularis Pittino, 2006
Aphodius nemoralis Erichson, 1848
Aphodius constans Duftschmid, 1805
Aphodius ictericus (Laicharting, 1781)

Aphodius conspurcatus (Linnaeus, 1758)
Aphodius distinctus (Müller, 1776)
Aphodius merdarius (Fabricius, 1775)
Aphodius coenosus (Panzer, 1798)
Aphodius plagiatus (Linnaeus, 1767)
Aphodius consputus Creutzer, 1799
Aphodius fasciatus (Olivier, 1789)
Euheptaulacus villosus (Gyllenhal in Schönherr, 1806)
Onthophagus medius (Kugelann, 1792)
Omaloplia ruricola (Fabricius, 1775)
Protaetia metallica (Herbst, 1782)
Gnorimus nobilis (Linnaeus, 1758)

12 Criteria used for assigning species to IUCN threat categories

Table 8. Criteria used to assign extant species to GB IUCN categories with a level of threat VU or greater, not including Regionally Extinct (RE) or Data Deficient (DD) species. (See Appendix 2 for summary of criteria and categories)

Scientific name	**Status**	**Criteria used**
Aegialia rufa	EN	B2a, bii, biv
Aphodius brevis	CR (PE)	B2a, bii, biv
Aphodius lividus	VU	B2a, bii, biv
Aphodius quadrimaculatus	CR	B2a, bii, biv
Aphodius sordidus	VU	B2a, bii, biv
Aphodius subterraneus	CR(PE)	B2a, bii, biv
Euheptaulacus sus	VU	D2
Heptaulacus testudinarius	CR(PE)	B2a, bii, biv
Brindalus porcicollis	CR	B2a, bii, biv, C2aii
Diastictus vulneratus	VU	D2
Copris lunaris	CR(PE)	B2a, bii, biv
Onthophagus fracticornis	VU	D2
Onthophagus nuchicornis	VU	B2a, bii, biv
Gnorimus nobilis	VU	A3, A1c
Gnorimus variabilis	EN	B2a, biii

13 List of Threatened, Nationally Rare and Nationally Scarce species

Table 9. List of Threatened, Nationally Rare and Nationally Scarce species

Species name	**Shirt (1987)**	**Hyman (1992)**	**This review (IUCN Status)**	**This review (GB Rarity)**
Odonteus armiger	RDB3	Na	LC	NS
Geotrupes mutator		Nb	NT	NR
Trypocopris pyrenaeus		Na	LC	NS
Trypocopris vernalis		Nb	LC	NS
Trox perlatus	RDB1	RDB1	RE	-
Trox sabulosus		Na	NT	NR
Lucanus cervus		Nb	LC	NS
Platycerus caraboides	Extinct	Extinct	RE	-
Aegialia insularis		Nb	LC	NS (Endemic)
Aegialia rufa	RDB1	RDB1	EN	NR
Aphodius arenarius		Nb	NT	NR
Aphodius brevis	RDB1	RDB1	CR (PE)	NR
Aphodius coenosus		Nb	LC	NS
Aphodius conspurcatus		Nb	LC	NS
Aphodius consputus		RDB3	LC	NS
Aphodius constans			LC	NS
Aphodius distinctus		Nb	LC	NS
Aphodius fasciatus		Nb	LC	NS
Aphodius ictericus			LC	NS
Aphodius lividus	RDB3	RDB1	VU	NR
Aphodius merdarius			LC	NS
Aphodius nemoralis		Na	DD	NS
Aphodius niger	RDB1	RDB1	LC	NR
Aphodius paykulli		Nb	NT	NR
Aphodius plagiatus		Nb	LC	NS
Aphodius porcus		Nb	NT	NR
Aphodius punctatosulcatus			RE	-
Aphodius quadrimaculatus	RDB3	RDB1	CR	NR
Aphodius scrofa	Extinct	Extinct	RE	-
Aphodius sordidus		Na	VU	NR
Aphodius subterraneus	RDB3	RDB1	CR(PE)	NR
Aphodius varians			RE	-
Aphodius zenkeri		Nb	LC	
Euheptaulacus sus	RDB3	RDB1	VU	NR
Euheptaulacus villosus		Na	LC	NS
Heptaulacus testudinarius	RDB3	RDB1	CR(PE)	NR
Brindalus porcicollis	RDB1+	Extinct	CR	NR
Diastictus vulneratus	RDB2	RDB2	VU	NR
Psammodius asper		Na	NT	NR
Pleurophorus caesus			RE	-
Copris lunaris	RDB1	RDB1	CR(PE)	NR
Onthophagus fracticornis		RDBK	VU	NR
Onthophagus medius		Nb	LC	NS

Onthophagus nuchicornis		Na	VU	NR
Onthophagus taurus	Extinct	Extinct	RE	-
Onthophagus verticicornis	Extinct	RDB1	RE	-
Melolontha hippocastani		RDBK	LC	NR
Polyphylla fullo	Extinct	Extinct	RE	-
Amphimallon fallenii		Na	NT	NR
Omaloplia ruricola		Nb	LC	NS
Protaetia metallica		Nb	LC	NS
Gnorimus nobilis	RDB3	RDB2	VU	NS
Gnorimus variabilis	RDB1	RDB1	EN	NR

14 The data sheets

Data sheets for the species assessed as Regionally Extinct, Critically Endangered (Possibly Extinct), Critically Endangered, Endangered, Vulnerable and Near Threatened are given in this section. The data sheets are arranged, within each Family of the Scarabaeoidea, in alphabetical order by scientific name. Individual species accounts can be located by looking up the generic or specific names, including synonyms used in Hyman (1992, 1994) and Jessop (1986) in the index.

GEOTRUPES MUTATOR
NEAR THREATENED
Order COLEOPTERA
Family GEOTRUPIDAE

Geotrupes mutator (Marsham, 1802)

Identification A dor beetle, characterised by its convex shining metallic blue-green dorsal and ventral surfaces, and the presence of nine well-marked striae between the elytral suture and humeral callus. Species of superficial similar appearance have only seven striae. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus by Emden (1941) and Jessop (1986) and to species level by Emden (1941) and Klausnitzer & Krell (1996).

Distribution A distinctly local distribution in southern counties of England, with one outlying population in north-east England. The species may still persist in Cornwall where it was last recorded in 1989 (Castle Point, St Gennys), but otherwise it appears to be very restricted in distribution with only thirteen locations since 1990 as follows, with hectad and most recent year recorded in parentheses: Druridge Bay, Northumberland (NZ29, 1996); Shapwick Heath, Somerset (ST44, 2012); Cholderton Estate, North Hampshire (SU24, 1998); Stagbury Hill, South Wiltshire (SU21, 2003); Hartland Moor (SY98), Black Down (SZ08) and Kingswood Farm, Dorset (SZ08), (2003, 2007, 2015 respectively); Chagford (SX78), Chudleigh Knighton Heath (SX87), Buck Tor (SX46), Whiddon Deer Park (SX78), and Deerpark Farm Trusham (SX88) all on Dartmoor, South Devon (1997, 2005, 2010, 2013 and 2015 respectively) and Farthing Downs, Surrey (TQ25) (2012). Previously considered widespread in England.

Widespread in the Palaearctic Region, recorded from: Azerbaijan, Albania, Armenia, Austria, Belgium, Bosnia Herzegovina, Belarus, Croatia, Czech Republic, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Moldavia, Netherlands, Poland, Portugal, Romania, Russia (Central European Territory, South European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. Asia: Iran, Kazakhstan and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology In Britain, this species inhabits unimproved pasture and moor, coastal grassland and coastal heathland. It is associated with cattle, horse and sheep dung. The beetle excavates a burrow beneath dung, which it stocks with dung for larval development. Adults are active mainly from April to October. Anecdotal evidence (Walters, J. pers. comm.) from observations of the populations in the Teign Valley area of east Dartmoor suggests this species may prefer drier soils than others of the genus.

Status Formerly widespread but highly localised, primarily in coastal counties in Wales and from the

Midlands southwards in England, with one outlying northerly population at Flamborough Head in south-east Yorkshire. Severe decline indicated historically in the late 1800s/early 1900s continuing into the middle of the 20th Century. Regional extinctions occurred in Wales by 1922, Worcestershire, Staffordshire, Leicestershire, East Sussex, the Scilly Isles and the Yorkshire colony by the early 1900s and latterly in Kent in 1962.

This species qualifies as NT as it is only known from 13 locations and historical decline is evident from the 62% reduction in hectads (AoO) between the two main date periods. It would qualify as VUB2ab if it were found at fewer locations.

Threats Grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will contribute to the decline of this species. The treatment of livestock with endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae.

Management and Conservation Some of the current sites are protected. Continuity of good quality dung is an important factor in the survival of this species within its current range. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung. Conversion of unimproved pasture to other land-use should be deterred.

Published sources Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Löbl & Smetana (2006).

TROX PERLATUS
REGIONALLY EXTINCT
Order COLEOPTERA
Family TROGIDAE

Trox perlatus (Goeze, 1777)

Identification *Trox perlatus* is a dull black beetle, differing from the other British *Trox* by the obvious tuberculate elytral intervals and black, rather than pale dorsal setae. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus by Emden (1941) and Jessop (1986), and to species in Klausnitzer & Krell (1996) and Scholtz (1991).

Distribution Previously known from Tyneham and the adjacent Worbarrow Bay in Purbeck, Dorset (SY87/88). There is an additional unsubstantiated record from Devon.

Widespread across Europe, recorded from: Austria, Belgium, Czech Republic, France, Great Britain, Germany, Italy, Netherlands, Poland, Slovakia, Spain and Switzerland (Löbl & Smetana, 2006).

Habitat and Ecology Like the other species of the genus, this beetle feeds on dry animal material. Paulian & Baraud (1982) state that it occurs on mainland Europe in 'detritus of animal origin, sometimes in carcasses, in debris beneath nests of diurnal raptors, in owl pellets and in carnivore faeces'. British specimens have been found in lamb skins and carrion on chalk cliff grasslands. Adults have been recorded in March, April, June, August and October.

Status Known from Worbarrow Bay and Tyneham, Dorset where it was initially discovered in August 1922 (Allen, 1967) and where specimens (now present in several Museum collections) were taken by P. Harwood in 1929 and again in the following year, from young lamb skins on the top of the cliffs (Harwood, 1929). It has not been seen since 1930 in Britain. The circumstances of its occurrence in the region, that of a small and localised population which persisted for several years and then died out, suggest that it may have been an introduction that failed to establish. Both Joy (1932) and Hyman (1992) also cite 'Devon' in reference to the species' distribution, but further details of this capture are unknown. It is possible that the Devon record relates to the date of '1860' that Hyman (1992) cites for the original discovery of *T. perlatus* in the region.

Threats The cause of regional extinction is unknown.
Management and Conservation None.

Published sources Allen (1967); Britton (1956); Emden (1941); Jessop (1986); Harwood (1929); Hyman (1992); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Paulian & Baraud (1982); Scholtz (1991).

TROX SABULOSUS
NEAR THREATENED
Order COLEOPTERA
Family TROGIDAE

Trox sabulosus (Linnaeus, 1758)

Identification *Trox sabulosus* is a dark, dull beetle distinguished from the other British *Trox* by a lack of large elytral tubercles, pale dorsal setae and having the sutural striae as broad as elytral intervals 1 and 2. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus by Emden (1941) and Jessop (1986) and to species in Klausnitzer & Krell (1996) and Scholtz (1991).

Distribution Since 1990 only known from six sites: Worcestershire (SO86) in 2002; Witley Common, Surrey (SU94) in 2011; Ambersham Common, West Sussex (SU91), 1997; three sites in the West Norfolk Brecks: Hockwold-cum-Wilton (TL78) in 1996, Cranwich Heath (TL79) in 2009 and most recently Weeting Heath (TL78) in 2010. Formerly widely distributed, but highly localised and scarce throughout the region.

Widespread in the Palaearctic Region, recorded from: Austria, Belgium, Bosnia Herzegovina, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Hungary, Great Britain, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Russia (Central European Territory, North European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine and Yugoslavia. Asia: Kazakhstan, Mongolia, North Korea, South Korea, Syria, Russia (East Siberia, West Siberia) and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology Stenotopic, restricted to exposed sites with sandy soils. Found in or about dry carrion on sandy soils on open heathland and commons. It feeds and breeds on dry material of animal origin. Observations cite specimens in and under dead rabbits and 'a small desiccated lamb' and more recently from ‘road-kill’ animals. Clark (undated specimens, probably 1930's) took 18 specimens from 'vegetable mould under a rabbit skin' at Bradgate Park, Leicestershire. Adults have been recorded in April, May, June and August.

Status Formerly, widely distributed if highly localised and scarce, with records from Fife, Cumbria, Staffordshire, Leicestershire, Warwickshire, Glamorgan, Devon, Berkshire, North and South Hampshire, Dorset, Kent, Suffolk, Hertfordshire and Cambridgeshire. Hyman (1992) also cites Oxfordshire. It disappeared from the majority of these counties by the turn of the 20th century or by the 1930s at the latest. The exceptions are South Hampshire where it was last recorded in 1967 and East Suffolk where it was last recorded in 1977 (Hallesley, TM34). Hyman (1992) cites South Essex, Glamorgan, Lanarkshire and East Inverness & Nairn with post-1970 records, however these data were unable to be traced and as such require confirmation.

This historical decline is represented by an 80% decrease in occupied hectads between the two main recording periods. However, between the two modern 16-year periods, there is an increase of 100% (from 2 hectads to 4 hectads), so continuing decline cannot be inferred from the data. The reasons for historical decline are not clear, but there have been similar apparent declines in other species which feed on dry carrion, such as *Nitidula* species (Lane, unpublished observations). The legal requirements imposed on landowners for the removal of dead livestock will have contributed to the reduction of suitable breeding sites for this species.

Trox sabulosus now appears to be restricted to three or four small locations in the region where it is

considered difficult to find (e.g. Norfolk, Collier, J. pers. comm.). It is likely to be under recorded throughout the region and it has not been the subject of targeted surveys. For these reasons, a cautious designation of Near Threatened is given, based on the low AoO, which is low enough to qualify for EN if continuing decline could be proven.

Threats This species requires continuity of dry carrion, therefore the removal of dead animals from grazed commons and heaths will negatively impact this species. Deterioration of heathland and common habitat by fragmentation, changes in land use, development, afforestation and scrub encroachment. The open heathland character of Midlands sites that were frequented by *Trox sabulosus*, such as Cannock Chase (Staffordshire), Sutton Park (Warwickshire) and Bradgate Park (Leicestershire), has changed considerably over the last 100 years, with woodland and scrub replacing open heath (unpublished observations).

Management and Conservation Tree thinning and scrub clearance to create a more open mosaic of suitable habitat is to be encouraged. Grazing and heathland restoration will also improve available habitat for this species. Roadkill and wild animal carcasses should be left *in situ*.

Published sources Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Hyman (1992); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Scholtz (1991).

PLATYCERUS CARARABOIDES
REGIONALLY EXTINCT
Order COLEOPTERA
Family LUCANIDAE

Platycerus caraboides (Linnaeus, 1758)

Identification The adult is described in Fowler (1890) and keyed in Baraud (1992). *Platycerus caraboides* differs from *Lucanus* and *Dorcus* in having the eyes entire and the antennal segments of different structure. It is more dorso-ventrally flattened than *Sinodendron*. The adult is blue-black or greenish-black and rather shining. The pronotum has strongly raised margins which are sinuate behind; thickly and distinctly punctured and the elytra are seriately punctured. The larva is keyed and figured in Klausnitzer & Krell (1996).

Distribution Previously known from southern England, with an unsubstantiated old record from Scotland. Widespread in the Palaearctic Region, recorded from: Azerbaijan, Armenia, Austria, Belgium, Bosnia Herzegovina, Belarus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Georgia, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Romania, Russia (North European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine and Yugoslavia. North Africa: Algeria, Morocco and Tunisia. Asia: Russia (East Siberia, West Siberia), Iran, Kazakhstan, Syria and Turkey. China (Northeast Territory) (Löbl & Smetana, 2006).

Habitat and Ecology On the continent this species is most abundant and widespread in woodland at lower elevations and in lowland country (Harde, 1998). Adults are most often encountered from May through July, flying around during the day in deciduous forests or staying on the ground on rotten branches. The larvae develop in decayed wood of oak and beech and possibly also in conifers (*Pinus* species). The only circumstantial information for a British-captured specimen is of an adult cut out of a dead oak in July (Allen, 1967).

Status Described by Fowler (1890) as 'very probably…really indigenous in our country, although very rare.' Allen (1967) concurs with Fowler and summarises the British records, there being 'at least four' in the Oxfordshire district, including one individual cut out of a dry oak not far from Witham [sic], between 1819 and 1822, another flying 'not far from the city' in 1830, one near Eton, one flying in the High Street, Oxford and one in Lord Abingdon's Park. Allen (1967) also cites a specimen from Windsor in June 1827 and references old literature sources for undated records 'near Bristol', 'the west of England' and Aberdeen. It appears that this species has not been recorded in Britain since 1830.

Threats The cause of regional extinction is unknown.

Management and Conservation None. The species is widespread in mainland Europe so future colonisation, either unassisted or through importation is possible.

Published sources Allen (1967); Baraud (1992); Fowler (1890); Harde (1998); Klausnitzer & Krell (1996); Löbl & Smetana (2006).

AEGIALIA RUFA
ENDANGERED B2ab(ii)(iv)
Order COLEOPTERA
Family SCARABAEIDAE

Aegialia rufa (Fabricius, 1792)

Identification A small reddish aegialiine, distinguished from the other British species by a combination of, a raised basal margin to the roughly-surfaced pronotum, broad, blade-like hind tibial spur and overall brown colour. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to subfamily level in Klausnitzer & Krell (1996). The immature stages of this species are undescribed.

Distribution Known only from two areas in Britain. These are Glamorganshire, South Wales - Merthyr Mawr Warren SSSI (SS87) and Kenfig Burrows NNR (SS78) and from the west coast sand-dune systems that stretch from Ainsdale in Lancashire south to Wallasey in Cheshire (SD20, 21, 31, SJ29, 39).Widespread in Europe, but considered 'Rare' throughout its range (Stebnicka, 1977), recorded from Belgium, Denmark, Finland, France, Great Britain, Germany, Kazakhstan, Latvia, Lithuania, Netherlands, Norway, Poland, Russia (Central European Territory) and Sweden. North America (Introduced) (Löbl & Smetana, 2006).

Habitat and Ecology Stenotopic, restricted to dune systems and other exposed sandy habitats (Landin, 1961). Very little is known about the ecology, but in mainland Europe it is known to frequent coastal dunes and sandy banks of inland waters (Stebnicka, 1977). Recorded specifically from vegetated dune slacks (Mann & Ramsay, 2001). Adults feed on detritus in the sand. Joy (1932) stated that this species is found 'chiefly at night'. The species is notoriously difficult to find and in recent years has rarely been found in numbers, which could indicate very low density populations. In Britain, adults have been observed between late April and early October with most records from May and June.

Status Marked decline in range indicated. In northern England, recorded historically from New Brighton (SJ39), Cheshire in 1862, from Wallasey Sand hills (SJ29), Cheshire between 1883 and 1907 and between the Rivers Dee and Ribble on the sand dunes at Southport and Birkdale, Lancashire (SD20, 21 and 31) where 65 specimens were collected between 1887 and 1919 and then again from this location (Formby dunes) in 1963, with others reported from here and Ainsdale dunes sporadically up until 1989. At Wallasey it was said to occur frequently during 1885 and 1886 and at its Lancashire stronghold, it was known to be locally abundant until 1906 at least (Mann & Ramsay, 2001).

In Wales, the earliest record concerns an isolated occurrence of a specimen captured in 1981 at Merthyr Mawr Warren NNR (SS87). It has since been found here in 2006 (Pavett, P.M. pers. comm.). At the second Welsh locality, Kenfig Burrows NNR (SS78) it was first found by pitfall trapping in 1994, but has yet to be found again at this site.

Continuing decline is demonstrated by the data with a 66% decline in occupied hectads between the two main date periods and 50% between the two more recent 16-year date periods. Assuming that the two post-1990 locations are still occupied, the overall AoO is 8km². Populations may exist at low density making detection difficult. The species is regularly targeted by Coleopterists but rarely found (unpublished observations). An IUCN designation of Endangered (EN) is satisfied by an Area of Occupancy of <10km^2, continuing decline and 5 or fewer modern locations.

Threats Loss of dune habitat through coastal storm erosion events, from natural succession, which may be exacerbated during prolonged outbreaks of myxomatosis in rabbit populations and through human

recreational development and disturbance.

Management and Conservation Kenfig and Merthyr Mawr are both SSSIs and NNRs. A rotation of sensitive grazing management may be desirable to maintain early successional stages and prevent scrub invasion. Selective manual scrub clearance would also be desirable. The long-term effects of potentially increasing frequency, magnitude and duration of floods are of concern and any methods to stabilise the dune systems against erosion from these events are desirable.

Published sources Britton (1956); Hyman (1992); Jessop (1986); Joy (1932); Landin (1961); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Mann & Ramsay (2001); Stebnicka (1977).

AMPHIMALLON FALLENII
NEAR THREATENED
Order COLEOPTERA
Family SCARABAEIDAE

Amphimallon fallenii (Gyllenhal, 1817)
Amphimallon ochraceus (Knoch, 1801): Hyman, 1992

Identification This large chafer can be identified by the antennal club which has no more than three segments, the elytra which are usually very sparsely covered with short hairs rather than a longer pilosity and the diagnostic male aedeagus. The adult is keyed by Joy (1932), Britton (1956), Jessop (1986) and Krell & Rössner (2009). The larva is keyed to genus in Jessop (1986), Emden (1941) and Klausnitzer & Krell (1996). The immature stages of this species are unknown.

Distribution England and Wales. Predominantly on coastal grasslands. Rare in England, where it has only been recorded with certainty from Cornwall, Berkshire, South Devon, Dorset and East Sussex. Hyman (1992) also gives Surrey and West Gloucestershire pre-1970 and North Devon since 1970, but these records require confirmation. In Wales, it has been recorded from Cardiganshire, Caernarvonshire, Anglesey, Pembrokeshire, Carmarthenshire, Glamorgan and Denbighshire. Records from Staffordshire (1977) and South Lincolnshire (1992) certainly require verification and should be regarded with caution at present.

A localised species in Europe, recorded from: Denmark, Great Britain, Germany and Sweden (Krell & Rössner, 2009).

Habitat and Ecology Stenotopic, restricted to high quality unimproved grasslands. In Britain associated with coastal grassland and downland (e.g. cliff-tops) and rarely inland downs. This chafer requires undisturbed and unimproved grassland. The soil dwelling larvae feed at the roots of grasses. Adults have been recorded between June and August and are most often seen in mid-day flight in warm weather.

Status In England, the species may be on the verge of regional extinction; last recorded from Cornwall in the 1800s, Berkshire in 1904, South Devon in 1918, Dorset in 1996 and East Sussex in 2008 (where it has been found at only one site, Telscombe Cliffs, since 1990). In Wales, this chafer is more widely distributed and more frequently recorded.

Since 1990, the species has been reported from 22 hectads and 20 locations. The coastal regions of Caernarvonshire and Pembrokeshire appear to be its strongholds. There is evidence of continuing decline with a reduction from 21 to 15 hectads in the main date period counts. Its recorded presence in 15 post-1990 hectads means that it fails to satisfy the criteria for IUCN Category VU. Designated NT on the basis of continuing decline but more than 10 locations since 1990. If the locations could be proven to be as few as 10 or less, then a status of VU would be satisfied.

Threats Threats come from coastal erosion, changes in land use and disturbance to habitat caused by coastal tourism. In addition, the application of chemical fertilisers and pesticides will negatively impact the larval development.

Management and Conservation Where rabbit populations are adversely affected on grassland sites, open conditions should be maintained by sensitive livestock grazing or by mechanical means. Scrub clearance should be encouraged at known localities.

Published Sources Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Klausnitzer & Krell

(1996); Krell & Rössner (2009).

APHODIUS ARENARIUS
NEAR THREATENED
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius arenarius (Olivier, 1789)
Aphodius putridus (Fourcroy, 1785): Hyman, 1992

Identification *Aphodius arenarius* is characterised by the combination of its diminutive size (2.5-3.5mm) and the carinate ninth elytral interval. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus by Emden (1941), Jessop (1996) and Klausnitzer & Krell (1996) and described by Verdú & Galante (2000).

Distribution Widespread across England and Wales, but highly localised. Since 1990, restricted to a very few areas of Britain: the Carmarthenshire dunes system around Pembrey, Wales (SN30, 1990-1992), with a possible post-1990 record from Glamorgan (Whiteford Burrows SS49 where it was certainly recorded as recently as 1988), from Detling (TQ75) and Hollingbourne Downs (TQ85) in East Kent in 2004 and 1991 respectively and from Cranwich Camp (TL79), Weeting Heath NR (TL78) and Brandon (TL78) in the Breckland, West Norfolk, in 2010, 2012 and 2014 respectively. Due to past confusion in nomenclature, records from the 1980's from Yorkshire require confirmation.

Widespread in the Palaearctic Region, though it is regarded as uncommon throughout most of its European range (e.g. Verdú & Galante, 2000). Recorded from: Albania, Armenia, Austria, Belgium, Bosnia Herzegovina, Belarus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Romania, Russia (South European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine and Yugoslavia. Asia: Cyprus, Kazakhstan, Turkmenistan and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology Probably stenotopic, restricted to open sites on well-draining soils (e.g. sand) (Landin, 1961). In Britain, recorded from sand dunes, chalk downland and other open habitats, on well-drained dry sandy or chalky soils. The adults and larvae are copro-saprophagous and are known to feed on sheep, horse, cattle and rabbit dung and also vegetable debris. Adults have been recorded at the entrance of rabbit burrows and have also been pitfall-trapped on weedy arable margins on sandy soil in The Breckland. All reliable British records are from March to June. Hibernation is probably in the adult stage.

Status A marked decline in range is indicated although the species is possibly under-recorded. There has been a significant decline historically with widespread losses across the region, all manifesting by 1938. Formerly known from several sites in Berkshire (Corallian Sands region) and from Wiltshire and Cambridgeshire, but the most significant losses are in previous strongholds along the south coast downs and south-eastern counties; from Surrey down through West and East Sussex into East Kent. The species survives in this region, but its current distribution is likely to be considerably more localised than formerly.

Since 1990, only known with certainty from the Carmarthenshire coast, Wales, from The Brecks in Norfolk and from East Kent (including the Kent Downs) – seven sites in total and five hectads. Possibly under recorded. There are plausible threats but little if any indication of continuing decline. Between the two main recording periods, there has been a reduction of some 75% AoO in terms of hectads occupied. However, the more recent recording period has seen no change in the hectad count. If the potentially unreliable records are taken into consideration, this would suggest a decline from 7 to 3 hectads. One of the five post-2000 sites, at Brandon in Norfolk, may face future development to the possible detriment of the species, representing a potential 20% loss of the currently extant regional population. Conversely, the

species is not under threat at Weeting Heath NR, Norfolk, where sympathetic management is in place, nor at Cranwich Camp, Norfolk where grazing and topsoil scraping have recently been established. The dune system population in Carmarthenshire, if still extant, may be threatened by coastal erosion or vegetative succession.

Confidence in the data is somewhat compromised because of possible under-recording and due to early nomenclatural confusion owing to shared synonymy with *Aphodius borealis.* A cautious approach has been taken during data analysis, to include only records of known reliability.

The species qualifies as NT based on the low number of locations, which would be low enough to satisfy criteria for VU if continuing decline could be proven.

Threats Development, agricultural improvement and 'tidying up' of Breckland field margins can reduce habitat quality. Loss of calcareous grassland through agricultural improvement such as reseeding and application of fertilisers or by conversion in land use. Grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will contribute to the decline of this species. The treatment of livestock with endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae. Coastal erosion due to tidal surge events may adversely affect dune habitat in south Wales, as would vegetative succession.

Management and Conservation Continuity of dung supply is an important factor in the survival of this species within its current range. Preventing scrub encroachment in order to retain open habitat and avoiding the use of chemical treatment on farmed land margins will also play a key role in conservation. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung. A rotation of sensitive grazing management may be desirable to sustain early successional stages and prevent scrub invasion. Selective manual scrub clearance would also be desirable.

Published sources Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Verdú & Galante, (2000).

APHODIUS BREVIS
CRITICALLY ENDANGERED (PRESUMED EXTINCT) B2ab(ii)(iv)
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius brevis Erichson, 1848

Identification Distinguished from other medium-sized black *Aphodius* by the combination of a transverse ridge in the front third of the distinctively convex head, a lack of tubercles on the head, which is dull and impunctate except for the posterior quarter which is finely punctate and shining. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva will key to genus in Emden (1941), Jessop (1996) and Klausnitzer & Krell (1996). The immature stages of this species are undescribed.

Distribution Since 1990, only known from one location- Ainsdale Dunes, Lancashire (SD21) where it was last recorded in 1995. Widespread in the Palaearctic Region, recorded from: Armenia, Austria, Belgium, Bosnia Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Finland, Great Britain, Germany, Georgia, Hungary, Estonia, Italy, Kazakhstan, Latvia, Netherlands, Norway, Poland, Romania, Russia (Central European Territory, South European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine and Yugoslavia. Asia: Kazakhstan, Russia (East Siberia, West Siberia) and Turkmenistan (Löbl & Smetana, 2006).

Habitat and Ecology In Britain, this species is found on coastal dunes, however over most of its range it is regarded as a stenotopic species, mostly found in forest habitats, though also at exposed localities such as dunes (Landin, 1961). In Lancashire it has been found in association with various types of dung, especially partially dried-out rabbit dung, but also known from dry cattle dung. On the continent this species is known to utilise a variety of dung, though almost exclusively on dung that is partially dried out (Landin, 1961). The beetle excavates burrows about 4cm long into which it retreats in dry weather (Jessop, 1986). Adults have been recorded in April, May, June and July. The larvae probably hibernate in the third instar (Landin, 1961).

Status This has always been a rare insect in Britain with a highly restricted range. Historically recorded from Birkdale dunes (Stockport) (SD31) between 1901 and 1908, but with no recent records. At Ainsdale sandhills (SD21), the species was believed last recorded in 1962 until its rediscovery in 1992 (Whitehead, 1993), with further records from this site on two dates in April 1995. Although the species possibly exists at low population density and hence may be difficult to find, it has suffered a historical decline and has not been recorded since 1995 clearly demonstrating a continuing decline. At present this species has an AoO of only 4km² or less and one locality, where it has not been seen for 10 years and therefore qualifies as CR(PE).

Threats Despite the Ainsdale dune system being protected as a National Nature Reserve, it is the dung supply that is critical to the continued existence of this species. Other factors which will be detrimental to the species continued existence in Britain are the loss of the dune habitat through coastal erosion and natural succession, which may be exacerbated during prolonged outbreaks of myxomatosis in rabbit populations. Human recreational development and disturbance will also have a negative impact on this species.

Management and Conservation A winter grazing regime has recently been implemented at Ainsdale. This may alleviate some of the problems caused by a lack of dung; however it is advised that low stocking densities throughout the year be implemented to provide a continuous supply of available dung. In addition a continual supply of livestock dung will supplement the rabbit dung resource and provide a

substitute food source, should the rabbit population succumb to myxomatosis outbreaks. The long-term effects of potentially increasing frequency and magnitude of floods are of concern and any methods to stabilise the dune systems against erosion from these events are desirable.

Published sources Britton (1956); Emden (1941); Hyman (1992); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Landin (1961); Löbl & Smetana (2006); Whitehead (1993)**.**

APHODIUS LIVIDUS
VULNERABLE B2ab(ii)(iv)
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius lividus (Olivier, 1789)

Identification One of the yellow-elytra *Aphodius* with lighter lateral edges to the pronotum and usually a dark clouding on the elytra. Superficially similar to *consputus*, *sphacelatus* and *prodromus.* The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva will key to genus in Emden (1941), Jessop (1996) and Klausnitzer & Krell (1996) and to species in Krell (1997).

Distribution A species of sporadic occurrence that has always been scarce and highly localised in distribution. The species may exist at low populations and thus be difficult to detect, but it appears nonetheless, that it is severely localised and at present occurs at a handful of sites in southern and south-east England. The seven post-1990 records from 4 hectads for Britain are from Epsom Downs, Surrey (TQ15, 25), 1994, 1995 and 1996, Eton Wick, Berkshire (SU97) in 2007 and 2008, Hockwold-cum-Wilton, West Norfolk (TL78) in 2015 and Lakenheath, West Suffolk (TL78) in 2015.

The species is on the northern edge of its European range in Britain and is more abundant in warmer southern European climates (unpublished observations). It is a cosmopolitan species, probably through human assisted dispersion, with a preference for warmer countries. Confusion with *Aphodius pseudolividus* Balthasar may account for some records in tropical countries (Angus *et al*., 2004).

Habitat and Ecology Eurytopic, though with a preference for well-draining soils. On pasture and downland. Jessop (1986) cites 'various sorts of dung, including that of horse and sheep and also in manure heaps'. Several of the database records cite manure heaps as the source of specimens. Of the most recent records, the Eton Wick specimens were sampled from manure heaps, the Lakenheath specimens from a paddock where horse dung had become trampled with straw and the Hockwold specimen from horse dung on dry well-draining sandy soils in an open paddock with short turf. The species is known to come to light. Adults have been recorded in April, June, July, August, September, October and November.

Status Historical decline is evident from the data with a reduction of approximately 80% in occupied hectads between the two main recording periods (pre-1990 and post-1990) and further decline is demonstrated in the last 32 year period with a 33% loss of AoO between the two 16-year date ranges..

Historically recorded but probably now lost from Northumberland, Cheshire, Lincolnshire, Leicestershire and Oxfordshire, as not known from these counties since the late 1800s/early 1900s. Hyman (1992) also gives East Kent, East Suffolk, Cambridgeshire and Huntingdonshire and Anglesey before 1970. There are also only old records for Hertfordshire (1926, 1928 and 1960) and Essex (1898). More recent pre-1990 records come from Lon Goed, Caernarvonshire in 1979 and Hoo, West Kent in 1987.

The number of localities and inferred decline suggests that this species should be designated IUCN Category EN, but the authors believe that its preference for poorly recorded habitats such as litter piles mixed with dung and dung heaps, will have resulted in under-recording of the species. It has been found in 2016 at a new location in West Norfolk (Lane pers obs.) which is beyond the scope of this Review. However, this supports the belief that a designation of IUCN Category VU is more appropriate than EN.

Threats Grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will contribute to the decline of this species. The treatment of livestock with

endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae. The tidying up and removal from horse paddocks of straw, litter piles and manure heaps will reduce available breeding sites.

Management and Conservation Continuity of dung supply and the presence of manure heaps are important factors for the survival of this species within its current range. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published sources Britton (1956); Emden (1941); Hyman (1992); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Krell (1997).

APHODIUS PAYKULLI
NEAR THREATENED
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius paykulli Bedel, 1907

Identification One of the yellow-elytra 'spotty' *Aphodius*, identified by a combination of characters which include an all-black pronotum except for yellow front margins, dark dash-spotting on the elytra which has no pilosity, an all-black clypeus and the dark dash at the front of the elytra present at the base of elytral interval four as well as five. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva will key to genus in Emden (1941), Jessop (1996) and Klausnitzer & Krell (1996). Although the immature stages of this species are undescribed they are likely to key near to *A. distinctus* in Krell (1997).

Distribution Currently very localised, though still widespread throughout England and Wales. The only records that post-date 1990 are from single localities in Cumbria, Caernarvonshire, Nottinghamshire, Oxfordshire, Cambridgeshire, West Norfolk, West Sussex and four in Surrey.

Widespread in the Palaearctic Region, recorded from: Armenia, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Greece, Hungary, Ireland, Italy, Latvia, Netherlands, Norway, Poland, Portugal, Romania, Russia (Central European Territory, North European Territory), Slovenia, Slovakia, Spain, Sweden, Switzerland, Ukraine and Yugoslavia. North Africa: Morocco and Tunisia. Asia: Lebanon and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology Eurytopic, occurring in both woodland and open habitats (Landin, 1961). In Britain, found on pasture, wood pasture, downland and dune grassland, though almost exclusively on light well-draining soils. Associated with sheep, cattle and horse dung and also recorded from dog faeces. Adults are mainly active in late autumn, with a few lasting until early spring, most records between October and April. Hibernation is probably undertaken in egg stage, with larval hatching in early Spring and developing through the Summer (Landin, 1961).

Status Previously widespread across England and Wales, with very few Scottish records and with a regional stronghold in the south-eastern counties (Surrey, Sussex and Kent). Significant declines of around 85% noted which indicate that it had largely disappeared from Scotland, northern England, the Midlands and south central and south-west England by the mid-1960s. Further localised declines are probably ongoing in the south-eastern counties. The species is likely to be under recorded due to its activity period. It is nonetheless highly localised, though still widespread. The geographically isolated populations are possibly undergoing decline. The lack of targeted surveys at previously known sites limits the interpretation of the data. In addition, hectad counts appear to be stable in the second recording period (1984-2015).

Designated NT on the basis that it has undergone an 85% decline in the main recording period but with 11 post-1990 locations. If it had been recorded from 10 or fewer locations since 1990, a designation of VUB2a,b would be appropriate.

Threats Grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will contribute to the decline of this species. In particular for this species late autumn and winter livestock grazing is crucial. The treatment of livestock with endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae.

Management and Conservation Continuity of dung is the foremost priority for this species, so it is important to introduce and/or maintain autumn and winter-grazing at known sites. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published sources Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Landin (1961); Klausnitzer & Krell (1996); Krell (1997); Löbl & Smetana (2006).

APHODIUS PORCUS
NEAR THREATENED
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius porcus (Fabricius, 1792)

Identification A medium-sized *Aphodius* with dark red, dull elytra, black pronotum and head. Although superficially very similar to other species in the genus, *porcus* is distinctive in having elytral striae that are as broad as the elytral intervals. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva will key to genus in Emden (1941), Jessop (1996) and Klausnitzer & Krell (1996). The immature stages of this species are undescribed.

Distribution Widely distributed in England and Wales but highly localised occurring at only 14 locations since 1990. These are: Braystones (NY00, 2008) in Cumberland, Arnside - Red Hills (SD47, 2002) in Westmorland, Gait Barrows, Heald Brow and Jack Scout (all SD47, al in 2002) in West Lancashire, Whiteford Burrows (SS49, 1992) and Tongwynlais (ST18, 2015) in Glamorganshire, Cholderton Estate (SU24, 1998) in North Hampshire, Burghley Park (TF00, 1996) in Northamptonshire, Hoe Rough (TF91, 2014) in West Norfolk, Pulborough Brooks (TQ01, 2002) in West Sussex, Farthing Down Coulsdon (TQ25 and TQ35, 1996 and 2002) and Headley Heath (TQ15 and TQ25, 1994 and 2002) in Surrey and Betteshanger (TR35, 1999 and 2000) in East Kent. Some of these populations are likely to be very isolated.

Widespread in the western Palaearctic Region, recorded from: Austria, Belgium, Bosnia Herzegovina, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Georgia, Greece, Hungary, Ireland, Italy, Netherlands, Norway, Poland, Romania, Russia (Central European Territory, North European Territory, South European Territory), Slovakia, Spain Sweden, Switzerland and Ukraine. Asia: Turkey (Löbl & Smetana, 2006). Considered rare and sporadic in France (Lumaret, 1990).

Habitat and Ecology Eurytopic, on pasture and wood pasture with a requirement for unimproved grassland. Hyman (1992) cites 'Grassland, including south-facing slopes on chalk downland and sandy pastures. According to Chapman (1869) it oviposits in the burrows of *Geotrupes* species, however this close association with *Geotrupes* may be exaggerated (unpublished observations). Adults have been recorded from horse, cattle and sheep dung. Adults are active in autumn, with most records from September and October. Hibernation takes place in the egg stage.

Status Significant decline and range contraction is indicated and ongoing. There is an approximate 60% decline in recorded hectads in the main date period and one of approximately 25% in the second date period (1984-2015). With more than 11 locations since 1990, but strongly inferred decline, the species is designated as Near Threatened.

Previously known from Scotland where last recorded in the late 1800s/early 1900s. Also historically disappearing from much of its previously occupied range across England and Wales with no records since the 1920s from Yorkshire, Denbighshire, Monmouthshire, Herefordshire, Warwickshire, Leicestershire, North Somerset, Dorset, Isle of Wight and Cambridgeshire. In Oxfordshire, Cornwall, Devon, South Hampshire, East Sussex and West Kent, the species fared better, but still appears to have largely disappeared by the late 1970s. Its stronghold in Glamorgan has also been impacted with six sites in the first recording period reduced to just two post-1990; Whiteford Burrows NR, where not recorded since 1992 and Tongwynlais in 2015.

A lack of more recent records from East Sussex and West Kent may be due to under recording as the south-eastern counties of Surrey, West Sussex and East Kent support just over 35% of the presumed extant populations (those recorded since 2000). Four of the eleven sites that have produced the species since 2000 are in this region. Five of the remaining seven are in Cumberland, West Lancashire and Westmorland with just two elsewhere, in West Norfolk and Glamorganshire.

Threats Grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will contribute to the decline of this species. The treatment of livestock with endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae. The species in particular may be sensitive to pasture improvement. Due to its autumnal activity period, *Aphodius porcus* will require dung at this time of year. There is an increasing trend for farmers to take livestock off pasture in the autumn and winter months, a practice which will not favour survival of this species. Pasture improvement by reseeding and fertiliser application may also be detrimental to the species, as will conversion of pasture to other land-use.

Management and Conservation Continuity of dung is a priority for this species, so it is important to introduce and maintain autumn/winter-grazing regimes. Conversion of unimproved pasture to other land use should be deterred. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Britton (1956); Chapman (1869); Emden (1941); Hyman (1992); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Krell (1997); Landin (1961); Löbl & Smetana (2006); Lumaret, (1990).

APHODIUS PUNCTATOSULCATUS
REGIONALLY EXTINCT
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius punctatosulcatus Sturm, 1805

Identification Very similar in appearance to *sphacelatus*, *prodromus* and to some extent *consputus*, but distinguished from these by a combination of the eighth elytral stria continuing almost to the base of the elytra where it almost joins the seventh (as in *sphacelatus*) and by the dark basal margin of the pronotum, a much broader block of dark-clouding on the elytra and the first segment of the meta-tarsus longer than the superior metatarsal spur (only as long in *sphacelatus*). The aedeagus is characteristic. The adult is keyed by Baraud (1992). The larva is keyed to genus by Jessop (1996), Emden (1941), Klausnitzer & Krell (1996) and Krell (1997) and is described by Frolov (2000).

Distribution Formerly known from East and West Kent but not recorded in the region since 1938. The nominate subspecies is widespread in Europe, recorded from: Austria, France, Germany, Great Britain, Hungary, Italy, Portugal and Spain. North Africa: Morocco. The second subspecies *A. punctatosulcatus hirtipes* Fischer von Waldheim, 1844 is widely distributed in the Palaearctic Region.

Habitat and Ecology Eurytopic, occurring in all types of dung (Landin, 1961). As with other members of the subgenus *Melinopterus*, *Aphodius punctatosulcatus* is predominantly winter/early spring-active, feeding on herbivore dung on pasture. Members of the subgenus *Melinopterus* are dung feeding as adults, but are saprophagous in the soil as larvae. In Britain, adults have been recorded in April and May. Hibernates in the adult stage.

Status Overlooked as a British insect until it was discovered 'new' to Britain by Mann *in* Hodge (2000). Five specimens were identified in Liverpool Museum, originating from Deal, East Kent (TR35), 15.v.1910 and one specimen was located in the BENHS collections, originating from Ryarsh, West Kent (TQ65), 22.iv.1938, collected by A. M. Massee. A further 20 Deal specimens (collected between 1891 and 1910) have been located since, along with an additional Ryarsh specimen from 1938 (Mann, unpublished). The species is superficially similar to the widespread and often abundant *A. prodromus* and *A. sphacelatus*, so it is not impossible that it may be overlooked in museum collections or the field. Nonetheless, Mann and others (unpublished observations) have recorded widely across the region over a 30 year period and have not encountered it, hence there being little doubt that the species is extinct in the region.

Threats The cause of regional extinction is unknown.

Management and Conservation None. The species is widespread in mainland Europe so future colonisation, either unassisted or through importation, is possible. If rediscovered in Britain, environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Baraud (1992); Emden (1941); Frolov (2000); Hodge (2000); Jessop (1986); Landin (1961); Klausnitzer & Krell (1996); Krell (1997).

APHODIUS QUADRIMACULATUS
CRITICALLY ENDANGERED B2ab(ii)(iv)
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius quadrimaculatus (Linnaeus, 1761)

Identification A fairly distinctive *Aphodius* which is black with four sharply-defined red spots (two on each elytra), one pair situated near the elytral apices and the other smaller pair, close to the elytral shoulders. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus by Jessop (1996), Emden (1941), Klausnitzer & Krell (1996) and Krell (1997). The immature stages of this species are undescribed.

Distribution Historically widespread, but scarce and sporadic in the region. The only record (within the period covered by this Review) since the 1950's is from Deep Dean in East Sussex (TQ50) in 1988.

Widespread in the Palaearctic Region, recorded from: Albania, Armenia, Austria, Belgium, Bosnia Herzegovina, Croatia, Czech Republic, Finland, France, Germany, Great Britain, Greece, Hungary, Italy, Latvia, Netherlands, Poland, Portugal, Romania, Russia (Central European Territory, South European Territory, North European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. North Africa: Algeria, Morocco and Tunisia. Asia: Kazakhstan, Lebanon, Russia (East Siberia, West Siberia), Syria and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology Stenotopic, a xerothermic species preferring well drained soils especially sand (Lumaret, 1990). In Britain, recorded from sheep dung and cattle dung on dry pastures, including chalk downland. Adults probably hibernate and have been recorded in April, May and July.

Status Formerly widespread. Fowler (1890) cites Norfolk (West Norfolk, Roudham Heath (Edwards, 1893), Swansea (near Cardiff), Reigate, Red Hill, Coombe Wood, Edinburgh and Windsor. There are records for the Bristol area (1800s), Ipswich, East Suffolk, between 1902 and 1907, Lydden, East Kent in 1949 and Wye, East Kent in 1951 and 1957, before the 1988 record.

Last recorded in the region from East Sussex in 1988 on the South Downs. Some 27 years have elapsed since this record, but the species has been found in 2016 at a new location (Mann & Watkins, pers obs.). This is beyond the scope of this Review. However, the authors have adjusted the status in accordance with this discovery, from CR(PE) to CR. The Deep Dean site, where it was last found in the region (after a gap of some 30 years), is a chalk downland escarpment, covering more than 10km². The quantity of potentially suitable grazed habitat within this landscape is unknown. There are records in the database for dung beetle surveys in the immediate area (TQ50) during 1974 (Alfriston and Milton Street), 1978 (Deep Dean and Lullington Heath), 1987 (Lullington Heath), 1988 (Willingdon Down), 1995 (Lullington Heath) and 2001 (Milton Street). It is not known how thorough the field survey was on these occasions, but dung was certainly sampled and during part of the activity period for *A. quadrimaculatus* although the species was not recorded.

Continuing decline is stringly inferred from the data. This, coupled with suitable habitat(location) area possibly below 10km^2 and no records of the species in the region for over 25 years, qualifies for IUCN CR B2a, b.

Threats Grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will contribute to the decline of this species. The treatment of livestock with

endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae.

Management and Conservation Lullington Heath is an NNR and Wilmington Down is an SSSI. A targeted survey should be prioritised for *Aphodius quadrimaculatus* at Deep Dean and the surrounding area of the South Downs National Park. The immediate site is regularly monitored for butterfly transects, so it is accessible for survey. Scrub clearance operations have been carried out in recent years on this area to open up the sward and restore the chalk grassland.

Continuity of dung is an important factor in the survival of this species within its current range. If spring/early summer grazing is not present at Deep Dean, it should be reintroduced providing this is compatible with other conservation projects at the site. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Britton (1956); Emden (1941); Fowler (1890); Hyman (1992); Jessop (1986); Joy (1932); Lumaret (1990); Klausnitzer & Krell (1996); Krell (1997); Löbl & Smetana (2006).

APHODIUS SCROFA
REGIONALLY EXTINCT
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius scrofa (Fabricius, 1787)

Identification A small, dull, dark species which is unique amongst the British *Aphodius* in having short, backwardly-directed pale hairs on the pronotum. These are also present on the elytra. The adult is keyed by Britton (1956) and Jessop (1986). The larva is keyed to genus by Jessop (1996), Emden (1941), Klausnitzer & Krell (1996) and Krell (1997). The immature stages of this species are undescribed.

Distribution Formerly recorded in the Britain from only three localities; in Cornwall, South Lancashire and Strathclyde during the 19th century. Widespread in the Palaearctic Region, recorded from: Armenia, Austria, Belgium, Bosnia Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Russia (Central European Territory, North European Territory, South European Territory) Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. North Africa: Morocco. Asia: Afghanistan, Iran, Kyrgyzstan, Kazakhstan, Mongolia, Tajikistan, Turkmenistan and Turkey. North America (Introduced) (Löbl & Smetana, 2006).

Habitat and Ecology Stenotopic on exposed sites with sandy soils (Landin, 1961). According to Jessop (1986), the species utilises the dung of sheep, horse and cattle in dry exposed areas on sandy ground. On the continent it is found in dry sandy habitats (Allen, 1967).

Status Regionally Extinct. There are only three historic records for this species in Britain, and at least one of these is regarded as doubtful. Stephens (1830) noted a record from dung at Pentire Point, Cornwall (SW76). Sharp (1868), noted the capture of a single specimen in 1865 from Southport, South Lancashire (SD31), collected by J. Sidebotham, however the validity for many of Sidebothams beetle captures have been questioned (Morris & Johnson, 2005). Jessop (1986) also cites a 19th Century record from Paisley (Strathclyde), Renfrewshire (NS46). It is probable that these records represent vagrants or imported specimens and that the species never became established in our region. Allen (1967) leaves a question mark over its merit for inclusion on the British list, pointing out the coincidence or otherwise that this species and *Pleurophorus caesus*, another species of questionable validity as British, have both been claimed from Pentire Point. Allen (1967) does, however remark of its appearance at coastal sites, and that such habitat specialisation in our region is in keeping with an old relict species approaching extinction. Duff (2012) treats the species as a non-established introduction.

Threats The cause of any regional extinction is unknown.

Management and Conservation None.

Published Sources Allen (1967); Britton (1956), Duff (2012); Emden (1941); Jessop (1986); Klausnitzer & Krell (1996); Krell (1997); Landin (1961); Löbl & Smetana (2006); Sharp (1868); Stephens (1830).

APHODIUS SORDIDUS
VULNERABLE B2ab(ii)(iv)
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius sordidus (Fabricius, 1775)

Identification One of the yellow-elytra *Aphodius*, bearing close similarity to several other species in the genus. Amongst other characters for separation are the larger size (5.5-8mm), the dull apex of the elytra, lack of elytral pilosity and the pale yellow lateral and occasionally basal margins of the pronotum. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus by Jessop (1996), Emden (1941) and Klausnitzer & Krell (1996) and to species by Krell (1997).

Distribution Widespread, occurring both coastally and inland but historical decline shows losses from many inland locations. Very localised at present. Since 1990, known only known from 9 hectads (10 locations). These are from the Outer Hebrides (NL69) in 2013, Dorback Burn, Moray (NJ01) in 2000, West Lancashire (SD46) in 2002, West Suffolk (TL77 and 78) in 1994 and 2005 respectively, West Norfolk (TL78) in 2015, Surrey (TQ04, 06 and 15) in 2002 and West Kent (TQ77) in 1991**.**

Widespread in the Palaearctic Region, recorded from: Albania, Armenia, Austria, Belgium, Bulgaria, Belarus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Georgia, Greece, Hungary, Ireland, Italy, Kazakhstan, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Russia (Central European Territory, North European Territory, South European Territory), Spain, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. China (Yunnan, Beijing Province). Asia: Japan, Kyrgyzstan, Kazakhstan, Mongolia, North Korea, Russia (East Siberia, Far East, West Siberia) and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology Stenotopic, occurring on exposed sites with well-draining soils with a preference for sandy soils (Landin, 1961). In Britain, *Aphodius sordidus* inhabits dry, sandy or chalky pastures, mainly near the coast. It is found on coastal grassland (Machair) and sand-substrate upland pasture in the northern part of its range and in Wales. Elsewhere, it is also found on lowland pasture on free-draining soils, including breck grassland and on dunes. Associated with cattle, sheep, horse and deer dung. Adults have been found in our region between June and September. Hibernation takes places at the third larval instar (Landin, 1961).

Status Although previously only very local, this species has undergone severe regional decline historically, disappearing from a large number of vice-counties, amongst them Kintyre, Cumberland, West Lancashire, North-east Yorkshire, North Lincolnshire, Cheshire, Glamorgan, the Midlands counties of Warwickshire, Oxfordshire and Leicestershire, Devon, Dorset, Wiltshire, Middlesex, South Essex, East Norfolk and East Suffolk, all by the late 1800s very early 1900s. This was followed further localised extinctions with last known records from South Hampshire, 1925, Durham, 1929, East Sussex, early 1930s, West Ross, 1933, South-east Yorkshire, 1948, East Kent, 1964 and West Gloucestershire, 1972. There is an interesting aggregation of older records from the Thames London district parks (Battersea, Pymmes, West Ham, Plumstead, Greenwich etc.), indicating that this was a stronghold for the beetle, but it has not been recorded from this particular area of the Surrey/Middlesex/West Kent counties since the turn of the 20th century. Records from the 1980s from Preston Merse (Kirkcudbrightshire), Holcombe Hill (South Lancashire), Ramsay Island area (Pembrokeshire), Witcombe (East Gloucestershire) and Burnham Beeches (Buckinghamshire) suggest that the species might survive at these localities and attempts should be made to re-survey these sites.

Known from only 10 locations since 1990. The loss from at least one and possibly both of its two recent Suffolk sites represents a 10-20% decrease in our region's currently known population. This loss is due to cessation of grazing and it shows how quickly land-use and grazing regime changes can impact the species. No satellite populations were identified nearby and the decline was noted casually rather than from targeted survey which suggests that other losses may be occurring elsewhere of equal magnitude. The species is designated VUB2a;b based on continuing decline, the presence at only 10 locations and an AoO of significantly less than 2,000km².

Threats Grassland improvements and disruption or cessation of dung availability, especially during the breeding season, will contribute to the decline of this species. In particular, the removal or reduction in herd size of grazing animals from sand dune systems and the Machair will be damaging. The treatment of livestock with endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae.

Management and Conservation Continuity of dung is a priority for this species, so it is important to have grazing livestock throughout the summer months for its continued survival. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Landin (1961); Klausnitzer & Krell (1996); Krell (1997); Löbl & Smetana (2006).

APHODIUS SUBTERRANEUS
CRITICALLY ENDANGERED (POSSIBLY EXTINCT) B2ab(ii)(iv)
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius subterraneus (Linnaeus, 1758)

Identification One of four species with a large scutellum, of between one-third and one-fifth of the elytral length. Distinguished from the other three species by size (6.0 -7.5mm) and the elytral striae being as wide as the strongly convex elytral intervals. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus by Jessop (1996), Emden (1941), and Klausnitzer & Krell (1996) and to species by Krell (1997).

Distribution Formerly widespread but locally distributed throughout England and Wales. Last validated records from the region are from Yorkshire; Spurn Head in 1950 and Scarborough in 1954.

Widespread in the Palaearctic Region, recorded from: Azerbaijan, Armenia, Austria, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Georgia, Greece, Hungary, Ireland, Italy, Kazakhstan, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Russia (Central European Territory, North European Territory, South European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. China (Xizang). North Africa: Algeria and Morocco. Asia: Kyrgyzstan, Kazakhstan, Mongolia, Russia (East Siberia, West Siberia), Tajikistan, Turkmenistan, Turkey and Uzbekistan. North America (Introduced) (Löbl & Smetana, 2006).

Habitat and Ecology Eurytopic, but with a preference for open habitats (Landin, 1961; Lumaret, 1990). Adults are polyphagous feeding on various types of dung, organic debris (e.g. manure, compost) and carrion. Adults hibernate and it is probable that hibernation also takes place in the third larval instar (Landin, 1961). In Britain, for a species that was once so widespread, ecological data is poor. Recorded from pasture, including downland and cliffs where it feeds in horse dung. Jessop (1986) cites 'many kinds of dung, also debris, compost and carrion' as sources. Adults have been recorded from May through to September.

Status Historically widespread in England and not infrequent, for example Edwards (1893) described it as 'Common' in Norfolk and it was known from six localities in north Warwickshire in the late 1800s/early 1900s. Also known from South Wales. A catastrophic decline is evident across its entire range and the species had disappeared by the mid-1950s. Apart from the two late Yorkshire records, it appears to have been lost from Northern England (Lancashire, Cumbria, North Lincolnshire, Cheshire, Derbyshire and Nottinghamshire) by 1923. In the Midlands and East Anglia (Leicestershire, Warwickshire, Oxfordshire, Suffolk and Norfolk), it had all but disappeared by around 1913. The last record from Wales, where it was known only from Glamorgan, dates from 1933 and from nearby Herefordshire it was lost much earlier. In south England, from Devon, east to Kent, there is a greater frequency and continuity of records eastwards, but the decline is similar, with last documented records as follows: Devon (1943), Somerset (1910), Dorset, Isle of Wight and Hampshire (Eversley 1948), Wiltshire (1879), Berkshire, Hertfordshire and Buckinghamshire (1932) and Surrey, Sussex, Middlesex and Essex (1944). Two recent (1987) records from West Kent require validation and for the purpose of this review, are treated by the authors as suspect.

Not recorded in Britain for 60 years and probably extinct. The species was known from 70 hectads in the first recording period (up to 1990).

Threats The cause of any regional extinction is unknown. However, the decline occurred during a period of increased agricultural intensification and pesticide use.

Management and Conservation None. The species is widespread in mainland Europe so future colonisation, either unassisted or through importation, is possible. If rediscovered, sites management should be considerate to the dung fauna. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Landin (1961); Lumaret (1990); Klausnitzer & Krell (1996); Krell (1997); Löbl & Smetana (2006).

APHODIUS VARIANS
REGIONALLY EXTINCT
Order COLEOPTERA
Family SCARABAEIDAE

Aphodius varians Duftschmid, 1805

Identification *Aphodius varians* is similar to *Aphodius plagiatus* and *A. niger* and is often confused with these two taxa (Lumaret, 1990). In common with the two *Liothorax* species, *A. varians* shares the incurved scutellary character, but can be separated in having a tuberculate frontal suture of the head. Purportedly British examples also differ from the aforementioned species by having a large red patch at the shoulder of each elytron. This patch extends and narrows to the mid-point of the elytron. The adult is keyed in Baraud (1992) and the larva is keyed to genus by Jessop (1996), Emden (1941), Klausnitzer & Krell (1996) and Krell (1997). The immature stages of this species are undescribed.

Distribution Allegedly found near Windsor (Berkshire) and at Ripley (Surrey), both before 1839 and possibly also reliably recorded from Swansea (Glamorgan) in 1899 (Allen, 1967).

Widespread in the Palaearctic Region, recorded from: Azerbaijan, Albania, Armenia, Austria, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, Denmark, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Kazakhstan, Latvia, Lithuania, Macedonia, Netherlands, Poland, Portugal, Romania, Russia (Central European Territory, South European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. China (Shanghai). North Africa: Algeria and Morocco. Asia: Iran, Israel, Kyrgyzstan, Kazakhstan, Russia (West Siberia), Tajikistan, Turkmenistan, Turkey and Uzbekistan (Löbl & Smetana, 2006).

Habitat and Ecology Eurytopic. This species is polyphagous feeding on both dung and decaying organic matter. Recorded in May and June.

Status This species' inclusion on the British List is at best tenuous with only a few British specimens without data in old collections in museums. Duff (2012) treats this species as a non-established introduction. If it ever was a native British species, it is long-extinct.

Threats The cause of the regional extinction is unknown.

Management and Conservation None.

Published Sources Allen (1967); Duff (2012); Emden (1941); Jessop (1986); Klausnitzer & Krell (1996); Krell (1997); Löbl & Smetana (2006).

BRINDALUS PORCICOLLIS
CRITICALLY ENDANGERED B2ab(ii)(iv); C2(a)ii
Order COLEOPTERA
Family SCARABAEIDAE

Brindalus porcicollis (Illiger, 1803)
Psammodius porcicollis (Illiger, 1803): Shirt, 1987

Identification This small dark species is recognised by the five or six strongly impressed transverse furrows on the pronotum, the thick longest hind tibial spur which is longer than the combined length of the first two tarsomeres and the course of the tenth interval of the elytra which terminates before reaching into the apical half of the elytra. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to species in Klausnitzer & Krell (1996) and described in Kim (2003).

Distribution Only known in Britain from a small area of Whitsand Bay, East Cornwall (SX35), where it was first discovered at the end of the nineteenth century (1895–1897).

A complete review of the occurrence of this species in Britain was provided by Mann & Booth (2000). *Brindalus porcicollis* was added to the British list by Waterhouse (1864) based on a single specimen without data. Keys and Walker later discovered the species at Whitsand Bay, East Cornwall (Walker, 1875a, b), where it occurred, and sometimes in numbers until 1895 (Walker, 1895). It was not recorded again for over one hundred years and declared extinct by Hyman (1992), until its rediscovery in 1999 at the Keys and Walker locality near Tregantle Fort (Mann & Booth, 2000). It has been noted there most recently in 2006 and 2008. Hyman (1992) also cited a recorded from Pyle, Glamorgan in 1899, but this is shown to be erroneous by Mann & Booth (2000).

The species has a limited distribution in Europe and North Africa, recorded from: Austria, Azores, France, Great Britain, Greece, Italy, Portugal and Spain. North Africa: Algeria, Canary Islands, Egypt, Libya, Morocco, Tunisia. Asia: Israel, Lebanon, Saudi Arabia, Syria and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology Restricted to sandy habitats, most often coastal sand dune systems. At its only British locality, it has been found in sand around the roots of restharrow (*Ononis repens*), sea rocket (*Cakile maritima*) and grass at the cliff base. Sand particle size and presence of suitable vegetation cover have been suggested as playing major roles in its distribution within dune systems. The larvae pass the summer in loose sand feeding on detritus, and adults overwinter to become active in March through to May, the generation of the year producing adults in late summer, which hibernate from September onwards (Mann & Booth, 2000).

Status At the only British site, the beetle appears to be restricted, within the whole expanse of beach, to a small patch of sand and at very low abundance such that it can be very difficult to find and record (unpublished observations). The species is designated CRB2a,bii, based on a projected decline in the area of occupancy due to the site having no protection from destruction by human activities and by its area of occupancy being significantly less than 10km². It also meets CR C2(a)ii based on projected decline and 90 – 100% of the mature individuals in one population.

Threats The only British site is extremely vulnerable to tidal surge events and erosion and also to disturbance or destruction by tourists.

Management and Conservation Some protection of the site might be afforded by partitioning the small area of heaped sand from the main beach; however this could also be counter-productive, attracting unwanted attention or vandalism. Further research is required into this species' ecology at Whitsand with

a view to creating further favourable habitat for colonisation at the site. Collecting should be discouraged because of the impact not only directly on the population, but also on the available habitat.

Published Sources Britton (1956); Jessop (1986); Joy (1932); Kim (2003); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Mann & Booth (2000); Walker (1875a, b, 1895).

COPRIS LUNARIS – Horned Dung Beetle
CRITICALLY ENDANGERED (POSSIBLY EXTINCT) B2ab(ii)(iv)
Order COLEOPTERA
Family Scarabaeidae

Copris lunaris (Linnaeus, 1758)

Identification The Horned Dung Beetle (*Copris lunaris*) is a large and distinctive species with a shiny black body. The major males have a long, sharp horn on the head and the pronotum is developed with lateral horns and excavations. The female has a short blunt horn and a raised area in the centre of the pronotum. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus in Emden (1941) and Jessop (1986) and to species in Klausnitzer & Krell (1996).

Distribution Formerly widespread but highly localised in England, with populations in Cheshire, Lincolnshire, Staffordshire, East Anglia, and in southern England in Somerset, Dorset and the Isle of Wight, South Hampshire, Oxfordshire and in the south-east, from Surrey, West Sussex and East and West Kent.

Widespread in the Palaearctic Region, recorded from: Armenia, Albania, Austria, Bosnia Herzegovina, Bulgaria, Croatia, Denmark, Estonia, France, Great Britain, Germany, Greece, Hungary, Italy, Kazakhstan, Latvia, Lithuania, Luxembourg, Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Russia (Central European Territory, South European Territory), Slovakia, Spain, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. Asia: Iran, Kyrgyzstan, Kazakhstan and Tajikistan, Turkey and Uzbekistan. China (Xinjiang). Australia (Introduced) (Löbl & Smetana, 2006).

Habitat and Ecology Eurytopic on grassland, with a preference for open habitats on well-drained soils. In Britain, found in dry, well-drained unimproved pastures primarily on sand or chalk soils, usually under fresh cattle dung. The beetle excavates a burrow 10-20cm deep under the dung, leaving a large, conspicuous cast on the surface. The burrow is stocked with dung for the larvae and the female tends both eggs and larvae *in situ* (Klemperer, 1982). Adults are known to fly at dusk on warm evenings from April to July and often come to light.

Status Formerly widespread, but has significantly declined to the point of extinction with the last British record from 1974. Recorded historically (late 1800s/early 1900s) only, from Cheshire (Hadfield), Lincolnshire, Staffordshire (Whitmore), Oxfordshire (Wantage), East Suffolk (Bungay, Ipswich), West Norfolk (Thetford Rifle Range and Brandon School Plain), the Isle of Wight (Ventnor), West Sussex (Charlton, Bexley) and East and West Kent (Chatham, Shoreham). In South Hampshire, recorded from 'Bournemouth' in 1936 and in Berkshire, it persisted until 1942 (Frilford Heath, Sheepstead Farm). More sites were occupied in Surrey, with historical records from Richmond Park and from 'Godalming' where it was found between 1903 and 1916 and also known in the county from Box Hill where it survived until 1955 (Jessop, 1986). Dorset produced an isolated record of a single specimen at Seatown on 'cliff grassland' in 1954 and in West Sussex there is a single record from Lancing Ring NR in 1960.

Based on available data North Somerset (ST76) is believed to have been its last stronghold. At Monkton Combe, it was recorded between 1948 and 1950 and again in 1970, at Batheaston (Little Solsbury Hill area), it was recorded in 1886 and again in 1970 and at Kelston Park, it was discovered in 1974, but has not been recorded here since.

Copris lunaris is probably regionally extinct for the following reasons. This is a large, distinctive beetle and its burrow excavations are voluminous and obvious and as such it is unlikely to be overlooked in the

field. It is attracted to light, so the fact that no Lepidopterists in the Somerset area have reported findings is indicative that it is extinct. In 2009, A.G. Duff and D.J. Mann (unpublished observations) visited some of the species' 1970s sites in Somerset and failed to rediscover the species. Although the pasture itself superficially appeared in suitable condition, the livestock management on site was no longer sympathetic to the continued existence of the species.

Threats Agricultural intensification, pasture improvement and cessation or interruption of continual grazing by cattle may all have contributed to the probable extinction of this species. The use of endectocides may have also played a part in its decline.

Management and Conservation Targeted surveys should be undertaken at the Somerset and Surrey localities during the peak activity period. The reports of records from the 1980s should be investigated further. If rediscovered, site management should be considerate to the dung fauna. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Klemperer (1982); Löbl & Smetana (2006).

DIASTICTUS VULNERATUS
VULNERABLE D2
Order COLEOPTERA
Family SCARABAEIDAE

Diastictus vulneratus (Sturm, 1805)

Identification A small species, characterised by a combination of the lack of transverse ridges on the outer edge of the hind tibiae, the lack of transverse ridges and depressions on the pronotum and the hind tarsi length being only half the length of the hind tibiae. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The immature stages of this species are undescribed.

Distribution A true Breckland specialist in our region. Only known since 1990 from three Breckland sites in West Norfolk and one in West Suffolk, but probably still extant at all four. There are older records from other Suffolk Breckland sites, where it also possibly persists. In the Norfolk Breck the sites are as follows: at Cranwich Camp (TL79), an open area of short turf rabbit-grazed Breck grassland, the species has been recorded sporadically from 1990 to 2014; at Stanford PTA (TL99), it was discovered in 1993 and at Weeting Heath NR (TL78) it was recorded between 1989 and 1991. In the Suffolk Breck, it is known from 'near Brandon' (around 1902), Knettishall Heath (TL98, last recorded 1939), Icklingham Plains (TL77, last recorded 1962), Thetford Heath (TL88, last recorded 1971), Foxhole Heath (TL77, last recorded 1987) and Lakenheath Warren (TL78, last recorded 1993).

Widespread in Europe, recorded from: Austria, Belgium, Bosnia Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, France, Great Britain, Germany, Greece, Hungary, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Romania, Russia (Central European Territory), Sweden, Switzerland, Ukraine and Yugoslavia (Löbl & Smetana, 2006).

Habitat and Ecology Stenotopic, almost exclusively in exposed sites on sandy soils. In Britain, restricted to the Breckland area of Norfolk and Suffolk. Found in dry, open heathy areas on sandy soils. At the Cranwich Camp site, the beetle has been taken in pitfall traps in short turf 'scraped' areas, under stones and in ground litter and has also been collected by sieving sand at the entrance to rabbit burrows (Allen, A.J.W. pers. comm.) which effectively act like pitfall traps (unpublished observations). On one occasion, specimens have been located by digging 6-10” deep into sand at plant roots (Booth, R. pers. comm.). The species probably feeds on organic detritus in the soil, which rabbit pellets contribute to, however there is no evidence to suggest a direct link between this beetle and rabbit dung (unpublished observations). Adults hibernate, and have been recorded from April to early July and in November.

Status Despite recent pitfall trapping programmes at both Weeting Heath and Stanford, the species has not been rediscovered at these sites. At Cranwich, the site where it has most recently been found and where it has been recorded most frequently, it is difficult to find (unpublished observations) and is evidently at low population levels and vulnerable to changes in the nature of the grassland. Rabbits are less evident here than in the past, so with regard to indirect association between the beetle and rabbit dung, the threat of myxomatosis or increased disturbance from dogs and dog walkers may contribute to a further decrease in the rabbit population and an associated decline in the beetle at the site. Recent anecdotal information about the species at its Suffolk sites is lacking.

Diastictus vulneratus is a xerothermic species, hence its restriction to the Brecks which provides the warm and dry micro-habitat for its development (unpublished observations). Recent decline is suspected but not proven. On the basis of there being fewer than 5 modern locations and plausible threats in the form og habitat deterioration in atleast two of its current sites, a designation of VU D2 is given.

Threats Conversion of land to development and afforestation. Cessation of grazing resulting in deterioration of short sward habitat. A possible threat is the decline in rabbit populations which could affect the quality of Breckland heath by reducing the frequency of 'diggings' and disturbed ground and allowing the sward to grow rank, as well as decreasing the availability of faecal organic debris that the beetle might utilise as a food source. Succession of grassland habitat and a corresponding change in sward height from short to tall would effect an increase in soil relative humidity and lower the temperature, neither of which would suit this xerothermic species.

Management and Conservation Grazing and/or mechanical scarification is required at Breckland sites to create a sand and short turf mosaic rather than allowing site deterioration to succession to rank grassland. Both grazing and scarification are currently practised at the Cranwich site.

Published Sources Britton (1956); Jessop (1986); Joy (1932); Löbl & Smetana (2006).

EUHEPTAULACUS SUS
VULNERABLE D2
Order COLEOPTERA
Family SCARABAEIDAE

Euheptaulacus sus (Herbst, 1783)

Identification *Euheptaulacus sus* is a relatively small dung beetle, characterised by having a pilose pronotum and elytra, the latter having a light brown background with dark brown spots on the intervals. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus by Klausnitzer & Krell (1996) and described in Frolov (2009).

Distribution The species has been recorded since 1990 from Northam Burrows NR (SS43) in North Devon, Sandwich Bay (TR35), East Kent, Hockwold-cum-Wilton (TL78) in the Norfolk Brecks and at nearby Lakenheath (TL78) in the Suffolk Brecks. It has not been recently recorded at its one known Scottish locality Dalmeny Park (NT17, West Lothian) since 1985, but it may still persist there.

Widespread in the Palaearctic Region, recorded from: Armenia, Austria, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Kazakhstan, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Romania, Russia (Central European Territory, North European Territory, South European Territory), Slovakia, Spain, Sweden and Ukraine. Asia: Iran, Kazakhstan, Russia (East Siberia, West Siberia), Syria, Turkmenistan and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology Stenotopic, mostly on exposed sites with sandy soils (Landin, 1961). All of the recent records have been associated with free-draining soils on sandy semi-improved pasture or sand dune systems. Jessop (1986) cites dry and sandy pasture on littoral or alluvial plains as the preferred habitat. Associated with sheep and horse dung. Adults are present in the field in July, August and September. Hibernation takes place in the larval stage (Landin, 1961).

Status Previously widespread but highly localised in coastal regions or sandy inland areas. The database lists Cheshire (Liverpool and Wallasey), Glamorgan (Swansea), North Somerset (Burnham-on-Sea), North Devon (Northam Burrows, Dartmoor and Coulson), Dorset (Chesil Beach), South Hampshire (Ashurst Wood), Surrey (Esher, Richmond, Woking and near Staines), East Sussex (Camber Sands), East Kent (Deal and Sandwich Bay), East Norfolk ('Norwich') and West Lothian (Dalmeny Park). The species has suffered a significant historical decline and has not been recorded from the majority of its known localities since the late 1800s and very early 1900s, the exceptions being Camber Sands where it persisted until 1922, Dalmeny Park (the only Scottish locality), where it was discovered 'in a sandy glade' in 1985 and the few sites where it is currently established. Its main stronghold is at Northam Burrows NR in North Devon in an area of sheep and horse-grazed coastal grassland covering less than 2 km². The East Kent, Norfolk and Suffolk sites are smaller, comprising pasture grassland on farmsteads. With only four current (post-1990) locations in the region with a combined area of much less than 20 km², with the difficulty of proving recent continuing decline, but with obvious threats, its status is designated Vulnerable D2.

Threats Grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will contribute to the decline of this species. The treatment of livestock with endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae. Northam Burrows NR has SSSI status, therefore the site is protected, but the ongoing supply of dung is not. The other sites are particularly vulnerable to the threats outlined.

Management and Conservation Continuity of dung supply is a priority for this species, so it is important to have grazing livestock throughout the year for its continued survival. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Britton (1956); Frolov (2009); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Landin (1961); Löbl & Smetana (2006).

GNORIMUS NOBILIS – Noble Chafer
VULNERBALE A2c
Order COLEOPTERA
Family SCARABAEIDAE

Gnorimus nobilis (Linnaeus, 1758)

Identification This is a large and distinctive metallic green chafer, distinguished from the superficially similar rose chafer by the scutellum which is transverse and less conspicuous in *Gnorimus* but very obvious and elongate in *Cetonia.* Compared to rose chafer, the noble chafer is also less parallel-sided, distinctly narrowing in outline towards the head. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus in Jessop (1986) and to species in Emden (1941) and Klausnitzer & Krell (1996).

Distribution England. Currently very locally distributed in Midlands and southern England with post-1990 records from Herefordshire, Gloucestershire, Worcestershire, Warwickshire, Buckinghamshire, Bedfordshire, Berkshire, Oxfordshire, Hampshire and Kent. A 1996 record from Mickleham, Surrey is erroneous. Previously also recorded from Leicestershire, Cumbria (?), Norfolk (?), Northamptonshire, Essex, Sussex, Middlesex and Devon, although some of these records may relate to adventives rather than established populations. The species' stronghold is in the fruit-growing areas of Herefordshire, Gloucestershire and Worcestershire where evidence of populations has since 1990, been found in 22 of the 35 post-1990 hectads in our region, and 22 of the 34 hectads in which the species has been recorded since 2000. Specimens labelled 'Windsor Forest' and traceable to larvae reared by Jon Owen, are present in at least two collections. However, research into these 'Windsor Forest' specimens has discovered that the labels are incorrect and should read “New Forest”, there having been some misunderstanding as to the origin.

A widespread European species, recorded from: Albania, Austria, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, Denmark, Estonia, France, Great Britain, Germany, Greece, Hungary, Italy, Latvia, Liechtenstein, Macedonia, Netherlands, Norway, Luxembourg, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine and Yugoslavia. Asia: Turkey (Löbl & Smetana, 2006).

Habitat and Ecology In Britain, primarily associated with orchards where the larvae develop in the wood mould or heartwood of old hollow fruit trees. Plum is most favoured, but it is also regularly recorded from apple, pear, damson and cherry. The species is also associated with woodland and there are reports of larval development in willow and possibly oak. The larval development takes at least two years. Adults are active between April and September although the peak emergence is probably in June. They visit flowers, particularly those of hogweed, angelica, rose and elder.

As a Priority Species, the Noble Chafer has been the subject of intensive research in its Midlands orchard habitat (e.g. Alexander, 2008, 2015; Bunney, 2012; Schenke, 2012). This species has been championed by the Peoples Trust for Endangered Species (PTES) as part of their ongoing Traditional Orchard Campaign Initiative. The Trust has provided comprehensive information to assist people in identification and monitoring of the chafer. Their survey results are largely based on the presence of the distinctive larval frass as well as the presence of larvae or adults themselves (https://ptes.org/noble-chafer-beetles/).

Status A Priority Species (NERC s.41). Nieto & Alexander (2010) in the European Red List of saproxylic beetles consider this species to be of IUCN category ‘Least Concern’ in Europe**.**

Status is discussed as follows for each distinctive region of occupation in England:

Main Orchard Populations:
The Noble Chafer has been the subject of intense survey at many of its orchard sites (Herefordshire, Gloucestershire, Worcestershire, Buckinghamshire, Bedfordshire, Warwickshire, Kent) and an ongoing audit programme initiated in 2000 by the PTES is largely responsible for the wealth of recent orchard data.

Several research projects have been undertaken to better understand the spatial dynamics of the orchard populations. Schenke (2012) wrote 'The fact that Noble Chafers have been observed nectaring and copulating on flowers up to 700 metres away from known orchard sites (e.g. Whitehead, 2003) indicates that they have the ability to disperse relatively far away to find suitable host trees'. Schenke (2012) also referenced Whitehead's (2003) supposition that the beetle could spend its whole life in one tree and could establish small populations in rather restricted areas if the habitat was suitable. With respect to both of these scenarios, Schenke (op. cit.) concluded that it is difficult to discern whether populations exist at site level or are operating at a broader landscape level.

Schenke (2012) also argued that for the species to be able to establish viable restricted and localised populations, there would need to be 'good links with other favourable habitats (e.g. Kindlmann *et. al*., 2005; Krauss *et. al*., 2005), a number of dispersive individuals (e.g. Kindlmann *et al*., 2005; Krauss *et. al*., 2005) or a continued supply of mature fruit trees (e.g. Lush *et. al*., 2009) otherwise the populations will eventually collapse.'

Due to the attention and scrutiny that the species has received in the West Midlands, the area total of 24 hectads is probably very close to the upper limit for the species' true distribution in this region. By April 2013, evidence of the species had been amassed at a total of 73 orchards in the area, amounting to a specific value of AoO of 1.058 km².

The PTES has recently acquired data (Alexander, 2015) to quantify significant orchard loss in the Midlands area where the species is present and in Kent, of the three orchards in which *Gnorimus* was recorded, one has been destroyed and one transplanted (partly failed) (Bowers, L., & Denton, J. pers. comm.).

Harry Green (pers. comm.) comments anecdotally that 'Most of the major orchard destruction, especially in the Vale of Evesham, happened quite a few years ago. Those orchards left after the great blitz have tended to remain there to grow old. In fact what is happening is that the decayed orchard tree resource is gradually declining right across Worcestershire as the trees planted 100-200 years ago fall over naturally.' He cites an instance of a big chafer orchard being destroyed recently as a result of 'tidying up'. Most importantly he states that 'although we have found a lot of new chafer orchards in recent years through diligent searching, the actual resource noble chafers need is slowly declining.' Alexander (2015) has, in his very recent research, found the decline and destruction of traditional orchards to be altogether more rapid and impacting.
Since orchard populations account for 91% of the region's population in terms of hectads (32 of 35 post-1990 hectads), the unknown rate of orchard destruction is a significant threat.

Alexander (2015, unpublished) sampled 42 orchards in 2015 and found a 51% reduction in habitat suitability within the West Midland's region over an approximate 10-year period. This reduction comprised the complete loss of 15% of orchards and the potential future loss of a further 36% through poor management. Although *Gnorimus* had only been identified from a small proportion of these sites, it is acceptable to infer that the 51% habitat decline can be equally applied to *Gnorimus*-occupied orchards. Alexander's findings can be extrapolated to encompass all orchard sites in the region.

The New Forest Population:

Here, the chafer has been recorded since 2000 from 3 hectads and 6 tetrads (9 tetrads if you include post-1990 records) equating to an AoO of 24km² (36 km² post-1990) if the IUCN prescriptive guidelines for calculating AoO are applied. Unfortunately, there has been no in-depth population research in the New Forest, so it is difficult to know the magnitude and spatial distribution of the breeding population. The AoO is likely to exaggerate the true area of occupation for this species. The use of 1km squares for AoO estimate would be preferential to the prescribed tetrad count for this species, and would give a post-1990 AoO of 9 km². The species here may not be dependent on orchards or at least there is no information as yet to suggest that it is.

The Chilterns Population:
Records from Peppard in 1913 and from the Kingwood Common, Peppard Common and Highmoor Cross area (2 hectads, 3 tetrads) between 1998 and 2005, involve larvae collected from both isolated and orchard cherry trees. It is difficult again to know whether this concerns one population or several small populations as the sites are some distance from each other. A conservative estimate assumes that one population is involved.

Berkshire:
A recent record from Marcham Park in old orchard pear trees is a recent addition to the orchard sites and adds another hectad and another location to the overall count.

The species is designated Vulnerable A2c based on the following rationale:

Alexander (2015, unpublished) visited 42 orchards in the Midland's region (not necessarily occupied by *Gnorimus*) and found a potential decline in habitat suitability of 51% magnitude over a 10-15 year period. Although only a small percentage of these orchards were known to be occupied by *Gnorimus*, it is acceptable to extrapolate the 51% habitat decline and loss across the whole range of orchard sites in the Midland's region and also in Kent, Berkshire, Buckinghamshire, Bedfordshire and the Chilterns.

A 51% decline over 15 years equates to a 38% decline over 10 years (as required by Criterion A). As stated by the IUCN guidelines (2014), the amount of habitat loss can be used to suspect a population reduction at a particular rate. Therefore the suspected information, based on circumstantial evidence, is sufficient to list this species as Vulnerable under Criterion A2 (c) based on a 38% decline over 10 years.

No similar research projects have been undertaken in The New Forest but as this represents less than 10% of the total population. The criteria under A3 are still satisfied as the decline will still be 30% or greater.

Conclusion – the species satisfies the criteria for Vulnerable A2(c).

Threats The main threats to this species are in its orchard habitats. Orchard neglect, lack of orchard management and no regeneration or new planting means that old orchard trees will reach an optimum level for occupation by *Gnorimus nobilis* and will then deteriorate as a resource for the chafer. Clearance (and 'tidying up') of old orchard sites and conversion to other forms of land use will have a direct and immediate impact on populations.

Management and Conservation Good management for saproxylic assemblages should aim to identify occupied habitat and provide future continuity of dead wood through a programme of planting in line with current saproxylic management practices. Dead wood (particularly standing dead wood) should be left *in situ*. Over collecting of specimens should be discouraged. Dissemination of information to orchard owners is paramount to the future conservation of this species in the West Midlands and other regions of England in orchard habitats. The PTES is a valuable resource for this kind of work. Continued research into spatial population dynamics will further inform good orchard management. Research into the New

Forest population is desirable.

Published Sources Alexander (2008, 2015); Britton (1956); Bunney (2012); Emden (1941); Jessop (1986); Joy (1932); Kindlmann *et al*. (2005); Klausnitzer & Krell (1996); Krauss *et al*. (2005); Löbl & Smetana (2006); Lush *et al*. (2009); Nieto & Alexander (2010); Schenke (2012); Webb & Thomas (1994); Webb *et al*. (2010); Whitehead (2003).

GNORIMUS VARIABILIS – Variable Chafer
ENDANGERED B2ab(iii). (European Red List of Saproxylic Beetles - Vulnerable)
Order COLEOPTERA
Family SCARABAEIDAE

Gnorimus variabilis (Linnaeus, 1758)

Identification A distinctive and unmistakeable chafer that is predominantly black apart from a small number of pale spots on the elytra (these are sometimes absent or difficult to see). The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus in Jessop (1986) and to species in Emden (1941) and Klausnitzer & Krell (1996).

Distribution England only. Very localised in the region. Historically recorded from a number of localities (mainly Commons) in Kent and Surrey, including Purley, Tooting Common, Penge, Balham and Lee with the last record from Purley Oaks in the early 1900s. Populations persist at two localities. These are Windsor Forest (and Great Park) (SU97) and surrounding areas (Telfer, M.G. pers comm.), where the species is widely dispersed but infrequent. Occasionally, larvae can be numerous in a single tree (Allen, 1960). The other modern site is Parham Park (TQ01), West Sussex, where the species was discovered in 2003 from a pronotum found in red rot in a hollow oak trunk. Here it has only been found in a very small number of old oaks.

Widespread, though localised in Europe, recorded from: Austria, Belgium, Bulgaria, Belarus, Croatia, Czech Republic, Denmark, Estonia, France, Great Britain, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and Ukraine. Asia: Turkey (Löbl & Smetana, 2006).

Habitat and Ecology Woodland and parkland. Adults are flower-visitors and are also found at rest on trees. Larvae develop in damp wood mould and red rot heartwood of veteran and old oak and beech trees. The main period of adult activity is June and July, with some records from August. This species is regarded as a key saproxylic quality indicator species (Fowles *et al*., 1999).

Status A Species of Principal Concern in England (NERC s.41). Nieto & Alexander (2010) in the European Red List of saproxylic beetles consider this species to be of IUCN category 'Vulnerable' in EU27 and Near Threatened in Europe. In Britain, known from five hectads and from four counties, but recently (post-1990) only from two hectads in two counties. At Windsor Forest and Great Park, it is known since 2000, to have occupied suitable habitat in five tetrads and six 1km squares (an additional two 1km squares, but not hectads, pre-1990). At Parham Park, it is known from 2 tetrads and two 1km squares.

This gives an estimate of AoO of 28 km². The Windsor Forest population is likely to comprise meta-populations, but the exact interaction between these is not known as no research has been conducted. The regional population appears to be stable and management at Windsor Forest is sympathetic to the needs of this and other saproxylic specialists.

This species qualifies as Endangered under criterion B2ab(iii). *Gnorimus variabilis* is present in only two locations (B2a) in Britain and, although there is no direct decline detected, it's habitat, heartwood decay in veteran trees is declining (Alexander, 2014). It therefore also qualifies under B2biii.

Threats There are limited threats specific to this species at Windsor Forest and Parham Park as both are

SSSIs. A lack of the continuity of veteran trees will become an issue in the future.

Management and Conservation Good management for saproxylic assemblages should aim to identify occupied habitat and provide future continuity of dead wood through a programme of planting in line with current saproxylic management practices. Dead wood (particularly standing dead wood) should be left *in situ*. Over collecting of specimens should be discouraged.

Published Sources Allen (1960); Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Nieto & Alexander (2010)**.**

HEPTAULACUS TESTUDINARIUS
CRITICALLY ENDANGERED (POSSIBLY EXTINCT) B2ab(ii)(iv)
Order COLEOPTERA
Family SCARABAEIDAE

Heptaulacus testudinarius (Fabricius, 1775)

Identification A small dung beetle, recognised by the pilose pronotum and elytra and by the elytra having a darkened background colour with pale brown spotting. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986).The larva is keyed to genus by Klausnitzer & Krell (1996). The immature stages of this species are undescribed.

Distribution Significant historical decline evident. Previously widespread but highly localised in Scotland, England and Wales, with records from Renfrewshire (Paisley), Yorkshire (Sandburn Woods), Glamorgan (Swansea and Llandaff), North and South Hampshire (several sites in the Lyndhurst area including Lyndhurst Common, The Bench and White Moor and also from Ferndown), Dorset (Lytchett Minster), Middlesex (Halliford, Hampstead Heath), Surrey (Esher Common, Hindhead Common, Richmond Park, Woking, Bagshot and Chobham) and Essex (Loughton/Epping Forest). The only areas that have produced records of this species post-dating the late1800s/very early 1900s are Dorset and Hampshire and here, records are sporadic and sparse, occurring on only a handful of occasions (i.e. 1927, 1928, 1930-31, 1934, 1937, between 1965 and 1969, 1970 and 1979) and St Andrews, Fife, in Scotland in 1955. The last British record, in 1979, originates from Bolton's Bench, Lyndhurst (SU30), a horse-grazed hillside 'lawn'.

Widespread in the western Palaearctic Region, recorded from: Armenia, Austria, Belgium, Belarus, Croatia, Czech Republic, Denmark, Estonia, France, Great Britain, Germany, Hungary, Italy, Kazakhstan, Latvia, Lithuania, Netherlands, Poland, Portugal, Russia (Central European Territory, South European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine and Yugoslavia. Asia: Kazakhstan and Uzbekistan (Löbl & Smetana, 2006).

Habitat and Ecology Stenotopic, on exposed sites with well-draining soils. In Britain, recorded from open pasture and heath on free-draining soils. Recorded at The Bench, Lyndhurst, from dry horse dung but Jessop (1986) also cites rotten vegetable material as a source. This rare species occurs in early spring on partially dry horse or cattle dung, always on sandy soil (Landin, 1961). Hibernation takes place in the adult stage. In Britain, adults have been recorded between February and early June.

Status Last recorded in the region in 1979. With no records for over 35 years, it is possible that the species is extinct in the region. Attempts have been made to rediscover it at the Lyndhurst site, but to date these have been unsuccessful, despite the continuation of grazing across the New Forest area.

Threats None known. The cause of the regional extinction is unknown. However, grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will have contributed to the possible extinction of this species. The treatment of livestock with endectocides will have been detrimental, reducing adult fecundity and survival and increased mortality rates in larvae.

Management and Conservation Continued attempts should be made to rediscover this species in suitable habitat in Dorset and Hampshire. Management and conservation should be prioritised as and when any extant populations are discovered. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations

reliant on livestock dung.

Published Sources Britton (1956); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Landin (1961); Löbl & Smetana (2006).

ONTHOPHAGUS FRACTICORNIS
VULNERABLE D2
Order COLEOPTERA
Family SCARABAEIDAE

Onthophagus fracticornis (Preyssler, 1790)

Identification This is a relatively large *Onthophagus* with mottled ochre and black elytra. The front angles of the pronotum are sinuously curved. Differences between this species and the superficially similar but smaller *O. similis* are comparative and include characteristics of the male cephalic horn and in the female, the posterior transverse ridge. In males, the cephalic horn is distinctly angled at the base, often dilated. The aedeagus is diagnostic. In the female, the cephalic carina is longer than the frontal carina and gently sloping. In *Onthophagus similis* females, this carina is always obtusely angled. There has been much confusion over these two species in the past, leading to many erroneous records of *fracticornis* in the literature and collections. The adult is keyed by Jessop (1986) and Baraud (1992). The larva is keyed to genus in Emden (1941) and Jessop (1986) and to species in Klausnitzer & Krell (1996).

Distribution Highly localised distribution in south-western England and Wales, and with modern records only from England in the Mendip Hills area of North Somerset. A record from Matley Bog in the New Forest in 1957 was proven to be erroneous.

Relatively recently discovered in the Mendips in North Somerset where the species has been found at Cross, near Axbridge (ST45) in 1970, Wavering Down (ST45) where it has been described as numerous on dry upland pasture, in 2000 and 2007; also recorded from here in 2008, Old Quarry Farm (ST45) in 2009, Crook Peak (ST35) in 2009, Compton Hill (ST35) in 2009, Cheddar Gorge (ST45) in 2010, near Bradley Cross (ST45) in 2013, Westbury-sub-Mendip (ST54) in 2013 and again in 2015, near Beacon Batch/Black Down (ST45) in 2015 and Pen Hill Bridleway (ST54) in 2015.

Widespread in the Palaearctic Region, recorded from: Albania, Armenia, Austria, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Russia (Central European Territory, North European Territory, South European Territory), Slovakia, Slovenia, Spain, Russia: Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. Asia: Cyprus, Iran, Russia (West Siberia), Syria and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology This is a dung beetle of open unimproved to semi-improved pasture on well-drained soils and more specifically, hillside pasture in The Mendips. On the continent it favours horse dung but will feed on that of other species (Dormont *et. al.*, 2007; Sowig, 1995). The 1970 specimen from Cross near Axbridge was from atypical habitat; lowland grazing marsh and this was almost certainly a peripheral specimen from the main population at Wavering Down (Mann, unpublished observations.). In Britain, the adults have been found feeding on horse, cattle and sheep dung and nesting burrows have been noted under cattle and sheep dung.

Status Historically known in Wales, from Llandaff (1899) and Castell Coch (1899) in Glamorgan and from Fairbourne, Merionethshire (1940). In England from North Somerset at Burnham-on-Sea (ST34) in 1931 and 1932; from Shapwick area (ST43) 1931 and Perranporth, Cornwall (SW75) in 1911. There are no recent records from these localities despite targeted surveys, so some historical decline is indicated with localised extinction at these sites.

Duff *et al.* (2007) suggested that this species 'ought to occur more widely in western parts of England and Wales, on hill slopes with reasonably drained soils' and it appears that this potential has been realised through targeted field survey. At Castell Coch, the site is no longer grazed – D.J. Mann recently surveyed Garth Hill, a suitable site nearby which is grazed and failed to find the species there.

The regional status of this species in England may look strong, until it is realised that four of the nine post-2000 Somerset sites (Wavering Down, Old Quarry Farm, Crook Peak and Compton Hill) are in fact part of one location. The grazing in this National Trust location is currently unintentionally sympathetic to the species requirements, but should there be any change in the grazing regime or an introduction of avermectins, the species could be lost from all four sub-locations within the time-frame of a single season – a very plausible threat to the future survival of the region's population. The Wavering Down colony is the strongest (unpublished obs.) and the other 'satellite' populations are likely to depend on the health of this core population. D.J. Mann sampled 20 sites in suitable habitat for this species over a 7-year period (2009 – 2015) and only found *O. fracticornis* at 6 of them. 20 of these sites are in the Somerset Mendips and 3 are in Glamorganshire. The sampling provides further evidence that even in suitable habitat, the species is highly localised and restricted. Consequently, the species is very vulnerable in its Somerset stronghold.

To summarise, there is no evidence of recent decline, although historical decline is highly likely, particularly in Wales where there have been no formal records since 1940. There are only 5 post-1990 locations (each centred around a hill formation), the combined grazed pasture for all locations (true AoO) is probably less than 20 km² although based on the prescriptive IUCN tetrad count, the AoO would be 36 km² (9 tetrads). There are very real threats to the population such that it could be wiped out in one season by a few changes in grazing regimes or the application of endectocides on these few hillsides.

A clear cut designation of IUCN Category VU D2 is satisfied with only 5 post-1990 locations and threats to the population that could cause rapid and significant or catastrophic decline.

Threats Grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will contribute to the decline of this species. The treatment of livestock with endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae.

Management and Conservation Continuity of of good quality dung is a priority for this species, so grazing livestock should be present throughout the summer months. Further surveys should be carried out to attempt to rediscover the species at the former Welsh sites. It is important to disseminate information on the conservation of this species to the relevant authorities and landowners, so that the significance of the Mendip Hills for this species can be considered in future management plans. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Baraud (1992); Dormont *et al.* (2007); Duff *et al.* (2007); Emden (1941); Jessop (1986); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Sowig (1995).

ONTHOPHAGUS NUCHICORNIS
VULNERABLE B2ab(ii)(iv)(v)
Order COLEOPTERA
Family SCARABAEIDAE

Onthophagus nuchicornis (Linnaeus, 1758)

Identification This is a relatively large *Onthophagus* characterised by its mottled ochre and black elytra, the strong black marks of which usually extend to the base of the fifth elytral interval. It also has a black pronotum without the metallic green colouration that is usually found in the closely-related *Onthophagus medius.* The lateral margins behind the anterior angles of the pronotum are regularly curved rather than sinuous. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed is keyed to genus in Emden (1941) and Jessop (1986) and to species in Klausnitzer & Krell (1996).

Distribution Since 1990, known from the following coastal dune sites: in Wales, from Kenfig Burrows (SS78), Whiteford Burrows (SS49), Merthyr Mawr Warren (SS87) Pennard/Penmaen Burrows (SS58), Crymlyn Burrows (SS79) in Glamorganshire and Morfa Harlech (SH53) in Merionethshire; in North Devon (Northam Burrows), East Sussex (Camber Sands) and East Kent (Greatstone-on-Sea). Inland, it has been recorded since 1990 from Lyndhurst (SU30) in the New Forest, South Hampshire and from two localities in the West Suffolk Breck; Foxhole Heath (TL77) and Lakenheath (TL78). Formerly more widespread across England and Wales, but its true historical distribution is hard to assess due to the misidentification of *O. similis* as *O. nuchicornis* and the confusion and use of the names in the early literature (e.g. Fowler, 1890).

Widespread in the Palaearctic Region, recorded from: Albania, Armenia, Austria, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Moldavia, Netherlands, Norway, Poland, Romania, Portugal, Russia (Central European Territory South European Territory, North European Territory), Slovakia, Spain, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. Asia: Kazakhstan, Mongolia, Russia (West Siberia), Turkmenistan and Turkey. China (Beijing Province, Xinjiang Province). Nearctic Region (Introduced) (Löbl & Smetana, 2006).

Habitat and Ecology This dung beetle is found in Breckland grassland and coastal dune systems on sandy soils where it is associated with the dung of cattle, rabbit, horse, dog and sheep. In Europe it is stated to have a preference for cattle dung (Harde, 1998). Adults are active mainly from April to September.

Status There is strong evidence of a marked range contraction and severe decline historically with regional extinctions in the late 1800s/early 1900s, and into the 1930s across England and Wales. Counties from which this species is listed from historic records which are not necessarily confirmed, are Lancashire, Cheshire, Lincolnshire, Leicestershire, Warwickshire, Oxfordshire, Cornwall, Scilly Isles, Isle of Wight, Dorset, Wiltshire, Cambridgeshire, West Norfolk, East Suffolk, West Kent and Essex. Decline appeared to continue well into the mid-20th Century and beyond with last records from Cardiganshire in 1959, Pembrokeshire in 1967, Carmarthenshire in 1970, Somerset in 1945, Huntingdonshire in 1973, Berkshire in 1942, Surrey in 1940 and Middlesex in 1943.

This species has been the subject of intensive surveys at its present and former North Devon, Somerset, Breckland and Welsh sites by Mann (unpublished observations) in the last five years. The hectad counts over the last thirty-two year period, appear to indicate that the population has remained more-or-less

static. However, due to the survey work undertaken by Mann, we can detect an evident continuing decline within the last 15 years; a decline which is not obvious from hectad counts alone. Data on survey time *vs* specimens recorded, during recent targeted surveys noted that in recent consecutive years, although survey time had increased, the number of records and sites for the species, has decreased (Mann, unpublished observations).

Of the ten locations (11 hectads) from which this species has been recorded since 2000, there are no recent records from two sites since 2005. These are Pennard/Penmaen Burrows (SS58), Glamorganshire and Foxhole Heath (TL77), West Suffolk. At Crymlyn Burrows (SS79), Glamorganshire, the species has not been recorded since 1996. In the Suffolk Brecks of East Anglia, where the beetle was, until 2005 relatively easily found at a handful of sites, a total of some 60 hours of survey in peak season during 2015 located just one solitary female. Within its now restricted range it can only be said to occur with certainty at eight sites: Northam Burrows, Kenfig Burrows, Whiteford Burrows, Merthyr Mawr Warren, Morfa Harlech, Camber Sands, Greatstone-on-Sea and Lakenheath (where it is barely present). Decline is undoubtedly continuing in England and Wales.

In summary, this species qualifies as VU under B2ab(ii)(iv)(v) as it is undergoing continued decline, and is now found at only 8 locations, with an AoO of less than 2000km².

Threats Grassland improvements and disruption or cessation of dung availability, in particular during the breeding season, will contribute to the decline of this species. The treatment of livestock with endectocides will be detrimental, reducing adult fecundity and survival and increasing mortality rates in larvae. A number of the post-2000 sites are SSSIs or NNRs, but some are unprotected. Regardless of the location's status, subtle changes in grazing regimes or, at worst, complete cessation of grazing, could significantly damage a population or potentially cause localised extinctions. As these populations become more isolated (e.g. Lakenheath, Northam Burrows, Camber Sands and Greatstone), recovery from such population crashes are increasingly unlikely.

Management and Conservation At sites where grazing exists, site managers should be encouraged to continue this practise, preferably with traditional breeds of livestock. Targeted surveys should continue at the species former sites. Monitoring of extant populations would be desirable to assess population sizes and their ecology. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Britton (1956); Emden (1941); Fowler (1890); Harde (1998); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Löbl & Smetana (2006).

ONTHOPHAGUS TAURUS
REGIONALLY EXTINCT
Order COLEOPTERA
Family SCARABAEIDAE

Onthophagus taurus (Schreber, 1759)

Identification *Onthophagus taurus* is a large uniformly dull black *Onthophagus* species. The front angles of the pronotum exhibit regular rather than sinuous lateral margins and the male has two backwardly-directed horns on its head. There are difficulties in separating this from *Onthophagus illyricus* Scopoli, and historic material should be re-examined. The adult is keyed by Britton (1956), Jessop (1986) and Baraud (1992). The larva is keyed to genus in Emden (1941) and Jessop (1986) and keyed to species in Klausnitzer & Krell (1996).

Distribution Formerly rare in the region. Recorded in the database from the New Forest (Denny Bog SSSI) pre-1839, for which Fowler (1890) gives 'in dung, Brockenhurst and Lyndhurst, very rare and somewhat doubtfully indigenous'. The Brockenhurst specimen dates from October 1824 and was a female taken by the side of a path (Allen, 1967). Jessop (1986) also cites Exmouth (pre-1867) and Oxford (pre-1841). The Oxford record relates to a pair *in cop*, taken in the garden of *Corpus Christi* College, Oxford (Allen, 1967). Allen (1967) summarises the records of this species by stating that 'It may have been resident for a time in the New Forest and the Exmouth district, and just possibly near Oxford; but whether the specimens were immigrants or their progeny, members of established colonies through introduction, or the remnants of indigenous stock, can only be conjectured'.

A specimen in Leicestershire Museum collected by F.A. Hunter labelled '*O. verticicornis* Epping Forest 1 June 1951' was re-identified as *O. taurus*, but is believed, after much research by the authors to be unreliable and erroneously labelled. Significantly or otherwise, Allen (2001) reports a specimen found in the Knightwood Inclosure of the New Forest at Lyndhurst in August 1967, a 'well-developed male' which remained in a private collection until identified by him. The authors are particularly concerned about the provenance of this record and await a convincing argument that validates the circumstance of its origin.

According to Jessop (1986) this species is not uncommon in the Channel Islands despite there being no recent published records (personal observations). Widespread in the Palaearctic Region, recorded from: Albania, Armenia, Austria, Azores, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Lithuania, Luxembourg, Macedonia, Netherlands, Poland, Portugal, Romania, Russia (Central European Territory, South European Territory), Slovakia, Slovenia, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. North Africa: Algeria, Egypt, Libya, Morocco and Tunisia. Asia: Afghanistan, Cyprus, Iran, Iraq, Israel, Kyrgyzstan, Kazakhstan, Syria, Tajikistan and Turkey. China (Xinjiang Province) (Löbl & Smetana, 2006).

Habitat and Ecology This species inhabits pasture where it feeds on and in dung. Pairs of beetles excavate branching galleries beneath the dung. The galleries terminate in brood chambers which are provisioned with dung on which the female oviposits (Harde, 1998). Adults have been recorded in our region in August and October.

Status The 1967 record from the New Forest invites speculation that *Onthophagus taurus* far from becoming extinct in the 1800s, has been present in the region in South Hampshire all along, at very low population density. Unfortunately, the authors have little confidence in this record and consider it to be presently unreliable.

The species is present in the fossil record. However, there has been some confusion between this and the closely related *O. illyricus* Scopoli (Robinson, 2013) in the Holocene record. There is the possibility that some if not many of the fossil records for *O. taurus* are in fact *O. illyricus* which is more widespread than the former species in northern Europe. *O. taurus* has a more south European distribution (Ljunberg 2002). One of the three 'British' specimens of *O. taurus* housed in the Hope Entomological Collections (OUMNH) was re-determined as *O. illyricus* (unpublished observations) and the authors recommend re-examination of specimens in museum collections to check the identification of *O. taurus*.

The last unequivocal record of this species in GB was mid 19th century (Jessop 1986) and it therefore qualifies as Regionally Extinct.

Threats None known. The cause of the regional extinction is unknown. Agricultural intensification, pasture improvement and cessation or interruption of continual grazing by cattle may all have contributed to the probable extinction of this species.

Management and Conservation If rediscovered, sites management should be considerate to the dung fauna. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Allen (1967); Allen (2001); Baraud (1992); Britton (1956); Emden (1941); Fowler (1890); Jessop (1986); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Ljunberg (2002); Robinson (2013).

ONTHOPHAGUS VERTICICORNIS
REGIONALLY EXTINCT
Order COLEOPTERA
Family SCARABAEIDAE

Onthophagus verticicornis (Laicharting, 1781)
Onthophagus nutans (Fabricius, 1787): Hyman, 1992

Identification This species is an all-black *Onthophagus* with sinuous anterior margins to the pronotum. Compared to the other *Onthophagus* species, it is relatively large at 6.0-11.0mm. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to genus in Emden (1941) and Jessop (1986) and to species in Klausnitzer & Krell (1996).

Distribution Historically known from North Somerset (Little Solsbury Hill (ST76), 1886 and Bath, 1887), Glamorgan (Swansea) and Essex (Chingford and Walthamstow – the latter probably erroneous (unpublished observations). Hyman (1992) also cites West Kent, which possibly relates to a Darenth Wood record. The Scarabaeoidea dataset lists some presumed erroneous records from Leicestershire (Uppingham) and Glamorgan (Merthyr Mawr Warren and Mynydd Maendy) in the 1960s and 1980s as well as a more plausible record, from Monks Wood NNR (Hunts.) in 1873 (Telfer, M.G. pers. comm.). The species probably became extinct in the early 20th Century as the last reliable record is from Milbourne St Andrew, Dorset in 1926. Most existing Museum specimens of purported British origin are without locality and date.

Widespread in the Palaearctic Region, recorded from: Albania, Armenia, Austria, Belgium, Bosnia Herzegovina, Bulgaria, France, Croatia, Great Britain, Germany, Georgia, Greece, Italy, Luxembourg, Macedonia, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Russia (South European Territory), Switzerland, Ukraine and Yugoslavia. Asia: Iran, Syria and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology In Britain, this species is associated with open pasture on sheep dung. On the continent, this species is regarded as eurytopic, though avoiding coastal areas (Lumaret, 1990) and has been recorded from a wide variety of dung, including that of cattle, horse, badger and human. Adults have been recorded in our region in May, although on the continent it is known to be active from April to July (Lumaret, 1990).

Status *Onthophagus verticicornis* is a relatively large and conspicuous dung beetle. The lack of records in Britain for over 90 years is a very strong indication that it is regionally extinct.

Threats None known. The cause of the regional extinction is unknown. Agricultural intensification, pasture improvement and cessation or interruption of continual grazing by cattle may all have contributed to the probable extinction of this species.

Management and Conservation If rediscovered, site management should take into consideration the conservation of dung fauna. Environmentally sensitive farming, with limited grassland improvements and minimal or no reliance on endectocide applications will be beneficial to populations reliant on livestock dung.

Published Sources Britton (1956); Emden (1941); Jessop (1986); Joy (1932); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Lumaret (1990).

PLEUROPHORUS CAESUS
REGIONALLY EXTINCT
Order COLEOPTERA
Family SCARABAEIDAE

Pleurophorus caesus (Creutzer in Panzer, 1796)

Identification A small beetle, characterised by a combination of the lack of transverse ridges on the outer edge of the hind tibiae, the lack of transverse ridges and depressions on the pronotum and the hind tarsi length being as long as the hind tibiae. The adult is keyed by Britton (1956) and Jessop (1986). The larva is keyed to genus in Klausnitzer & Krell (1996).

Distribution Historical localities from the literature are 'near Bristol', and Pentire Point, Cornwall (Stephens, 1830). Hyman (1992) gives Glamorgan as a locality, and it has also been recorded from Tresco, Scilly Isles in October 1890 when two or three specimens were taken (Dale, 1896). Jessop (1986) lists Southport as a historical site, but this record is associated with Sidebotham, a known originator of spurious records (Morris & Johnson, 2005, Darby, 2009). Recently imported on celery; Huntingdon, Cambridgeshire in 1997 (Eversham, B.E., pers. comm.). This species may still persist on the Scilly Isles.

Widespread in the Palaearctic Region, recorded from: Azerbaijan, Austria, Azores, Bosnia Herzegovina, Bulgaria, Croatia, Czech Republic, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Kazakhstan, Luxembourg, Malta, Macedonia, Poland, Portugal, Romania, Russia (South European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. North Africa: Algeria, Canary Islands, Egypt, Morocco, and Madeira Arch., Tunisia. Asia: Israel, Japan, Kazakhstan, Russia (North European Territory), Turkey and Uzbekistan (Löbl & Smetana, 2006).

Habitat and Ecology A thermophilous species requiring warm sites for development. In our region it has been reported from dry, sandy areas on the coast. Associated with plant debris and probably at the roots of plants. Jessop (1986) notes that the species should be looked for in vegetable detritus and flood debris on sandy soils. In central Europe, the beetle is found under dry cattle dung and decaying vegetation (Harde, 1998). In France, Lumaret (1990) describes this species as occurring in dry and open areas, under plant debris, in manures and potting soil. Also found in dung of horse and sheep. It has also been found under debris at the edge of temporary pools on dune systems (unpublished observations). Lumaret (1990) records this species throughout the year, but with a peak activity period between April and July.

Status Described by Fowler (1890) as 'somewhat doubtful as British'. Hyman (1992) describes it as 'Presumed extinct and possibly never a true native'. The species has been reported as a pest of crops in the USA where it was introduced in 1871 (Cartwright, 1948). If it was ever indigenous to Britain, which is doubtful, it appears to be extinct.

Threats None. The cause of any regional extinction is unknown.

Management and Conservation None.

Published Sources Britton (1956); Cartwright (1948); Dale (1896); Fowler (1890); Harde (1998); Hyman (1992); Jessop (1986); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Lumaret (1990); Stephens (1830).

POLYPHYLLA FULLO – Pine Chafer
REGIONALLY EXTINCT
Order COLEOPTERA
Family SCARABAEIDAE

Polyphylla fullo (Linnaeus, 1758)

Identification This large and unmistakeable chafer has distinctive mottled dark brown and white elytral patterning. The adult is keyed by Jessop (1986) and Baraud (1992). The larva is figured and keyed to genus in Klausnitzer & Krell (1996).

Distribution A number of specimens were collected on the Kent coast before the mid-1800s, perhaps up until 1869, most on the Deal and Sandwich dune systems (e.g. eight specimens in that area in July 1815 (Allen, 1967). Stephens (1830; 1839) cites the distribution as 'sandy places between Hythe and Ramsgate….Deal, Sandwich, Margate, Dover, Hythe'. Historically there is a report of one (an adventive?) captured at St Leonard's, Sussex in 1902. More recently, a singleton was observed at Lappel Bank, Port of Sheerness, East Kent in 2012 (Telfer, M.G. pers. comm.), This presumed import was caught outside the CapeSpan pack-house. Another imported specimen was captured in Leicestershire at Braunstone in 2006 (Skevington, M. & Calow, G. pers. comm.). The view of the authors is that this large, conspicuous beetle, had it been present in Britian, would have been noted. This and the finding of the species at an import pack house supports the view that this specimen arrived in Britain as a result of human interaction.

A widespread species in Europe, recorded from: Albania, Armenia, Austria, Belgium, Bosnia Herzegovina, Bulgaria, Belarus, Croatia, Czech Republic, Denmark, France, Great Britain, Germany, Georgia, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Macedonia, Netherlands, Poland, Romania, Russia (Central European Territory, South European Territory), Slovakia, Slovenia, Spain, Russia, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia (Löbl & Smetana, 2006).

Habitat and Ecology *Polyphylla fullo* is an inhabitant of coastal sandhills, where larvae feed in soil at the roots of plants. Adults are phytophagous on various plants and are considered to be harmful to some crops (Keller & Zimmermann, 2005). They are active fliers in the evening and have been recorded from June to August and in November.

Status The species occurs on the coast in France, Holland and Belgium, therefore the historical records in England could have resulted from chance immigration. Allen (1967) however produced a convincing argument that it was not immigrants that were collected in the 1800s but representatives of an indigenous Kent coast population that subsequently died out. Allen (1967) argued that if the species was imported, then it was odd that it only occurred on a small stretch of coastline and that records abruptly ceased around 1850. Allen (1967) also asserted that the population could be native, because immigration would likely have resulted in more widespread dispersal and again, it is strange that immigration should have ceased around 1850. Allen (1967) noted that the habitat at the Kent sand-hill locations was very similar to that of its occupied habitats on the coastal fringes of France and Belgium. This distinctive species should be regarded as an extinct native.

Threats None. The cause of regional extinction is unknown.

Management and Conservation None. It is possible this species may re-colonise England in the near future, either through assisted importation or immigration. Mark Telfer (pers. comm.) noted individuals in flight over the sea along the Atlantic coast on the French mainland and noted that this species, like others chafers is a strong flyer.

Published Sources Allen (1967); Baraud (1992); Jessop (1986); Keller & Zimmermann (2005); Klausnitzer & Krell (1996); Löbl & Smetana (2006); Stephens (1830); Stephens (1839).

PSAMMODIUS ASPER
NEAR THREATENED
Order COLEOPTERA
Family SCARABAEIDAE

Psammodius asper (Fabricius, 1775)

Identification This small dark species is recognised by the five or six strongly impressed transverse furrows on the pronotum, the thick longest hind tibial spur which is longer than the combined length of the first two tarsomeres and the course of the tenth interval of the elytra which extends into the apical half of the elytra. The adult is keyed by Joy (1932), Britton (1956) and Jessop (1986). The larva is keyed to species in Klausnitzer & Krell (1996).

Distribution Predominantly coastal with very few validated inland records. Recently found at five dune systems in England and Wales, and at one coastal sand and shingle site. The localities and most recent record dates are: Formby, Lancashire (SD20, 2008), an inland dune system south of the Humber estuary at Risby Warren NR North Lincolnshire (SE91, 1992), Poppit Dunes, Pembrokeshire (SN14, 1999), Northam Burrows NR, North Devon (SS43, 2011), Merthyr Mawr, Glamorgan (SS87, 1999) and Dungeness/Lydd, East Kent (TR01 and TR02, 2000 and 2012).

There are four inland sites in the database; East Wretham Heath NR (TL98) in the West Norfolk Brecks in 1911, Thetford Warren (TL88) in the West Suffolk Brecks in 1895, Aylesford Sandpit (TQ75) in West Kent in 1972 and Yarwell Quarry (TL09) in Northamptonshire in 1988. Although these inland records are not disputed, future confirmation of their validity is desirable. Hyman (1992) also cites West Gloucestershire pre-1970.

Widespread in the western Palaearctic Region, recorded from: Austria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Great Britain, Germany, Hungary, Italy, Kazakhstan, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russia (Central European Territory, North European Territory), Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and Yugoslavia. Asia: Iran, Kazakhstan, Mongolia and Turkey (Löbl & Smetana, 2006).

Habitat and Ecology Stenotopic, usually on exposed sites with sandy soils (Landin, 1961). *Psammodius asper* is saprophagous, feeding on detritus in the soil. In Britain it found almost exclusively in sandy coastal areas, including dunes, sand-hills and sandpits (and rarely on inland gravel pits). Adults are nocturnal occurring in and on sand at the roots of plants, under debris and have been found under seaweed on the strandline. Occasionally found in numbers trapped in dune blowouts in spring. Sometimes found in association with rabbit dung, for example it has been collected at Dungeness by sieving surface soil under rabbit dung (Telfer, M.G. pers comm.). It has also been noted at the roots of prostrate plants in sandy areas, under debris and rocks on sand dunes and on the banks of sandpits. Adults have been recorded from March to June and August to October. Adults hibernate, and it is likely this species is bivoltine.

Status Formerly more widespread, with coastal records from North Devon (Woolacombe and Braunton Burrows) until 1967, East Sussex (Bournes Field/Castle Water area) until 1986 and Somerset (Burnham on Sea), Yorkshire (Scarborough) and Fife (Tay district), the latter three sites all pre-1900. Within Lancashire, Pembrokeshire, Glamorgan and Kent, more dune sites were occupied historically than at present indicating localised range contraction. There is a 70% decline in the number of occupied habitats between the two main recording periods and a decline of 43% between the two recent 16-year periods. This is indicative that the historical decline undergone by this species may be ongoing. However, the beetle can be difficult to find (unpublished observations) and for this reason it is likely to be under

recorded. There have been no targeted surveys at its former haunts, nor have there been attempts to evaluate spatial distribution of populations, so any decline is purely speculative. The populations may well be stable. Due to the high probability of under recording, the species is designated NT.

In summary, this species qualifies as NT because although it would satisfy the criteria for VUB2a,bii,biv with only 6 modern locations (if continued decline were proven), it is thought to be under recorded.

Threats Most of its present sites are vulnerable to coastal erosion events such as tidal surges. In addition, succession of vegetation to scrub may cause deterioration of suitable habitat. The majority of current sites are protected SSSIs and NRs.

Management and Conservation Targeted surveys for this species in suitable coastal habitat would be useful to gain a better understanding of its current distribution. In particular, clarification of inland records in eastern England and East Anglia is desirable. Management for this species on coastal sites should focus on grazing or mechanical disturbance to maintain open conditions and minimise scrub encroachment.

Published Sources Britton (1956); Jessop (1986); Joy (1932); Landin (1961); Klausnitzer & Krell (1996); Löbl & Smetana (2006).

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Appendix 1: Summary Table - An alphabetical list of the stag beetles, dor beetles, dung beetles, chafers and their allies – Lucanidae, Geotrupidae, Trogidae and Scarabaeidae (note: more information is included in the accompanying Excel spreadsheet)

Species Name	GB IUCN Status (2016)	Qualifying criteria	Rationale	GB Rarity status (2016)	Presence in England	Presence in Scotland	Presence in Wales	AoO (hectads) <1990	AoO (hectads) 1990-2015	AoO (tetrads) 1990-2015	No. of Locations 1990-2015
Aegialia arenaria	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid. There are no perceived threats specific to this species.		E	S	W	88	82		
Aegialia insularis	LC		No perceived threats specific to this species.	NS	E	S	W	47	33		
Aegialia rufa	EN	B2ab(ii,iv)	Assuming that the two post-1990 locations are still occupied, the overall AoO is 8km squared. Populations may exist at low density making detection difficult. The species is regularly targeted by Coleopterists (pers obs). Designation EN is satisfied by continuing decline and 5 or fewer modern locations.	NR	E		W	6	2	3	2
Amphimallon fallenii	NT		Evidence of continuing decline with a reduction from 21 to 15 hectads in the main date period counts and from 14 to 7 hectads between the date periods (1984-1999) and (2000-2015). However, its recorded presence in 15 post-1990 hectads means that it fails to satisfy the criteria for IUCN Category VU. NT is advised. Threats come from coastal erosion, changes in land use and tourism.	NR	E		W	21 (22)	15 (16)	22	20

Amphimallon solstitiale	LC		No perceived threats specific to this species.		E		W	83	153		
Anomala dubia	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid. There are no perceived threats specific to this species.		E	S	W	77	64		
Anoplotrupes stercorosus	LC		No perceived threats specific to this species.		E	S	W	190	189		
Aphodius arenarius	NT		Since 1990, only known with certainty from the Carmarthenshire coast, Wales, from The Brecks in Norfolk and from East Kent (including the Kent Downs) – seven sites in total and five hectads. Possibly under recorded.	NR	E		W	21 (26)	5 (6)	5 (7)	6 (7)
Aphodius ater	LC		No perceived threats specific to this species.		E	S	W	317	458		
Aphodius borealis	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid. There is no evidence of decline and no perceived threats specific to this species.		E	S	W	44	57		
Aphodius brevis	CR(PE)	B2ab(ii,iv)	This has always been a rare taxon in Britain with a highly restricted range. Although the species possibly exists at low population density and hence may be difficult to detect, it has suffered a historical decline, has not been seen since 1995, and currently has an AoO of only 8km squared or substantially less and only the one location in Britain.	NR	E			2	2	2 (?)	1
Aphodius coenosus	LC		No perceived threats specific to this species.	NS	E		W	30	28		
Aphodius conspurcatus	LC		Likely to be under recorded as it is an autumn to spring active species, hence the post-1990 hectad count of 31 is likely to significantly underestimate its current status. There are no perceived threats specific to this species.	NS	E	S	W	48	31		

Aphodius consputus	LC		Since 1990, almost entirely restricted to the south-eastern tip of England. The species is however likely to be under recorded, partly because it is winter-active, when less fieldwork is undertaken and partly because Coleopterists have returned to 'known localities' in search of specimens rather than surveying for the species at new sites.	NS	E		W	20	21	21	21
Aphodius constans	LC		No perceived threats specific to this species.	NS	E	S	W	66	31		
Aphodius contaminatus	LC		No perceived threats specific to this species.		E	S	W	245	293		
Aphodius depressus	LC		No perceived threats specific to this species.		E	S	W	153	273		
Aphodius distinctus	LC		Widespread historical range contraction and decline across much of the region with further ongoing localised declines in the last two decades. Currently restricted to a small patch of Sherwood Forest, Nottinghamshire, from East Anglia, from Worcestershire and from the Corallian sands in Berkshire/Oxfordshire, but it can be abundant in some of these regions. This is clearly a highly localised species, but fails the criteria for IUCN categorisation.	NS	E	S	W	89	38		
Aphodius erraticus	LC		No perceived threats specific to this species.		E		W	124	113		
Aphodius fasciatus	LC		There is a danger of over-estimating the regional rarity of this species. Hectad counts are of only 14 hectads for the pre-1990 period and 10 for the 2000-2015 period, but this is a localised northern and western species and the Midland/north England counties of Derbyshire, North Cheshire and Staffordshire are, like Scotland, relatively poorly recorded for this genus, Also, woodland dung beetles like *fasciatus* are generally less easy to locate than those which frequent open sites like pasture.	NS	E	S	W	38	14	15	15
Aphodius fimetarius	LC		No perceived threats specific to this species.		E	S	W	6 (data deficient)	54 (data deficient)		

***Aphodius fimetarius* agg**. (comprising *Aphodius fimetarius* and *pedellus*)	n/a				E	S	W	256	273		
Aphodius foetens	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid. There are no perceived threats specific to this species.		E	S	W	104	78		
Aphodius foetidus	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid.		E	S	W	48	90		
Aphodius fossor	LC		No perceived threats specific to this species.		E	S	W	217	286		
Aphodius granarius	LC		No perceived threats specific to this species.		E		W	136	199		
Aphodius haemorrhoidalis	LC		The distribution appears to be stable with no perceived threats specific to this species.		E	S	W	122	157		
Aphodius ictericus	LC		The species is likely to be under recorded but within some well-recorded areas of the region, a decline is indicated in the main data count period. For example, it was recorded from 19 TQ/TR/TV hectads in south-east England before 1990 and only 10 since 1990. This 48% reduction in hectads is reflected, albeit less markedly, in the National trend as seen from the main period hectad count. In the second period (1984-2015), the decline appears to have halted with the number of hectads in each 16-year period being of similar magnitude. Any declines in the south-east appear to have been offset in this recent period by new populations discovered in the East Anglian Brecks up into north-west Norfolk and also in Berkshire. No perceived specific threat.	NS	E	S	W	67	47		
Aphodius lapponum	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-		E	S	W	81	57		

			recorded and is likely to be present currently in more than 100 hectads of the National grid. There are no perceived threats specific to this species.								
Aphodius lividus	VU	B2ab(ii,iv)	A species of sporadic occurrence that has always been scarce and highly localised in distribution and continues to be so. The species may exist at low populations and thus be difficult to detect, but it appears nonetheless, that it is critically localised and perhaps currently only present at a handful of sites in southern England. Historical decline is evident from the data with a reduction of around 70% in occupied hectads between the two recording period in the main date ranges and further decline in the last 32 year period of 25% between the two 16-year date ranges.	NR	E		W	23	6	7	6
Aphodius luridus	LC		No perceived threats specific to this species.		E	S	W	84	123		
Aphodius merdarius	LC		Although still present in most regions, significant decline has caused it to become highly localised and much fragmented throughout its range.	NS	E	S	W	120	34		
Aphodius nemoralis	DD		This is a difficult species to locate because its typical habitat of grazed upland and montane woodland may be difficult to access and woodland *Aphodiines* are generally more difficult to find than those in open habitats (pers obs.). Its main area of distribution (Scotland and northern England) is also poorly recorded, so although there are only nine post-1990 hectads for the species, we can conclude that it is likely to be more widespread than this paucity of records might indicate.	NS	E	S	W	17	9	9	9
Aphodius niger	LC		Within a restricted distribution, this species appears to be stable, if not increasing and there are no obvious threats. Where it occurs, it can be abundant (Mann & Garvey, 2014). The latter authors suggest that further populations are certain to be discovered across the New Forest and possibly elsewhere in central southern England.	NR	E			?1	6	12	13

Aphodius obliteratus	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid.		E	S	W	90	78		
Aphodius paykulli	NT		The species is likely to be under recorded because it is winter active. It is nonetheless highly localised (though still widespread) and this geographically-fragmented population is possibly subject to continuing localised declines, although the lack of targeted searches in known haunts makes this difficult to prove.	NR	E	S	W	60	10	13	11
Aphodius pedellus	LC		Under recorded due to the recent discovery that 'fimetarius' in Britain comprises the present species and *Aphodius fimetarius sensu stricto* (Wilson, 2001). From reliably recorded specimens, the species appears to have a wider distribution than *fimetarius* and may also be more frequent than that species (pers. obs.). *A. pedellus* is found across southern England, north to the Midlands and northern England, into Wales and also sparingly in mainland Scotland. Like *fimetarius*, it also inhabits the Outer Hebrides and the Ebudes. Interestingly, the distribution pattern suggests that the species might be more-or-less coastal north of Midlands England, but this may simply reflect recording bias.		E	S	W	5 (data deficient)	99 (data deficient)		
Aphodius plagiatus	LC		This species appears to be as widespread and frequent since 1990 as formerly. The fact that it has no dependence on dung is likely to be a contributory factor in its regional stability. No perceived threats specific to this species.	NS	E	S	W	34	28		
Aphodius porcus	NT		Significant decline and range contraction is indicated and ongoing. There is an approximately 60% decline in recorded hectads in the main date period and one of approximately 25% in the second date period (1984-2015). The species may be very sensitive to pasture improvement and the use of endectocides.	NR	E	S	W	39	12	14	16
Aphodius prodromus	LC		No perceived threats specific to this species.		E	S	W	253	472		

Aphodius punctatosulcatus	RE		A number of specimens found in Museum collections were collected around Deal, East Kent in the early part of the 20th Century and also from West Kent (Hodge, 2000).		E			2	0		
Aphodius pusillus	LC		No perceived threats specific to this species.		E	S	W	128	145		
Aphodius quadrimaculatus	CR	B2ab(ii,iv)	Last recorded in the region from East Sussex in 1988 on the South Downs. Some 27 years have elapsed since this discovery, but rediscovered in England in 2016, outside of the scope of this Review.	NR	E	S	W	12	0	0	0
Aphodius rufipes	LC		No perceived threats specific to this species.		E	S	W	355	447		
Aphodius rufus	LC		No perceived threats specific to this species.		E	S	W	160	223		
Aphodius scrofa	RE		Regionally Extinct.		E			3	0	0	0
Aphodius sordidus	VU	B2ab(ii,iv)	Known from only 10 locations since 1990. Examples of ongoing decline are proven, though not throughout. The loss from at least one and possibly both of its two recent Suffolk sites represents a 10-20% decrease in our region's currently known population.	NR	E	S	W	41	9	10	10
Aphodius sphacelatus	LC		No perceived threats specific to this species.		E	S	W	236	376		
Aphodius sticticus	LC		No perceived threats specific to this species.		E		W	135	203		
Aphodius subterraneus	CR(PE)	B2ab(ii,iv)	Not certainly recorded in Britain for 60 years and probably extinct.	NR	E		W	70 (71)	0	0	0
Aphodius varians	RE		Near Windsor and Ripley, Surrey before 1839 and possibly also reliably recorded from Swansea, 1899 (Allen, 1967).					3	0	0	0
Aphodius zenkeri	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid.		E		W	43	62		

Brindalus porcicollis	CR	B2ab(ii,iv), C2a(ii)	Its only British site is highly vulnerable to tidal surge events and erosion and also to disturbance or destruction by tourists. The beetle appears to be restricted (within the whole expanse of beach) to a tiny patch and is at very low abundance such that it can be very difficult to find and record (pers obs.). A designation of CR B2a,b is advised based on a projected decline in the area of occupancy due to the site having no protection from destruction by human activities and by its area of occupancy being significantly less than 10km squared.	NR	E			1	2	2	1
Cetonia aurata	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid.		E	S	W	65	81		
Copris lunaris	CR(PE)	B2ab(ii)(iv)	This is a large, conspicuous and distinctive beetle and its burrow excavations are voluminous and distinctive. It is also attracted to light, so the fact that no Lepidopterists in the Somerset region have reported it further indicates that it is likely to be extinct. In 2009, AGDuff and DJMann visited some of the species' 1970s sites in Somerset and observed that grazing had ceased and there may have been a degree of improvement to the pasture. Although the pasture itself was probably still in suitable condition, the animal husbandry or lack of, on site was no longer sympathetic to the continued existence of the species.	NR	E			19	0	0	0
Diastictus vulneratus	VU	D2	Despite recent pitfall trapping programmes at both Weeting Heath and Stanford, the species has not been rediscovered at these sites. At Cranwich, the site where it has most recently been found and where it has been found most frequently, it is actually very difficult to find (pers obs.) and is evidently at low population levels and vulnerable to changes in the nature of the grassland.	NR	E			3	3	4	4
Dorcus parallelipipedus	LC		No perceived threats specific to this species and no decline observed.		E		W	152	334		

Euheptaulacus sus	VU	D2	The species has not been rediscovered at its one Scottish locality (Dalmeny Park) since 1985, but may still persist there. Its main stronghold is at Northam Burrows NR in North Devon in an area of sheep and horse-grazed coastal grassland covering less than 2 square kilometres. The East Kent, Norfolk and Suffolk Breckland sites are smaller, comprising pasture grassland.	NR	E	S	W	17	4	5 (6)	4
Euheptaulacus villosus	LC		Although a historical decline is evident from the data with a 57% decrease in hectads between the pre-1990 and post-1990 recording periods, no continuation of decline is apparent in the recent 32-year period. Whilst IUCN Categories do not apply, the species is close to a regional designation of Near Threatened.	NS	E	S	W	44	19	23	18
Geotrupes mutator	NT		Only known from 11 modern hectads. Historical decline inferred from 62% reduction in hectads (AoO) between the two main date ranges, though no recent decline proven as there have been no targeted surveys to rediscover the species at former locations.	NR	E		W	38	11	13	13
Geotrupes spiniger	LC		No perceived threats specific to this species.		E	S	W	141	189		
Geotrupes stercorarius	LC		No perceived threats specific to this species.		E	S	W	200	230		
Gnorimus nobilis	VU	A2c	See Species Account Sheet for Rationale	NS	E			39	35	106	13 minimum
Gnorimus variabilis	EN	B2ab(iii)	Known from 5 hectads and from four counties, but recently (post-1990) only from 2 hectads in 2 counties. At Windsor Forest and Great Park, it is known since 2000, to have occupied suitable habitat in 5 tetrads and 6 x1km squares (an additional 2 x 1km squares, but not hectads, pre-1990). At Parham, it is known from 2 tetrads and 2x1km squares. This gives an estimate of AoO of 24 square kilometres. The Windsor Forest population is likely to comprise meta-populations, but the exact interaction between these is not known as no research has been carried out on them. This species qualifies as Endangered under criterion B2ab(iii). Gnorimus variabilis is present in only two locations (B2a)	NR	E			4	2	7	2 (?)

			in Britain and, although there is no direct decline detected, it's habitat, heartwood decay in veteran trees, is declining (Alexander, 2014). It therefore also qualifies under B2biii.								
Heptaulacus testudinarius	CR(PE)	B2ab(ii,iv)	There being no reports for over 35 years, the species is probably extinct in the region. Attempts have been made to rediscover it at the Lyndhurst site, but to date these have been unsuccessful, despite the continuation of grazing here (pers obs.). The reasons for its decline are not understood, but habitat fragmentation, dung availability and the use of endectocides are possibly contributory factors. Collecting may also have taken its toll.	NR	E	S	W	19	0	0	0
Hoplia philanthus	LC		No perceived threats specific to this species.		E	S	W	80	125		
Lucanus cervus	LC		Although the species is clearly Nationally Scarce, it does not appear to be at risk of extinction and the declines observed from the data are mostly historic.	NS	E		W	165	49		
Melolontha hippocastani	LC		This large and distinctive species is highly localised and likely to be under recorded because of its primarily Scottish distribution. There is no proven recent decline. There are only 6 post-1990 locations but there are no obvious threats so the species does not satisfy the criteria for VU. Designation as NT is advised.	NR	E	S	W	16	6	6	6
Melolontha melolontha	LC		No perceived threats specific to this species		E	S	W	228	430		
Odonteus armiger	LC		This species is likely to be under reported as most records are from light traps and these are usually operated by Lepidopterists whose primary motivation is to record moths. For this reason, the total of 26 post-1990 hectads is thought to be a gross under-representation of the species' true distribution. Historical decline only. No perceived threats specific to this species.	NS	E		W	25 (26)	26		

Omaloplia ruricola	LC		No perceived threats specific to this species	NS	E		W	43	44		
Onthophagus coenobita	LC		No perceived threats specific to this species.		E		W	66	133		
Onthophagus fracticornis	VU	D2	The species may be locally extinct in Wales and Cornwall. The regional status of this species in England may look healthy, until it is realised that four of the nine post-2000 Somerset sites are all one location and relate to the same hill formation. The Wavering Down colony is the strongest (pers. obs.) and the other 'satellite' populations are likely to depend on the health of this core population. DJMann surveyed 16 'sites' in suitable habitat for this species over a 5-year period (2009 – 2013) and only found *fracticornis* at 6 of them; further evidence that even in suitable habitat, the species is highly localised and restricted.	NR	E		W	6 (8)	3	9	5
Onthophagus joannae	LC		No perceived threats specific to this species.		E	S	W	79	123		
Onthophagus medius	LC		Ongoing decline in terms of range contraction is suspected but difficult to prove throughout its range and under recording is likely. Whilst IUCN Categories do not apply, the species is close to a regional designation of Near Threatened.	NS	E		W	42	16	17	16
Onthophagus nuchicornis	VU	B2ab(ii,iv,v)	This species has been the subject of intensive target surveys at its North Devon, Breckland and Welsh sites by Darren Mann in the last ten years. The hectad counts over the last thirty-two year date period, appear to indicate that the population has remained more-or-less static. However, due to the survey work carried out by Darren Mann, we can detect an evident continuing decline within the last 15 years. Of the nine locations from which this species has been recorded since 2000, it has disappeared from two since 2005.	NR	E		W	25 (52)	13 (14)	18	12

Onthophagus similis	LC		No perceived threats specific to this species.		E		W	99	159		
Onthophagus taurus	RE		Formerly rare in the region and only recorded in the database from the New Forest (Denny Bog SSSI) pre-1839. Jessop (1986) also cites Exmouth (pre-1867) and Oxford (pre-1841).		E			1	0	0	0
Onthophagus verticicornis	RE		Historically known from Somerset (Bath), Glamorgan (Swansea) and Essex (Chingford and Walthamstow). Hyman (1992) also gives West Kent.		E		W	4 (5)	0	0	0
Oxyomus sylvestris	LC		Data analysis from the last two 16-year periods indicates that any decline is not ongoing. The species is often found in association with garden grass and compost heaps and like other species that occupy this habitat (e.g. the rove beetle *Philonthus jurgans*), it is likely to be under recorded.		E	S	W	62	35		
Oxythyrea funesta	NA		This species has established in the region very recently, following increasing recent reports of what were presumably imported 'adventives'.		E			5 (+)	6		
Phyllopertha horticola	LC		No perceived threats specific to this species.		E	S	W	135	259		
Platycerus caraboides	RE		Extinct in the region. There are only very old records, the latest being from Oxford (1830) and Windsor (1827).		E	S		8?	0		
Pleurophorus caesus	RE		Described by Fowler (1890) as 'somewhat doubtful as British' and stated by Stephens to be ' a rare species at least towards the eastern parts of Britain.		E			3	0	0	0
Polyphylla fullo	RE		A number of specimens were collected on the coast of Kent before the mid 1800s, perhaps up to 1869, most on the Deal and Sandwich dune systems (e.g. eight specimens in that area in July 1815 (Allen, 1967)). There is also a report of one (an adventive?) captured at St Leonard's, Sussex in 1902.		E			3 (+)	0		

Protaetia metallica	LC		Although only reported from 17 hectads in the period since 1990, the species is assessed as Nationally Scarce rather than Nationally Rare and as having no IUCN Status due to a high probability that it is under recorded in parts of its Scottish range.	NS	E	S		12	17		
Psammodius asper	NT		From available data, it appears that the species decline that occurred historically is ongoing, although the species can be difficult to find (pers obs.) and for this reason it is highly likely to be under recorded, so its populations may in fact be stable. Its present sites are vulnerable to coastal erosion events such as tidal surges. Due to the high probability of under recording, a designation of NT is advised.	NR	E	S	W	25	7	7	6
Rhyssemus germanus	NA		It is difficult to evaluate the true status of this species based on available data. It may be an indigenous species that has passed below the radar for a considerable time only to have been coincidentally found at a small number of sites in recent years due to favourable conditions affording a resurgence and expansion in the population. Conversely, the current populations could be the result of introductions and the historical populations either introduced themselves, or indigenous and historically wiped-out.	NR	E		W	2	4	4	4
Saprosites mendax	NA		An Australian species accidentally introduced into Sussex.		E			1	1		
Saprosites natalensis	NA		A South African species accidentally introduced into the London area.		E			0	5		
Serica brunnea	LC		No perceived threats specific to this species.		E	S	W	141	250		
Sinodendron cylindricum	LC		No perceived threats specific to this species and no decline observed.		E	S	W	142	287		
Tesarius caelatus	NA		A long-established introduced species that originates from North America.		E			3	3	3	3
Tesarius mcclayi	NA		An introduced species originating from North America.				W	0	2	2	2

Trichius fasciatus	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid.		E (?)	S	W	43	60		
Trichius gallicus	NA		This bee mimic chafer is currently established and increasing in the region. It may have been introduced, but there is no strong correlation in the data between the locations of records and proximal industrial estates or docks etc.		E			3	8		
Trox perlatus	RE		Known from Worbarrow Bay and Tyneham, Dorset where initially discovered in 1922 (Allen, 1967).		E			1	0		
Trox sabulosus	NT		Inferred historical decline and appears now to be restricted to three or four small areas of the region where it is thought to be difficult to find (e.g. Norfolk pers comm MJCollier). Very probably under recorded, with no known targeted survey for the species and for these reasons, a designation of Near Threatened only is advised.	NR	E	S	W	25	5	5	6
Trox scaber	LC		This species with records from less than 100 hectads since 31st December 1989, would normally qualify as Nationally Scarce (NS), but the authors believe that it is under-recorded and is likely to be present currently in more than 100 hectads of the National grid.		E	S	W	81	64		
Trypocopris pyrenaeus	LC		No perceived threats specific to this species.	NS	E		W?	23	21		
Trypocopris vernalis	LC		There are no immediate perceived threats specific to this species. A reduction of around 50% of hectads in the main recording period may simply reflect under recording, particularly in more northerly parts of its range, in Wales, northern England and Scotland.	NS	E	S	W	74	37		
Typhaeus typhoeus	LC		No perceived threats specific to this species.		E	S	W	136	170		

Appendix 2. IUCN Criteria and Categories

Summary of the five criteria (A–E) used to evaluate if a taxon belongs in a threatened category (Critically Endangered, Endangered or Vulnerable)

	Critically Endangered	Endangered	Vulnerable
A. Population reduction			
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%

A1. Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible **AND** understood **AND** have 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 (AOO), extent of occurrence (EOO) and/or habitat quality

(d) actual or potential levels of exploitation

(e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

A2. Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased **OR** may not be understood **OR** may not be reversible, based on (a) to (e) under A1.

A3. Population reduction projected or suspected to be met in the future (up to a maximum of 100 years) based on (b) to (e) under A1.

A4. An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a maximum of 100 years in future), and where the causes of reduction may not have ceased **OR** may not be understood **OR** may not be reversible, based on (a) to (e) under A1.

B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)			
B1. Extent of occurrence (EOO)	< 100 km²	< 5,000 km²	< 20,000 km²
B2. Area of occupancy (AOO)	< 10 km²	< 500 km²	< 2,000 km²

AND at least 2 of the following:

(a) Severely fragmented,

OR

Number of locations	= 1	≤ 5	≤ 10

(b) Continuing decline observed, estimated, inferred or projected in any of: **(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: **(i)** extent of occurrence; **(ii)** area of occupancy; **(iii)** number of locations or subpopulations; **(iv)** number of mature individuals.

C. Small population size and decline			
Number of mature individuals	< 250	< 2,500	< 10,000
AND at least one of C1 or C2:			
C1. An observed, estimated or projected continuing decline of at least (up to a maximum of 100 years in future): (up to a max. of 100 years in future)	25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2. An observed, estimated, inferred or projected continuing decline **AND** at least 1 of the following 3 conditions:			
(a i) Number of mature individuals in each subpopulation:	≤ 50	≤ 250	≤ 1,000
or			
(a ii) % of mature individuals in one subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals.			

D. Very small or restricted population			
Either:			
Number of mature individuals	< 50	< 250	**D1.** < 1,000
D2. *Only applies to the VU category*. Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.			**D2.** typically: AOO < 20 km² or number of locations ≤ 5
E. Quantitative Analysis			
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years