

**Red List of Fungi for Great Britain: *Bankeraceae*, *Cantharellaceae*,
Geastraceae, *Hericiaceae* and selected genera of *Agaricaceae*
(*Battarrea*, *Bovista*, *Lycoperdon* & *Tulostoma*) and *Fomitopsidaceae*
(*Piptoporus*)**

Conservation assessments based on national database records, fruit body morphology and DNA barcoding with comments on the 2015 assessments of Bailey *et al.*

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1. Foreword

The conservation assessments for 19 fungal genera presented in this report were developed from a Natural England (NE) funded project carried out by JHS until his untimely death on 3rd March 2014. The project report was completed and submitted to NE by AMA on 31st March 2015 and, after further work, was sent to JNCC on 4th June 2015 for approval as an official Red List. A second draft, addressing JNCC's comments and queries, was submitted on 21st July 2015. Several sections of standard text were inserted in the document between 23rd July and 11th September 2015 by NE in consultation with JNCC. They also adjusted the format to comply with the requirements for publication as a "review" under the auspices of the Species Status project. The aim of this project is for the UK's statutory nature conservation agencies, specialist societies and NGOs to initiate, resource and publish Red Lists and other status reviews of selected taxonomic groups for Great Britain which are then submitted to JNCC for accreditation.

On 23rd Aug 2015 the Fungus Conservation Trust, formerly the Association of British Fungus Groups, submitted a "Red Data conservation assessment" of exactly the same 19 genera to JNCC for accreditation (Bailey *et al.* 2015). Both assessments made exclusive use of IUCN Criterion D. Following a formal mediation process, JNCC declined to accredit the two assessments on 11th April 2016.

The passages of standard text inserted by NE were then deleted and the current report (i.e. Smith *et al.* 2016) documenting our 2015 assessment was first published online in April 2016. Comments relating to the assessments of Bailey *et al.* (2015), as submitted to the officially-appointed mediator on 6th November 2015, have been inserted where appropriate.

A.M. Ainsworth 18 April 2016

2. Background and Introduction to this Review

Following two unofficial fungal red-listing exercises in Great Britain (GB) by Ing (1992) and Evans *et al.* (2006), the first official Red List for British fungi was produced by Ainsworth *et al.* (2013). This was approved and published by the Joint Nature Conservation Committee (JNCC), which is significant because JNCC is a body approved by the International Union for Conservation of Nature and Natural Resources (IUCN) for quality-assuring regional Red Data Lists (RDL) such as those for GB. The taxonomic scope of the 2013 GB red-listing or, more accurately, conservation status assessment project, included all members (66 species and 2 varieties) of the Family *Boletaceae*, a well-known, conspicuous and popular group of macrofungi. This template has now been developed and used to assess a second tranche of well-known macrofungal groups comprising all known British representatives of four families and of five genera belonging to two other families. A total of 95 species were treated in the assessment reported herein.

2.1. Taxonomic scope and nomenclature

Following the approach of Ainsworth *et al.* (2013), the second tranche of relatively conspicuous fungal groups to be assessed was also selected from the *Basidiomycota*. Four families were prioritised for study partly based on their popularity among field mycologists and general naturalists and partly because, on the indications of previous RDLs (Ing 1992, Evans *et al.* 2006), they were expected to be relatively well-endowed with threatened species. The families are:

1. *Bankeraceae* tooth fungi dependent on woody plant roots (ectomycorrhizal symbionts, ECM)
2. *Cantharellaceae* chanterelles (ECM)
3. *Geastraceae* earthstars (litter recyclers, saprotrophs)
4. *Hericiaceae* wood-inhabiting tooth fungi (wood recyclers, saprotrophs)

All genera within the four families, as listed in the online checklist GBCHKLST maintained by the British Mycological Society (BMS), were selected for conservation assessments following the strategy used for assessing the *Boletaceae* (Ainsworth *et al.* 2013). An additional small group of genera was similarly targeted to represent two further families (*Agaricaceae* and *Fomitopsidaceae*) although it was not possible to assess all the genera within these large taxa during the current project.

The species assessed within the chosen genera were all those included as British in the freely-accessible online database (CBIB, <http://www.basidiochecklist.info/>) maintained by RBG, Kew. The most recent (sixth) update was published online during the course of this assessment (Ainsworth & Henrici 2015). This resource was also followed for nomenclatural purposes. However, additional data on fungi reported as occurring in GB and published elsewhere (e.g. *Tulostoma fimbriatum*) or communicated as unpublished observations were also used as appropriate.

All British species in the following 19 genera were assessed in the current project:

<i>Bankera</i> (<i>Bankeraceae</i>)	<i>Laxitextum</i> (<i>Hericiaceae</i>)
<i>Battarrea</i> (<i>Agaricaceae</i>)	<i>Lycoperdon</i> (<i>Agaricaceae</i>)
<i>Boletopsis</i> (<i>Bankeraceae</i>)	<i>Myriostoma</i> (<i>Geastraceae</i>)
<i>Bovista</i> (<i>Agaricaceae</i>)	<i>Phellodon</i> (<i>Bankeraceae</i>)
<i>Cantharellus</i> (<i>Cantharellaceae</i>)	<i>Piptoporus</i> (<i>Fomitopsidaceae</i>)
<i>Craterellus</i> (<i>Cantharellaceae</i>)	<i>Pseudocraterellus</i> (<i>Cantharellaceae</i>)
<i>Dentipellis</i> (<i>Hericiaceae</i>)	<i>Sarcodon</i> (<i>Bankeraceae</i>)
<i>Geastrum</i> (<i>Geastraceae</i>)	<i>Sphaerobolus</i> (<i>Geastraceae</i>)
<i>Hericium</i> (<i>Hericiaceae</i>)	<i>Tulostoma</i> (<i>Agaricaceae</i>)
<i>Hydnellum</i> (<i>Bankeraceae</i>)	

2.2. Data sources and preparation

The main data sources used in the *Boletaceae* assessment were the two national databases CATE2 managed by the Fungal Conservation Trust (FCT), formerly the Association of British Fungus Groups (ABFG), and FRDBI managed by the BMS (Ainsworth *et al.* 2013). Attempts were made to retain this partnership approach for a second tranche of British fungal conservation assessments, but these were unsuccessful due to the ongoing dispute between the BMS and ABFG/FCT regarding fungal recording and their “rival databases” (see p.237, Marren 2012). The current project team was not granted full (registered) access to CATE2 and so, using data that were made available to us, we worked with the FRDBI (full version), CATE2 (publicly accessible version with georeferences at hectad resolution), together with other collector-held (e.g. Leech *et al.* 2009) or organisation-held (e.g. Scottish Natural Heritage surveillance database and Kew’s mycological collections database, Herbtrack) record data as agreed with Natural England who provided financial support. Ordnance Survey (OS) grid references and site names were corrected for FRDBI records, where appropriate, by one of us (JHS) using herbaria@home (OS

grid reference to vice-county conversion) and MAGIC (Natural environment geographic information service managed by Natural England). For records associated with dried fruit body material (voucher specimens) in the national collections (fungaria) at Kew (K) and Edinburgh (E), the specimen packets and/or the associated accessions databases were sometimes checked to verify or augment the data held elsewhere.

3. Methods

3.1. Rationale

The aim of conservation status assessments is to generate RDLs and categorise taxa to highlight which are at greatest risk of extinction. Taxa can then be prioritised for action based on an assessment of the relative degrees of threat they face. The current assessment, underpinned by current IUCN guidance (IUCN 2012a, 2012b, 2014), used the following IUCN Red List categories where appropriate: Regionally Extinct (RE), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD) and Not Applicable (NA). Fungi in the categories CR, EN and VU are regarded as Threatened. The five IUCN criteria which may be used to assign taxa to the appropriate IUCN Red List category are summarised as:

- Criterion A: Population size reduction
- Criterion B: Geographic range in the form of extent of occurrence (EOO) or area of occupancy (AOO) coupled with other factors including fragmentation, decline and extreme fluctuations.
- Criterion C: Small population size and decline.
- Criterion D: Very small or restricted population.
- Criterion E: Quantitative analysis, indicating the probability of extinction

The use of Criteria A–C requires an assessment of population decline. To provide a preliminary guide to any declining fungal species, Evans *et al.* (2006) compared the British fruiting populations recorded over two time intervals. Population size was measured by counting the number of pre- and post-1960 occupied hectads (OS grid squares of 100 km² area represented by two letters and two digits) and hence “For a species recorded in n hectads since 1960 there is considered to be evidence of decline if it was recorded in at least $2n + 1$ hectads prior to 1960” (Evans *et al.* 2006). The selection of 1960 as the cut-off date was linked to their interpretation of Extinction. Evans *et al.* (2006) assessed a species as Extinct if there were no records post-1960. The assessment for the *Boletaceae* project opted for a different interpretation with a rolling 50-year timeframe. A British fungal species was categorised as Extinct if it had not been “found over the last 50 years despite appropriate searching”. It follows, therefore, that all mycelia that have been recorded in a fruiting state within the last 50 years are to be regarded as extant at the time of a conservation assessment (unless

their habitat is known to have been destroyed). This approach was retained in the current assessment, except that the RE category was used for extinct species to indicate that extinction had only been assessed in a regional, not worldwide, context. In two cases, (*Lycoperdon ericaeum* and *L. radicum*) the “Possibly Extinct” tag was used for a potentially Regionally Extinct species for which there have been insufficient (or insufficiently-documented) recent surveys in historic sites and other appropriate habitat to justify an assessment of RE (IUCN 2014).

For each species considered in the current assessment, the total number of occupied 1 km OS grid squares (monads) recorded over the last 50 years (to December 2014) was compared with a corresponding measure of the extant population as it existed 50 years ago (monads recorded during the preceding 50 y) using FRDBI data. As with the previous hectad-based (Evans *et al.* 2006) and monad-based (Ainsworth *et al.* 2013) comparisons, far from alerting us to potentially declining populations (with the possible exception of a lost *Geastrum berkeleyi* site), the results simply highlight the recent upsurge in recording effort and database usage.

In general, the national databases record positive sightings of fungi made on a casual basis, but do not record when target species were deliberately, but unsuccessfully, searched for at their historical sites (null returns). It is therefore very difficult or impossible to track the numbers of lost sites or diminishing fruiting at extant sites. Evidence of population decline remains very elusive in all but the most clear-cut cases, such as the British extinction of *Sarcodon regalis* when its only known (and type) locality was destroyed by housing development (see species accounts below for details).

The current project therefore focused on the application of IUCN Criterion D for species conservation status assessments. A similar lack of evidence of decline in species or habitat attributes was noted in the *Boletaceae* project for which Criterion D was used exclusively following the approach used for hybrid plants by Cheffings *et al.* (2005).

In future, it might be possible to remedy this to some extent for fungi, at least for some species, using statistical correction programs (e.g. Frescalo: FREquency SCAling LOcal) which depend on identifying suitable, commonly-encountered,

benchmark species whose records are used as a proxy for recorder activity (Hill 2012, Fox *et al.* 2014, Isaac *et al.* 2014, Stroh *et al.* 2014). Clearly there is a need to investigate the applicability of such methods, with a particular focus on the selection of suitable benchmark fungi, to improve the potential utility of national fungal records.

Although comparing species records from two consecutive time periods each of 50 years duration failed to provide evidence of decline, the monad values obtained for the most recent period were nevertheless useful for rapidly assigning the commonest species to the category Least Concern (see below and Table 1).

3.2. Application of IUCN Criterion D (very small or restricted populations)

The majority of the fungi treated in this assessment can be regarded as terrestrial mycelia which, under suitable conditions, form fruit body patches. Therefore they are amenable to the interpretations of mature individuals in Dahlberg & Mueller (2011) and the current IUCN Red-listing Guidelines (2014) following the approach used to assess the *Boletaceae* (Ainsworth *et al.* 2013). However, a total of three fungal lifestyles can be recognised in the current tranche based on Dahlberg & Mueller's (2011) categories of mature individual as detailed (A–C) below. The relevant lifestyle category is also included in the text of the assessments for all threatened and near-threatened species.

- A. **Lignicolous fungus of large centralized decay columns:** having a wood-inhabiting mycelium occupying central trunk wood (irrespective of the presence of clearly differentiated heartwood) and spreading to major limbs such that each occupied tree is considered to represent a single genotype or genet (functional individual), each of which is assumed to comprise 2–3 ramets or mature individuals for IUCN-compliant red-listing purposes. The choice of number employed is species-specific and is discussed in each case assessed herein. Genera assessed: *Dentipellis*, *Hericium* and *Piptoporus*.
- B. **Moss-cushion-associated fungus:** having a soil-dwelling mycelium and forming groups of fruit bodies such that all fruit bodies associated with a single moss-cushion are considered to represent a single ramet or mature individual for IUCN-compliant red-listing purposes. Species assessed: *Tulostoma niveum*.

C. **Terrestrial patch-forming fungus:** having a soil-dwelling mycelium and forming scattered groups of fruit bodies such that all fruit bodies within a circle of 10 m diam. are considered to represent a single genotype or genet (functional individual), each of which is assumed to comprise 10 ramets or mature individuals for IUCN-compliant red-listing purposes. Genera assessed: all those not listed in categories A and B above (unless stated otherwise in the individual species assessments).

Applying Criterion D as in Ainsworth *et al.* (2013), the following thresholds were used to assign terrestrial patch-forming taxa to the three IUCN threatened categories following the guidelines for “terrestrial fungi” in Dahlberg & Mueller (2011) and for “diffuse organisms, not wholly visible, in continuous habitats” in IUCN (2014):

1. CR D: <5 discrete fruiting patches (genets) representing <50 mature individuals
2. EN D: 5–24 discrete fruiting patches representing 50–240 (<250) mature individuals
3. VU D1: 25–99 discrete fruiting patches representing 250–990 (<1,000) mature individuals

When applying Criterion D, we considered that 100–110 discrete fruiting patches representing 1,000–1,100 mature individuals satisfied the category of NT (almost VU D1). Least Concern (LC) was defined as >110 discrete fruiting patches representing >1,100 mature individuals (if Criterion D2 not met). All terrestrial patch-forming species with over 110 currently occupied monads (1,100 mature individuals) in the FRDBI are shown in Table 1. These LC candidates were then individually assessed in the context of taxonomic investigations (see Table 2 and relevant species assessments). Additional terrestrial patch-forming species were assigned to the LC category based on assessments of FRDBI data georeferenced at a finer scale than that of the monad (1 km grid square).

The rationale and assessment process for fungi having other categories of mature individual (lignicolous occupying large centralized decay columns and moss-cushion-associated) is outlined in each of the appropriate species assessments below.

Bailey *et al.* (2015) did not take into account any pertinent lifestyle differences between mycelia occupying the central core of tree trunks, moss cushions or those

Table 1: Terrestrial patch-forming taxa selected as candidates for the category LC based on their occupation of >110 monads (OS 1 km grid squares) based on FRDBI records. No attempt has been made to interpret the fungal names or records with respect to modern taxonomic concepts. These are discussed in more detail in the following tables and individual species assessments.

Species	Monads Jan 1965–Dec 2014	Species	Monads Jan 1965–Dec 2014
Geastraceae: <i>Geastrum</i>, <i>Myriostoma</i>, <i>Sphaerobolus</i>			
<i>Geastrum fimbriatum</i>	200+	<i>Geastrum triplex</i>	200+
<i>Geastrum rufescens</i>	125	<i>Sphaerobolus stellatus</i>	200+
<i>Geastrum striatum</i>	165		
Cantharellaceae: <i>Cantharellus</i>, <i>Craterellus</i>, <i>Pseudocraterellus</i>			
<i>Cantharellus cibarius</i>	200+	<i>Craterellus cornucopioides</i>	200+
<i>Cantharellus tubaeformis</i>	200+	<i>Pseudocraterellus undulatus</i>	200+
Bankeraceae: <i>Bankera</i>, <i>Boletopsis</i>, <i>Hydnellum</i>, <i>Phellodon</i>, <i>Sarcodon</i>			
<i>Bankera fuligineoalba</i>	125	<i>Sarcodon squamosus</i>	119
<i>Hydnellum conrescens</i>	122		
Selected genera within Agaricaceae: <i>Battarrea</i>, <i>Bovista</i>, <i>Lycoperdon</i>, <i>Tulostoma</i>			
<i>Bovista nigrescens</i>	200+	<i>Lycoperdon nigrescens</i>	200+
<i>Bovista plumbea</i>	200+	<i>Lycoperdon perlatum</i>	200+
<i>Lycoperdon echinatum</i>	200+	<i>Lycoperdon pratense</i>	200+
<i>Lycoperdon excipuliforme</i>	200+	<i>Lycoperdon pyriforme</i>	200+
<i>Lycoperdon lividum</i>	200+	<i>Lycoperdon utriforme</i>	200+
<i>Lycoperdon molle</i>	200+		

forming diffuse patches in soil. They treated all assessed fungi as “terrestrial patch-forming fungi” such that two fruit body records over 10 m apart were regarded as representing two genets and 20 ramets or mature individuals. Among the IUCN’s (2014) “examples of possible interpretations of the definition of a mature individual” there is one for “fungi living more or less concealed in dead wood”. This states that “each patch (trunk or log colonized by the species) could – if no better information exists – be counted as 2–10 mature individuals, depending on the size of the tree”. For *Hericium* and *Piptoporus* species, based on field and laboratory experience of these and ecologically similar fungi, the current project considered that an occupied tree (assumed to be inhabited by a single genet) would, on average, occasionally fragment into two or three physically separated elements (ramets or mature individuals sensu

IUCN). Hence each tree trunk occupied by one of these species would therefore be considered to represent 2–3 mature individuals in the current project but 10 mature individuals using the Bailey *et al.* (2015) approach. Such differing interpretations of “mature individual” resulted in significant discrepancies in the two assessments for such species. Bailey *et al.* (2015) assessed *H. cirrhatum*, *H. erinaceus* and *P. quercinus* as LC and *H. coralloides* as VU D1 whereas they are assessed respectively as VU D1, VU D1, VU D1 and EN in the current report. Conversely, in the case of *Tulostoma niveum*, Bailey *et al.* (2015) assessed it as CR D based on 4 genets and 40 mature individuals whereas the current report assesses it as VU D1 by estimating the number of occupied moss cushions (ca. 320). This approach is in accordance with IUCN Guidelines (2014) which state that “a discrete cushion” of a moss “would be counted as one mature individual”.

Although it is expected that most British fungal records are now represented in one or both of the two national databases, CATE2 and FRDBI, there will always be some fungal records in private repositories or awaiting incorporation in a national database which cannot be captured over the lifespan of a time-bound, externally-funded conservation assessment project. These are effectively unavailable to the project team. Such constraints apply to all assessment projects, however data availability for the current project departed from that of the preceding pilot *Boletaceae* project because CATE2 records were only made available to us georeferenced at hectad resolution. We accept that it is likely, therefore, that even using all associated data elements available to us, there will be a small number of species for which we would have calculated higher numbers of mature individuals had we been granted registered access to CATE2 georeferences (i.e. at finer than hectad resolution). A pragmatic and “population best-case scenario” approach was taken (see below) and, as a result, a few assessments were downgraded to allow for the hectad-level precision of the available CATE2 data.

A typical assessment workflow would start by assembling all checked FRDBI georeferences recorded at 10 m grid square (8-digit grid referencing) precision. These were used to indicate unique terrestrial fruiting patches and occupied tree trunks/main limbs (i.e. genets) if more detailed abundance information was lacking. The numbers of non-overlapping occupied 100 m grid squares (6-digit grid referencing) were then added to this total, followed by the non-overlapping occupied 1 km grid squares (4-

digit grid referencing) and 1 hectad grid squares (2-digit grid referencing). CATE2 records from additional unique hectads were then added to this. Examination of all the publicly-accessible CATE2 data associated with a species (combinations of date, collector and habitat) sometimes allowed the recognition of multiple previously unaccounted-for fruiting patches within single hectads.

Many records initially entered in the FRDBI have now also been accessioned in CATE2 (some overtly tagged as “emended FRDBI source” and others identifiable from the identical statements in the Notes fields). For all species assessed using Criterion D as threatened, a pragmatic “population best-case scenario” assumption was made to allow for multiple CATE2 records per hectad. CATE2 records from within the same hectad associated with data indicating that they were not included in FRDBI and did not represent repeated surveillance of a single fruiting patch in different years were assumed to represent unique fruiting patches (erring on the side of population overestimation). In most cases, the incorporation of these additional “best-case scenario” fruiting patches did not raise the total numbers of mature individuals sufficiently to alter the resulting assessment category. However, when the upper threshold of an IUCN assessment category was breached by such an addition, we downgraded the species and it was assessed at the next (lower) threat level. This was also done when the total (FRDBI + CATE2) number of fruiting patches was close to a category threshold and it was considered likely that a few more unrecorded patches were very likely to be extant. For example, a terrestrial patch-forming species with four recorded fruiting patches (40 mature individuals), and therefore just one patch below the upper threshold for CR, was downgraded to EN to take account of the probability of unrecorded patches, sometimes referred to as the “unrecorded number” (Dahlberg & Mueller 2011). Such downgrading was applied in the following cases:

***Geastrum elegans* 40 mature individuals: CR D→EN D**

Bailey *et al.* (2015) assessment: 40 mature individuals CR D

***G. fornicatum* 940 mature individuals: VU D1→NT**

Bailey *et al.* (2015) assessment: 730 mature individuals VU D1

***G. quadrifidum* 230 mature individuals: EN D →VU D1**

Bailey *et al.* (2015) assessment: 230 mature individuals EN D

***Boletopsis perplexa* 40 mature individuals: CR D→EN D**

Bailey *et al.* (2015) assessment: 40 mature individuals CR D

***Hydnellum spongiosipes* 950 mature individuals: VU D1→NT**

Bailey *et al.* (2015) assessment: 1140+ mature individuals LC

***Phellodon confluens* 680 mature individuals: VU D1→NT (special case, see detailed assessment)**

Bailey *et al.* (2015) assessment: 710 mature individuals VU D1

***Sarcodon scabrosus* 1070 mature individuals: NT→LC**

Bailey *et al.* (2015) assessment: 290 mature individuals VU D1 (but a different taxon was assessed so data not comparable)

***Bovista paludosa* 40 mature individuals: CR D→EN D**

Bailey *et al.* (2015) assessment: 20 mature individuals CR D

***Lycoperdon decipiens* 40 mature individuals: CR D→EN D**

Bailey *et al.* (2015) assessment: 50 mature individuals EN D

To provide further insight into the process and the interrelationships of FRDBI, CATE2 and Kew's collections database, Herbtrack, the first example above, *Geastrum elegans*, is dealt with in detail below:

Post-1964 FRDBI records of *G. elegans*

1) Date as "1966", location unknown, from Herb. Plowright.

Comparison with Herbtrack data indicates collection is pre-1964 – ignore record.

2) Date 1979 TM46 Dunwich Heath (10 mature individuals).

3) Date 1987 and 2011, SN69 Ynyslas and assumed to be two distinct fruiting patches (20 mature individuals).

4) Date 1999, SH36 Aberffraw.

Identification verified at Kew by ITS sequence data (10 mature individuals).

5) Date 2002, TF84 Holkham.

Redetermined as *G. campestre* at Kew based on ITS sequence data – ignore record.

6) Date 2003, TF84 Holkham.

Redetermined as *G. minimum* on arrival at Kew on morphology – ignore record.

Based on FRDBI and other data available to us: 40 mature individuals which would accord with category CR D.

Post-1964 CATE2 records of *G. elegans*

- 1) Date 1979 TM46 Dunwich Heath (10 mature individuals).
- 2) Date 1987 and 2011, SN69 Ynyslas and assumed to be two distinct fruiting patches (20 mature individuals).
- 3) Date 2002, TF84 Holkham.

Redetermined as *G. campestre* at Kew based on ITS sequence data – ignore record.

- 4) Date 2003, TF84 Holkham.

Redetermined as *G. minimum* on arrival at Kew on morphology – ignore record.

No further mature individuals detected taking CATE2 data into account. In view of the likelihood that at least one more fruiting patch is extant (and hence there are at least 50 extant mature individuals in total), this assessment was downgraded from CR D to EN D.

4. Results: summary of conservation assessments

The results of the 2015 assessments are shown in Tables 2–7 alongside the two previous unofficial British RDLs (Ing 1992, Evans *et al.* 2006) which used IUCN-recognised categories but different assessment criteria/methodology. Fungal taxa not listed in the first RDL are categorised in Tables 2–7 as NE, but this could be an overestimate because Ing (1992) did not document any taxa that he assessed as LC or DD. Almost the same caveat applies to the application of the NE category with respect to the second RDL, however the likelihood of overestimating non-evaluated taxa was reduced in this case. RDL working documents (S.E. Evans unpubl.) produced prior to the publication of Evans *et al.* (2006) were obtained and used to identify those taxa the authors considered to be LC but which were omitted from, or “annexed” in, the final publication. The non-IUCN category “annexed” indicated that there were too many known records for a threatened or near threatened status and so species annexed by Evans *et al.* (2006) were assigned to LC in the following Tables.

Of the 95 species assessed, 60 (63.2%) are now considered to be on the Red List (categories CR, EN, VU, NT, DD) with the following breakdown by category:

RE:	01	1.1%	LC:	27	28.4%
CR:	04	4.2%	DD:	18	18.9%
EN:	14	14.7%	NA:	07	7.4%
VU:	20	21.1%	(Total: 95	100%)	
NT:	04	4.2%			

The 95 species were assigned to the following categories (totals shown for each). For explanations of the nomenclature applied to unidentified species, see the species assessments which follow:

Regionally Extinct RE (1):

Sarcodon regalis

Critically Endangered CR (4):

Geastrum berkeleyi

Lycoperdon radicum (Possibly Extinct)

Lycoperdon ericaeum (Possibly Extinct)

Myriostoma coliforme

Endangered EN (14):

<i>Boletopsis perplexa</i>	<i>Geastrum elegans</i>
<i>Bovista paludosa</i>	<i>Geastrum lageniforme</i>
<i>Bovista pusilla</i> (=limosa s. auct. Brit.)	<i>Hericium coralloides</i>
<i>Cantharellus friesii</i>	<i>Lycoperdon atropurpureum</i>
<i>Cantharellus melanoxeros</i>	<i>Lycoperdon caudatum</i>
<i>Geastrum campestre</i>	<i>Lycoperdon decipiens</i>
<i>Geastrum corollinum</i>	<i>Sarcodon</i> sp. 1 (with <i>Fagaceae</i>)

Vulnerable VU (20):

<i>Battarrea phalloides</i>	<i>Hericium cirrhatum</i>
<i>Bovista aestivalis</i>	<i>Hericium erinaceus</i>
<i>Cantharellus amethysteus</i>	<i>Hydnellum aurantiacum</i>
<i>Cantharellus aurora</i>	<i>Hydnellum caeruleum</i>
<i>Geastrum coronatum</i>	<i>Hydnellum ferrugineum</i>
<i>Geastrum floriforme</i>	<i>Lycoperdon mammiforme</i>
<i>Geastrum marginatum</i> (=minimum s. auct. Brit.)	<i>Lycoperdon umbrinum</i>
<i>Geastrum pectinatum</i>	<i>Piptoporus quercinus</i>
<i>Geastrum quadrifidum</i>	<i>Tulostoma melanocyclum</i>
<i>Geastrum schmidelii</i>	<i>Tulostoma niveum</i>

Near Threatened NT (4):

<i>Cantharellus cinereus</i>	<i>Hydnellum spongiosipes</i>
<i>Geastrum fornicatum</i>	<i>Phellodon confluens</i>

Least Concern LC (27):

<i>Bankera fuligineoalba</i>	<i>Lycoperdon echinatum</i>
<i>Bovista nigrescens</i>	<i>Lycoperdon excipuliforme</i>
<i>Bovista plumbea</i>	<i>Lycoperdon lividum</i>
<i>Cantharellus cibarius</i>	<i>Lycoperdon molle</i>
<i>Cantharellus tubaeformis</i>	<i>Lycoperdon nigrescens</i>
<i>Craterellus cornucopioides</i>	<i>Lycoperdon perlatum</i>
<i>Geastrum fimbriatum</i>	<i>Lycoperdon pratense</i>
<i>Geastrum rufescens</i>	<i>Lycoperdon pyriforme</i>
<i>Geastrum striatum</i>	<i>Lycoperdon utrifforme</i>
<i>Geastrum triplex</i>	<i>Phellodon melaleucus, Phellodon Group I</i>
<i>Hydnellum peckii</i>	<i>Phellodon tomentosus</i>

Piptoporus betulinus
Pseudocraterellus undulatus
Sarcodon scabrosus

Sarcodon squamosus
Sphaerobolus stellatus

Data Deficient DD (18):

Cantharellus ferruginascens
Dentipellis fragilis
Geastrum britannicum
Hydnellum ?concrecens, Hydnellum
Group V
Hydnellum cumulatum
Hydnellum gracilipes
Hydnellum sp., Hydnellum Group I
Hydnellum sp., Hydnellum Group III
Laxitextum bicolor

Lycoperdon dermoxanthum
Lycoperdon lambinonii
Phellodon niger, Phellodon Group V
Phellodon sp., Phellodon Group II
Phellodon sp., Phellodon Group VII
Phellodon sp., Phellodon Group IX
Sarcodon joeides
Sarcodon sp. 2
Tulostoma brumale

Not Applicable NA (7):

Bankera violascens
Bovista limosa
Geastrum pseudolimbatum
Hericiium abietis
Hydnellum scrobiculatum
Sarcodon glaucopus
Tulostoma fimbriatum

Table 2: Conservation assessments of all 20 British *Geastraceae* sensu GBCHKLST.

The 2015 assessments are based on IUCN Criterion D.

Ing (1992) RDL	Evans <i>et al.</i> (2006) RDL	Taxon	2015 assessment	Post-1964 mature individuals from known records	Notes on 2015 assessment
Ex	EN B	<i>Geastrum berkeleyi</i>	CR D	20	No fruiting since 2004?
NE	NE	<i>Geastrum britannicum</i>	DD	150	Described in 2015
Ex	EN B	<i>Geastrum campestre</i>	EN D	60	
V	EN B	<i>Geastrum corollinum</i>	EN D	90	
NE	NE	<i>Geastrum coronatum</i>	VU D1	570	
V	EN B	<i>Geastrum elegans</i>	EN D	40	
NE	NE	<i>Geastrum fimbriatum</i>	LC	2000+	From Table 1
NE	NE	<i>Geastrum floriforme</i>	VU D1	260	
V	NE	<i>Geastrum fornicatum</i>	NT	940	
Ex	NT	<i>Geastrum lageniforme</i>	EN D	150	
V	VU D2	<i>Geastrum minimum</i>	VU D1	310	Now det. as <i>G. marginatum</i>
NE	NE	<i>Geastrum pectinatum</i>	VU D1	910	
NE	NE	<i>Geastrum pseudolimbatum</i>	NA	0	One British collection (2011) now redetermined
V	NT	<i>Geastrum quadrifidum</i>	VU D1	230	Some specimens redetermined and assessed as <i>G. britannicum</i>
NE	NE	<i>Geastrum rufescens</i>	LC	1250	From Table 1
NE	NE	<i>Geastrum schmidelii</i>	VU D1	410	
NE	NE	<i>Geastrum striatum</i>	LC	1650	From Table 1
R ¹	NE	<i>Geastrum triplex</i>	LC	2000+	From Table 1
Ex	CR B	<i>Myriostoma coliforme</i>	CR D	20	
NE	NE	<i>Sphaerobolus stellatus</i>	LC	2000+	From Table 1

¹ *G. saccatum* was assessed as R (Rare), an IUCN Category in 1992, however this name is now treated in Britain and Ireland (CBIB) as a synonym of either *G. triplex* or *G. lageniforme*. *G. triplex* is possibly the species assessed as Rare because *G. lageniforme* was listed as Extinct in Ing (1992).

Table 3: Conservation assessments of all 10 British *Cantharellaceae* sensu GBCHKLST. The 2015 assessments are based on IUCN Criterion D.

Ing (1992) RDL	Evans <i>et al.</i> (2006) RDL	Taxon	2015 assessment	Post-1964 mature individuals from known records	Notes on 2015 assessment
NE	NE	<i>Cantharellus amethysteus</i>	VU D1	770	
V ¹	LC	<i>Cantharellus aurora</i>	VU D1	600	
NE	NE	<i>Cantharellus cibarius</i>	LC	2000+	From Table 1
V	LC	<i>Cantharellus cinereus</i>	NT	1020	
V	NT	<i>Cantharellus ferruginascens</i>	DD	390	
V	VU B	<i>Cantharellus friesii</i>	EN D	130	
NE	VU D2	<i>Cantharellus melanoxeros</i>	EN D	180	
NE	NE	<i>Cantharellus tubaeformis</i>	LC	2000+	From Table 1
NE	NE	<i>Craterellus cornucopioides</i>	LC	2000+	From Table 1
V ²	LC	<i>Pseudocraterellus undulatus</i>	LC	2000+	From Table 1

¹ *Cantharellus aurora* was assessed in 1992 as *C. lutescens*.

² *Pseudocraterellus undulatus* was assessed in 1992 as *P. sinuosus*.

Table 4: Conservation assessments of all 6 British *Heriaceae* sensu GBCHKLST.

The 2015 assessments are based on IUCN Criterion D.

Ing (1992) RDL	Evans <i>et al.</i> (2006) RDL	Taxon	2015 assessment	Post-1964 mature individuals from known records	Notes on 2015 assessment
NE	NE	<i>Dentipellis fragilis</i>	DD	1?	First (only?) British collection in 2006
NE	NE	<i>Hericum abietis</i>	NA	1	Presumably introduced with timber
V ¹	LC	<i>Hericum cirrhatum</i>	VU D1	326	
V ²	NT	<i>Hericum coralloides</i>	EN D	210	
V	LC	<i>Hericum erinaceus</i>	VU D1	441	
NE	NE	<i>Laxitextum bicolor</i>	DD	33+	

¹ *Hericum cirrhatum* was assessed in 1992 as *Creolophus cirrhatus*.

² Ing's RDL included assessments for both *Hericum coralloides* (V) and *H. alpestre* (V) although the latter is currently not considered to be British (CBIB) and all such historical collections would probably now be identified as *H. coralloides*.

Table 5: Conservation assessments of 28 British *Bankeraceae* sensu GBCHKLST as updated by AMA. The 2015 assessments are based on IUCN Criterion D. *Hydnellum* and *Phellodon* “Groups” are sequence-based groupings in Ainsworth *et al.* (2010) corresponding to species (including those currently not named).

Ing (1992) RDL	Evans <i>et al.</i> (2006) RDL	Taxon	2015 assessment	Post–1964 mature individuals from known records	Notes on 2015 assessment
E	LC	<i>Bankera fuligineoalba</i>	LC	1250+	From Table 1
NE	NE	<i>Bankera violascens</i>	NA	340	Presumably introduced with <i>Picea</i>
V ¹	VU D2 ¹	<i>Boletopsis perplexa</i>	EN D	40	
E	VU B	<i>Hydnellum aurantiacum</i>	VU D1	890	
V	NT	<i>Hydnellum caeruleum</i>	VU D1	850	
V	LC	<i>Hydnellum ?concrescens</i> Hydnellum Group V	DD	1430	Fulvous tints when immature
Included in the above and in <i>H. scrobiculatum</i>	Included in the above and in <i>H. scrobiculatum</i>	<i>Hydnellum sp.</i> Hydnellum Group I	DD	Included in the above and in <i>H. scrobiculatum</i>	Rosy tints when immature (possibly = <i>H. tardum</i>)
Probably included in <i>H. scrobiculatum</i>	Probably included in <i>H. scrobiculatum</i>	<i>Hydnellum cumulatum</i>	DD	220	Accepted as British in 2010
E	NT	<i>Hydnellum ferrugineum</i>	VU D1	500	Excluding all English records
Probably included in <i>H. scrobiculatum</i>	Probably included in <i>H. scrobiculatum</i>	<i>Hydnellum gracilipes</i>	DD	130	Accepted as British in 2010
E	LC	<i>Hydnellum peckii</i>	LC	1100+	
E	LC	<i>Hydnellum scrobiculatum</i>	NA	0	Not British
Included in <i>H. scrobiculatum</i>	Included in <i>H. scrobiculatum</i>	<i>Hydnellum sp.</i> Hydnellum Group III	DD	unknown	Scottish and undescribed
R	LC	<i>Hydnellum spongiosipes</i>	NT	950	
E	LC	<i>Phellodon confluens</i>	NT	680	
V	LC	<i>Phellodon melaleucus</i> Phellodon Group I	LC	>50% of 2080	Lilac tints and assumed s.str.
Included in the above	Included in the above	<i>Phellodon sp.</i> Phellodon Group IX	DD	Remainder of the above total	Yellow tints and ?undescribed

NE	NE	<i>Phellodon</i> sp. Phellodon Group II	DD	?20+	Two fruiting patches and ?undescribed
R	LC	<i>Phellodon niger</i> Phellodon Group V	DD	500	All <i>Pinaceae</i> records and assumed s.str.
Included in the above	Included in the above	<i>Phellodon</i> sp. Phellodon Group VII	DD	560	All <i>Fagaceae</i> records and ?undescribed
E	LC	<i>Phellodon tomentosus</i>	LC	1850	
NE	NE	<i>Sarcodon glaucopus</i>	NA	0	Sensu British authors is misdet. <i>S. scabrosus</i>
NE	NE	<i>Sarcodon joeides</i>	DD	?10+	One site since 2008
Ex	EX 1969	<i>Sarcodon regalis</i>	RE	0	Only known from type locality, now destroyed
E ²	VU B ³	<i>Sarcodon scabrosus</i>	LC	1070	Scottish with <i>Pinus</i>
Included in the above	NT ⁴	<i>Sarcodon</i> sp. 1 (with <i>Fagaceae</i>)	EN D	170	<i>S. scabrosus</i> sensu auct. Brit. p.p.
NE	NE	<i>Sarcodon</i> sp. 2	DD	?10+	One site since 2008
V ⁵	LC	<i>Sarcodon squamosus</i>	LC	1190	From Table 1

¹ *Boletopsis perplexa* was assessed in 1992 and 2006 as *B. leucomelaena* (a misdetermination).

² Ing's (1992) RDL assessed *Sarcodon scabrosus* although this concept conflated two species which were recognised in Evans *et al.* (2006) as a mainly English *S. scabrosus* associated with *Fagaceae* and a mainly Scottish *S. glaucopus* associated with *Pinaceae*. However the consensus view has changed again and these are now thought respectively to be a currently unidentified *Sarcodon* sp. (herein sp.1 associating with *Fagaceae*) and *S. scabrosus* s. str. (with *Pinaceae*).

³ Evans *et al.*'s (2006) RDL therefore assessed *S. scabrosus* s. str. as *S. glaucopus* (a misdetermination) and ⁴ *Sarcodon* sp. 1 (with *Fagaceae*) as *S. scabrosus* (a misdetermination). See below for further details.

⁵ *Sarcodon squamosus* was assessed in 1992 as *S. imbricatus* (a misdetermination).

Table 6: Conservation assessments of 29 selected members of *Agaricaceae* sensu GBCHKLST comprising puffballs (all British members of *Bovista* and *Lycoperdon*) stalkballs (all British members of *Tulostoma*) and the sandy stiltball (the sole British representative of *Battarrea*). The 2015 assessments are based on IUCN Criterion D.

Ing (1992) RDL	Evans <i>et al.</i> (2006) RDL	Taxon	2015 assessment	Post-1964 mature individuals from known records	Notes on 2015 assessment
E	NT	<i>Battarrea phalloides</i>	VU D1	420	
NE	NE	<i>Bovista aestivalis</i>	VU D1	400	
NE	NE	<i>Bovista limosa</i>	NA	0	Not British
NE	NE	<i>Bovista nigrescens</i>	LC	2000+	From Table 1
Ex	EN B	<i>Bovista paludosa</i>	EN D	40	
NE	NE	<i>Bovista plumbea</i>	LC	2000+	From Table 1
V ¹	NT ¹	<i>Bovista pusilla</i>	EN D	130	
NE	NE	<i>Lycoperdon atropurpureum</i>	EN D	60	
E	VU D2	<i>Lycoperdon caudatum</i>	EN D	120	
V	EX 1923	<i>Lycoperdon decipiens</i>	EN D	40	
NE	NE	<i>Lycoperdon dermoxanthum</i>	DD	940	Possibly two species present
NE	NE	<i>Lycoperdon echinatum</i>	LC	2000+	From Table 1
Ex	EX 1883	<i>Lycoperdon ericaeum</i>	CR (Possibly Extinct)	0–30?	
NE	NE	<i>Lycoperdon excipuliforme</i>	LC	2000+	From Table 1
V	NE	<i>Lycoperdon lambinonii</i>	DD	20?	
NE	NE	<i>Lycoperdon lividum</i>	LC	2000+	From Table 1
NE	NE	<i>Lycoperdon mammiforme</i>	VU D1	550	
NE	NE	<i>Lycoperdon molle</i>	LC	2000+	From Table 1
NE	NE	<i>Lycoperdon nigrescens</i>	LC	2000+	From Table 1
NE	NE	<i>Lycoperdon perlatum</i>	LC	2000+	From Table 1
NE	NE	<i>Lycoperdon pratense</i>	LC	2000+	From Table 1
NE	NE	<i>Lycoperdon pyriforme</i>	LC	2000+	From Table 1
Ex ²	EX 1952 ²	<i>Lycoperdon radicatatum</i>	CR (Possibly Extinct)	0?	
NE	NE	<i>Lycoperdon umbrinum</i>	VU D1	700	

NE	NE	<i>Lycoperdon utriforme</i>	LC	2000+	From Table 1
NE	NE	<i>Tulostoma brumale</i>	DD	1050+	Two species present
NE	NE	<i>Tulostoma fimbriatum</i>	NA	0	Not British
R ³	EN B	<i>Tulostoma melanocyclum</i>	VU D1	250	
V	VU D2	<i>Tulostoma niveum</i>	VU D1	ca.320	

¹ *Bovista pusilla* was assessed in 1992 and 2006 as *B. limosa* (a misdetermination).

² *Lycoperdon radicum* was assessed in 1992 and 2006 as *Bovistella radicata*.

³ *Tulostoma melanocyclum* was assessed as R (Rare), an IUCN Category in 1992.

Table 7: Conservation assessments of 2 selected members of *Fomitopsidaceae* sensu GBCHKLST comprising two polypores (both British members of *Piptoporus*). The 2015 assessments are based on IUCN Criterion D.

Ing (1992) RDL	Evans <i>et al.</i> (2006) RDL	Taxon	2015 assessment	Post-1964 mature individuals from known records	Notes on 2015 assessment
NE	NE	<i>Piptoporus betulinus</i>	LC	1100+	
E ¹	LC	<i>Piptoporus quercinus</i>	VU D1	825	

¹ *Piptoporus quercinus* was assessed in 1992 as *Buglossoporus pulvinus*.

5. Results: species assessment details

Detailed assessments follow for all species except those assessed as LC for which brief summary statements are provided.

Assessments for Geastraceae

Geastrum berkeleyi Masee

This assessment: CR D

Previous assessments: Ex (1992), EN B (2006)

Section 41 species

Extant mature individuals: 20

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–14 fruit bodies recorded per visit to each of two unique georeferenced sites (i.e. unique 8-digit grid cells plus all non-overlapping <8-digit grid cells) with one fruiting patch each (20 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 50, therefore this is treated as a very small and restricted extant population (Criterion D) assessed as CR D.

A species with a very limited extant distribution in GB (Herefordshire and Worcestershire only), associated with *Fraxinus* and *Ulmus* in broadleaved woodland or scrub. No known records at the lectotype locality (Lambley, Nottinghamshire) since 1880. Indeed there are no post-Dec. 1964 records known from any of the sites reported prior to this date. At its modern Herefordshire station (observed fruiting 1999–2004), fruiting occurs on a litter layer of small, naturally-occurring woodchips fallen and washed from the core of a decaying standing *Fraxinus* trunk. Found in a much broader range of habitats elsewhere in Europe such as in open grazed ground, in coniferous woodland, near *Juniperus* or deciduous bushes and on soils that are calcareous and rich in nutrients, especially nitrogen (Sunhede 1989, Jeppson *et al.* 2013). Internal Transcribed Spacer (ITS) DNA sequence barcodes (SRP 2014) from specimens representing both extant English sites cluster with those of *G. berkeleyi* published in Jeppson *et al.* (2013) and in Zamora *et al.* (2014). Bailey *et al.* (2015) assessment: 20 mature individuals CR D.

***Geastrum britannicum* J.C. Zamora**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: >150

Assessment: A recently-described (2015) taxon, thus far only known from Britain, previously collected in England and Wales although apparently misdetermined as *G. quadrifidum*, *G. fornicatum* or recognised as having affinities with these species. Current distribution data should therefore be regarded as preliminary and further targeted surveys, preferably over a ten year period, are required to provide adequate information for a sound status assessment.

This earthstar was described in Zamora *et al.* (2015) and DNA barcode sequences for three British specimens preserved in K, named as *G. quadrifidum* or cf. *quadrifidum*, were published in Brock *et al.* (2009). These three collections now represent the holotype (Cockley Cley) and paratypes (Breamore [incorrectly originally recorded as “New Milton”] and Surlingham) of *G. britannicum*. A further collection, from Rushford, was sequenced by LMS for this project and was duly confirmed as this species. British specimens have been found on soil or woody debris, often under churchyard yews (*Taxus*) but it has also fruited near pine (*Pinus*) and oak (*Quercus*). *G. britannicum*, with determinations based on sequenced type material (Zamora *et al.* 2015), morphological examination or re-examination of specimens originally named *G. quadrifidum* (B.M. Spooner pers. comm.), is now known from the following sites: Breconshire (Llandefaelog Fach), East Norfolk (Surlingham), Herefordshire (Ashperton and Cusop), Monmouthshire (Abergavenny), North Somerset (Ashton Court), Oxfordshire (Shiplake), Radnorshire (Clyro, Glasbury, Llandeilo Graban and Nantmel), Shropshire (Ashford Carbonell), South Hampshire (Breamore), Surrey (Esher), West Norfolk (Cockley Cley and Rushford), West Sussex (Easbourne). Excluded from the assessment of Bailey *et al.* (2015).

***Geastrum campestre* Morgan**

This assessment: EN D

Previous assessments: Ex (1992), EN B (2006)

Extant mature individuals: 70

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–10 fruit bodies recorded per visit to each of seven unique georeferenced sites (70 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 250, therefore this is treated as a very small and restricted population (Criterion D) assessed as EN D.

A species with a limited southern distribution, associated with non-native and naturalised trees such as *Cedrus*, *Chamaecyparis*, *Cupressocyparis*, *Pinus* and *Quercus ilex* in cemeteries, parks, gardens and planted dunes, which was formerly regarded as “probably not native to Britain” (Pegler *et al.* 1995). However, since it is not obligately associated with such trees and has been recorded in grey coastal dunes in England, it is difficult to judge whether it has been introduced and, as a precaution, it is considered to be within its natural range for this assessment. Elsewhere in Europe, *G. campestre* is chiefly found in dry, warm, open calcareous or acidic habitats such as dunes, grasslands and “steppic sites” (Sunhede 1989, Jeppson *et al.* 2013). ITS-DNA sequence barcodes (Brock *et al.* 2009) from specimens collected from Dungeness and Pyrford cluster with a sequence generated from a Holkham specimen (SRP 2014) and with those of *G. campestre* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014).

Excluded from the assessment of Bailey *et al.* (2015).

***Geastrum corollinum* (Batsch) Hollós**

This assessment: EN D

Previous assessments: V (1992), EN B (2006)

Section 41 species

Extant mature individuals: 90

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–36 fruit bodies recorded per visit to each of nine unique georeferenced sites (90 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 250, therefore this is treated as a very small population (Criterion D) assessed as EN D.

A species with a limited southern distribution, associated with various broadleaved and coniferous trees in disturbed sandy/stony habitats such as hedgerows, disused gravel pits, embankments and on waste ground. Elsewhere in Europe it is found in

shaded sites in well-drained, base-rich, often nitrogen-rich woodlands, shrubberies and dry scrub areas (Sunhede 1989, Jeppson *et al.* 2013). ITS sequence barcodes from specimens representing four extant English sites cluster with those of *G. corollinum* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014). These were obtained from material in K from Herefordshire and Warwickshire (Brock *et al.* 2009) and from E. Norfolk and W. Suffolk (SRP 2014).

Bailey *et al.* (2015) assessment: CR D but based on 50 mature individuals and so should be amended to EN D.

***Geastrum coronatum* Pers.**

This assessment: VU D1

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 580

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–20+ fruit bodies recorded per visit to each of 58 unique georeferenced fruiting patches (580 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

A species with a mostly southern distribution in Britain (one recent site recorded in Scotland and four in Wales) associated with dunes, gardens, heathland, hedgerows and various woodland types (*Cedrus*, *Pinus*, *Quercus*, *Sequoiadendron*, *Taxus*, *Thuja* and *Ulmus*). Elsewhere in Europe it is associated with mixed broadleaved and coniferous woodland, gardens, isolated shrubs or open dry ground in base- and nitrogen-rich sites (Sunhede 1989, Jeppson *et al.* 2013). ITS sequence barcodes (Brock *et al.* 2009) obtained from specimens collected at Bridgnorth and Stretton-on-Fosse cluster with those of *G. coronatum* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014). The voucher specimen supporting the inclusion of *G. pseudolimbatum* on the British list (Ainsworth & Henrici 2015) was recently redetermined as *G. coronatum* based on DNA sequence data (LMS unpubl.).

Bailey *et al.* (2015) assessment: 440 mature individuals VU D1.

***Geastrum elegans* Vittad.**

This assessment: EN D

Previous assessments: V (1992), EN B (2006)

Section 41 & 42 species

Extant mature individuals: 40

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–5 fruit bodies recorded per visit to each of four unique georeferenced sites (40 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) could reach 50 but is not expected to reach 250, therefore this is treated as a very small and restricted population (Criterion D) assessed as EN D.

A species with a scattered distribution but with extant populations seemingly favouring coastal dunes and heathland in East Anglia and Wales. Elsewhere in Europe it is mainly found in open, dry, grazed calcareous sites with scattered shrubs or in woodland of various types including *Picea* plantations (Sunhede 1989, Jeppson *et al.* 2013). The ITS sequence barcode (Brock *et al.* 2009) from a specimen collected in Anglesey clustered with those of *G. elegans* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014). However, these differed from the corresponding sequence (SRP 2014) obtained from material preserved in K named as *G. elegans* and originating in W. Norfolk (Holkham). The latter collection has now been redetermined as *G. campestre*, based on molecular and morphological evidence, and included in the appropriate assessment herein.

Bailey *et al.* (2015) assessment: 40 mature individuals CR D.

***Geastrum fimbriatum* Fr.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

The ITS sequence barcode (Brock *et al.* 2009) from a specimen collected in King's Somborne clustered with those of *G. fimbriatum* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014). However, a specimen collected in Kew Gardens, originally determined as *G. fimbriatum*, generated a sequence (Brock *et al.* 2009) that clustered with those of *G. triplex* in Jeppson *et al.* (2013) and with some labelled as *G. michelianum* (a “*triplex* group” segregate not currently on the British list) in Zamora *et al.* (2014) and so was redetermined as *G. triplex* sensu lato pending further studies on this species complex.

Bailey *et al.* (2015) assessment: LC.

***Geastrum floriforme* Vittad.**

This assessment: VU D1

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 260

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–40+ (Pegler *et al.* 1995) fruit bodies recorded per visit to each of 26 unique georeferenced sites (260 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

A species with a scattered distribution in England (one Welsh site known), with European records from dry open grasslands, shaded nitrogen-rich gardens/parks/cemeteries or coastal sandy sites. It is usually associated with *Cupressus* or other conifers but has also been found fruiting near *Carpinus*, *Crataegus* and *Quercus ilex* and has a broad ecological range in continental Europe (Sunhede 1989, Jeppson *et al.* 2013). Seemingly much more frequently recorded in recent years with almost all sites being found after 1970. Although this suggests that this species might be spreading and therefore on the way to becoming NT and possibly LC in the future, the IUCN Guidelines (2014) state that “a taxon qualifies for Criterion D if the population of mature individuals is smaller than the threshold set for each of the categories of threat”. Therefore rather than assume a continuing diminishing threat level or assign to DD, the current data “snapshot” was used to assess this earthstar as VU D1. The ITS sequence barcodes (Brock *et al.* 2009) from specimens collected in Stourhead and West Molesey clustered with those of *G. floriforme* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014).

Bailey *et al.* (2015) assessment: 220 mature individuals EN D.

***Geastrum fornicatum* (Huds.) Hook.**

This assessment: NT

Previous assessments: V (1992), LC (2006)

Scottish Biodiversity List

Extant mature individuals: 940

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–30+ fruit bodies recorded per visit to each of 94 unique georeferenced sites (940 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) might be expected to exceed 1,000, therefore this is treated as a widely distributed but very small population (Criterion D) assessed as NT.

A species with a widespread distribution and often found in company with other earthstars. Most known sites are in central and southern England with comparatively few in Scotland and Wales. It is associated with various broadleaved or coniferous trees in gardens, hedgerows, open woodland/parkland and roadsides. Mostly found in base-rich and often nitrogen-rich soils with broadleaved trees (*Acer*, *Corylus*, *Fraxinus*, *Quercus*, *Robinia*, and *Ulmus*) in continental Europe (Sunhede 1989, Jeppson *et al.* 2013). The *G. fornicatum* sequence in Brock *et al.* (2009) clustered with those of *G. fornicatum* in Zamora *et al.* (2014), but was generated from material collected in Jersey and so is beyond the geographic scope of the current assessment. Unpublished sequences (LMS) obtained from this species collected in Breconshire and Pembrokeshire also clustered with the published sequences of *G. fornicatum*. Bailey *et al.* (2015) assessment: 730 mature individuals VU D1.

***Geastrum lageniforme* Vittad.**

This assessment: EN D

Previous assessments: Ex (1992), NT (2006)

Extant mature individuals: 150

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–10 fruit bodies recorded per visit to each of 15 unique georeferenced sites (150 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as EN D.

A species with a scattered distribution although usually found in central and southern England and associated with various woody species such as *Alnus*, *Betula*, *Corylus*, *Crataegus*, *Cupressus*, *Larix*, *Pinus* and *Quercus* in hedges, parks and woodland. Elsewhere in Europe it is associated with dry woodlands on calcareous soil or sandy sites with *Robinia* (Sunhede 1989, Jeppson *et al.* 2013). This species has undoubtedly

been confused with the commoner *G. triplex* in the past. Indeed, of the three specimens sequenced by Brock *et al.* (2009), only one, from Iping, clustered with those of *G. lageniforme* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014). The others, from Harlestone and Merthyr Mawr, and clustering with *G. triplex* sequences in Jeppson *et al.* (2013), also clustered with sequences of *G. michelianum* in Zamora *et al.* (2014) (see *G. fimbriatum* above) and so were redetermined as *G. triplex* sensu lato pending further studies on the “*triplex* group”. Conversely, a sequence in Brock *et al.* (2009) derived from a specimen (Symonds Yat) identified as *G. cf. triplex* clustered with those of *G. lageniforme* and has now been redetermined as this by J.C. Zamora.

Bailey *et al.* (2015) assessment: 120 mature individuals EN D.

***Geastrum minimum* Schwein.**

Assessment background: Although Jeppson *et al.* (2013) accepted this as a species of worldwide distribution with *G. marginatum* Vittad. listed as a synonym, further DNA sequencing by Zamora *et al.* (2014, 2015) demonstrated that the morphospecies comprised several distinct taxa. These authors could not be certain that the specimen marked as “type” in K really belonged to Schweinitz’s original material and regarded the protologue as having insufficient detail to determine which species was being described. They concluded that usage of the name *G. minimum* should be discontinued because they regarded it as a *nomen ambiguum* and *dubium* (Zamora *et al.* 2015). Two European “*minimum* group” segregate species could be distinguished within their dataset. These were *G. granulatum* Fuckel and *G. marginatum* Vittad., both of which were listed as synonyms of *G. minimum* in Sunhede (1989) and Pegler *et al.* (1995). Zamora *et al.* (2015) considered that a sequence obtained by Kasuya *et al.* (2012) from the Russian specimen K(M)154623 (and published as *G. minimum*) represented *G. granulatum* and likewise sequences from American, Spanish and Swedish material. However, these sequences do not cluster with any of those obtained from British material named as *G. minimum* (Brock *et al.* 2009, SRP 2014, unpubl.). On the other hand, all the British sequences do cluster with those of *G. marginatum* in Zamora *et al.* (2015). Therefore the sequenced British collections (and all those in K from the same sites as these) have now been redetermined as *G. marginatum*. Specimens from Cumberland were provisionally assigned to *G. marginatum* and included in the assessment, although they did not yield useful sequence data during

the current project and require further sequencing effort to confirm their identification.

***Geastrum marginatum* Vittad.**

This assessment: VU D1

Previous assessments as *G. minimum*: V (1992), VU D2 (2006)

Section 41 species as *G. minimum*

Extant mature individuals: 310

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–50+ fruit bodies recorded per visit to each of 31 unique georeferenced fruit body patches (310 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small and restricted population (Criterion D) assessed as VU D1.

A sand dune species in Britain with very few sites and often associated with other earthstars such as *G. schmidelii*. Although only confirmed by DNA sequencing as extant at two coastal sites in GB (with unconfirmed extant sites in Cumberland, E. Suffolk, Hertfordshire and N. Lincolnshire in GB plus one Manx site), *G. marginatum* is one of the most intensively-surveyed of all the British earthstars. This is due to the attention it has received at its stronghold on the Holkham NNR, part of the North Norfolk Coast SSSI, where it has been known (as *G. minimum*) since 1958 (Leech *et al.* 2009). Telfer *et al.* (2000) reported finding this species at Holkham Gap in 1995 after an apparent 37-year gap in the records (although there had been a collection in 1993 (Leech *et al.* 2009)) and noted a “severe threat” existed at the site as some of the pathside fruiting patches were at risk from trampling by people and horses. They recommended the construction of a boardwalk across the sand to prevent further erosion of the sparsely-vegetated pathsides favoured by the earthstar. This triggered conservation interest in the species and, fortunately, further fruiting patches were discovered further away from the busiest paths along several kilometres of coastline. The site has been monitored by the Norfolk Fungus Study Group since 2000 who report that “in general the earthstar appears to be thriving” (Leech *et al.* 2009). Counts of over 300 fruit bodies were recorded across the site in 2003 (Revett in FRDBI) and 2009 (Ainsworth unpublished survey for Plantlife/Natural England). The latter survey recorded 21 distinct fruiting patches using 8-figure GPS-derived Grid References,

each of which was considered to represent a different genet and formed the basis for the current assessment of mature individuals at Holkham. Other records (4- or 6-figure Grid References) were then taken into consideration bringing the site total for mature individuals at Holkham to 260.

The other extant British site confirmed by DNA sequence data is in Westmorland VC69 which was only discovered in 2013 (Ainsworth *et al.* 2014). This and the four unconfirmed GB sites are currently considered as each holding a single genet (50 mature individuals in total).

Bailey *et al.* (2015) assessment (as *G. minimum*): 40 mature individuals CR D but apparently based on assuming a single genet was present at each of four sites.

***Geastrum pectinatum* Pers.**

This assessment: VU D1

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 910

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–8 fruit bodies recorded per visit to each of 91 unique georeferenced sites (910 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small but widely distributed population (Criterion D) assessed as VU D1.

A species with a widespread British distribution, associated with various broadleaved (*Corylus Crataegus*, *Fraxinus*, *Quercus*, and *Ulmus*) and gymnospermous trees (*Cedrus*, *Chamaecyparis*, *Cupressus*, *Larix*, *Picea*, *Pinus*, *Sequoia* and *Taxus*) in dunes, hedges, parks and woodlands. Mostly associated with coniferous woodland in northern Europe (Sunhede 1989) and regarded there as one of the most common earthstars. Jeppson *et al.* (2013) noted that it frequented nutrient-rich woodlands, but was sometimes found in base-poor soils and dry, open habitats. Sunhede (1989) pointed out that fungarium specimens of *G. pectinatum* were “not rarely” misdetermined as *G. striatum*. Conversely, weathered specimens of *G. striatum* can be misdetermined as *G. pectinatum*. Indeed, a specimen from Alcester bearing the latter name sequenced by Brock *et al.* (2009) yielded an ITS sequence clustering with those of *G. striatum* in Jeppson *et al.* (2013) and it has now been redetermined as this. Of

the remaining two *G. pectinatum* sequences in Brock *et al.* (2009), one was generated from Jersey material, and therefore beyond the geographical scope of this project, and the other, sourced from Baldock, clustered with sequences of *G. pectinatum* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014).

Bailey *et al.* (2015) assessment: 710 mature individuals VU D1.

***Geastrum pseudolimbatum* Hollós**

This assessment: NA

Previous assessments: NE (1992), NE (2006)

Assessment: A single fruit body recently discovered (2011) under conifers at one site in Britain (Shalford) and used as a voucher to support the addition of *G.*

pseudolimbatum to the British list (Ainsworth & Henrici 2015). However, an ITS sequence generated from this material by LMS for this project failed to cluster with those of *G. pseudolimbatum* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014).

Instead the sequence clustered with those of *G. coronatum* and so the specimen has been redetermined as this and *G. pseudolimbatum* will be excluded from the British list (CBIB) in due course.

Geastrum pseudolimbatum is a rare European species of warm, dry, “steppic” sites and usually associated with sandy soils, including dunes. It is also found in open wooded or nitrogen-rich sites with various trees such as *Crataegus*, *Cupressus*, *Pinus*, *Populus*, *Quercus* and *Robinia* (Sunhede 1989, Jeppson *et al.* 2013).

Excluded from the assessment of Bailey *et al.* (2015).

***Geastrum quadrifidum* Pers.**

This assessment: VU D1

Previous assessments: V (1992), NT (2006)

Extant mature individuals: 230

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–5 fruit bodies recorded per visit to each of 23 unique georeferenced sites (230 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) might be expected to exceed 250, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

Three specimens in K named as this (or “*Geastrum quadrifidum* cf.” in one case) with published DNA sequences (Brock *et al.* 2009) have been redetermined as the recently-described species *G. britannicum* (Zamora *et al.* 2015) and are considered herein under that new name together with specimens subsequently redetermined as *G. britannicum* on morphological evidence (B.M. Spooner pers. comm.).

Geastrum quadrifidum has a predominantly southern British distribution and is usually found on calcareous soils associated with various trees such as *Cupressus*, *Fagus*, *Picea*, *Pinus* and *Taxus*. Regarded as one of the commonest earthstars and as “mainly a forest species growing on well drained, +/- calcareous soils” in northern Europe (Sunhede 1989) and as a species of nitrogen-rich woodlands or calcareous dry grasslands under *Juniperus* (Jeppson *et al.* 2013).

Bailey *et al.* (2015) assessment: 230 mature individuals EN D.

***Geastrum rufescens* Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

The ITS sequence barcode (Brock *et al.* 2009) from a specimen collected near Stevenage clustered with those of *G. rufescens* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014). However, a specimen collected in Kew Gardens sequenced by Brock *et al.* (2009) and clustering with those of *G. triplex* in Jeppson *et al.* (2013) was also found to cluster with sequences of *G. michelianum* in Zamora *et al.* (2014) (see *G. fimbriatum* above) and so was redetermined as *G. triplex* sensu lato pending further studies on the “*triplex* group”. Conversely, a sequence in Brock *et al.* (2009) derived from a specimen (Limpsfield Chart) identified as *G. cf. fimbriatum* clustered with those of *G. rufescens* and has now been redetermined as this.

Bailey *et al.* (2015) assessment: NT but based on 1130 mature individuals and so should be amended to LC.

***Geastrum schmidelii* Vittad.**

This assessment: VU D1

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 420

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–5 fruit bodies recorded per visit to each of 41 unique georeferenced sites (410 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

A species with a scattered distribution in Britain often associated with coastal sand-dunes with a short sward. It can often produce many fruit bodies where it occurs although few notes regarding abundance are included in the British national databases. Elsewhere in Europe, *G. schmidelii* is found in open sandy environments, often with *Pinus* or in mixed woods, and in calcareous, dry grasslands sometimes beneath *Juniperus* (Sunhede 1989, Jeppson *et al.* 2013). An ITS sequence (Brock *et al.* 2009) from a specimen collected at Sandscale Haws clustered with those of *G. schmidelii* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014). Bailey *et al.* (2015) assessment: 370 mature individuals VU D1.

***Geastrum striatum* DC.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

The ITS sequence barcode (Brock *et al.* 2009) from a specimen collected in Pinner clustered with those of *G. striatum* in Jeppson *et al.* (2013) and in Zamora *et al.* (2014).

Bailey *et al.* (2015) assessment: LC.

***Geastrum triplex* Jungh.**

This assessment: LC (see Table 1)

Previous assessments: R (1992, as *G. saccatum?*), LC (2006)

Scottish Biodiversity List species

Sequencing data (Kasuya *et al.* 2012) show that worldwide specimens named as this belong in multiple taxa and that a taxonomic revision is needed. Furthermore it should be noted that *G. triplex* was originally described from Java and that European material is “presumably” (fide Kasuya *et al.* 2012) not *G. triplex* sensu stricto and so will require a new name(s) in due course. The specimen named as this (from Otterbourne) sequenced by Brock *et al.* (2009) clustered with the *G. triplex* sequence in Jeppson *et al.* (2013), but also clustered with those of *G. michelianum* in Zamora *et al.* (2014).

This collection was annotated as *G. triplex* sensu lato in K pending further studies on the “*triplex* group”.

Bailey *et al.* (2015) assessment: LC.

***Myriostoma coliforme* (Dicks.) Corda**

This assessment: CR D

Previous assessments: Ex (1992), CR B (2006)

Section 41 species

Extant mature individuals: 20

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–30 fruit bodies recorded per visit to each of two unique georeferenced sites (20 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 50, therefore this is treated as a very small and restricted population (Criterion D) assessed as CR D.

Although British records for this species date back to the seventeenth century, there was a recording gap from 1880 until its re-discovery in Suffolk in 2006 and it was described as “apparently extinct” in Phillips (1981) and unofficially assessed as such in Ing (1992). This earthstar-relative is now known from two extant sites in Suffolk (Evans 2006a, b; Mahler & Ainsworth 2010) on sandy banks beneath broadleaved trees. Unfortunately for the recovery of this fungus in Britain and despite a high level of surveillance, several specimens have already disappeared from one of the sites, allegedly due to collectors, and so it was recently proposed for special protection by inclusion on Schedule 8 of the Wildlife & Countryside Act (decision pending).

This species is present in sandy soil in the Channel Islands and has a predominantly central to southern European distribution, favouring warm, open, well-drained, calcareous and often sandy or rocky wooded sites (Sunhede 1989, Jeppson *et al.* 2013). It is probably close to its northern limit in Sweden and Britain.

An ITS sequence (SRP 2014) from a specimen representing one of the extant English sites (material from the more recently discovered site failed to yield any useful sequence) and two sequences obtained from Jersey collections (SRP 2014, Brock *et al.* 2009) clustered with that of *M. coliforme* in Jeppson *et al.* (2013) and the European representative of this species in Zamora *et al.* (2014).

Bailey *et al.* (2015) assessment: 40 mature individuals CR D but erroneously based on four extant sites.

***Sphaerobolus stellatus* Tode**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

Assessments for *Cantharellaceae*

***Cantharellus amethysteus* (Quél.) Sacc.**

This assessment: VU D1

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 770

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–10 fruit bodies recorded per visit to each of 77 unique georeferenced sites (770 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

A species with a widespread distribution in Britain, it is usually associated with *Fagus* and *Quercus*, occasionally with *Betula*, *Picea* or *Pinus*, and often fruits in moss (Pegler *et al.* 1997, Kibby 2012).

Bailey *et al.* (2015) assessment: NT but based on 780 mature individuals and so should be amended to VU D1.

***Cantharellus aurora* (Batsch) Kuyper**

This assessment: VU D1

Previous assessments: V (1992, as *C. lutescens*), LC (2006)

Extant mature individuals: 600

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–10 fruit bodies recorded per visit to each of 60 unique georeferenced sites (600 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

A species with an apparently widespread distribution in Britain, although the few records associated with lowland English *Fagus* and *Quercus* may prove to be of *C. tubaeformis* var. *lutescens*. In GB, *C. aurora* is mainly associated with upland *Pinus* and *Betula* in Scotland. It is occasionally found with *Picea* in plantations, preferring calcareous soils and margins of wet upland areas. (Pegler *et al.* 1997, Kibby 2012 [as *Craterellus lutescens*]). The current name in CATE2 and IF is *Craterellus lutescens*, a decision yet to be adopted by CBIB and FRDBI.

Bailey *et al.* (2015) assessment (as *C. lutescens*): 500 mature individuals VU D1.

***Cantharellus cibarius* Fr.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Cantharellus cinereus* (Pers.) Fr.**

This assessment: NT

Previous assessments: V (1992), LC (2006)

Extant mature individuals: 1020

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–10 fruit bodies recorded per visit to each of 102 unique georeferenced sites (1020 mature individuals). This is treated as a very small but widely distributed population (Criterion D) and since the total number of known mature individuals exceeds 1,000 but is less than 1,100, it is assessed as NT.

A species with a widespread distribution in Britain, mainly associated with *Fagus*, *Quercus* and *Tilia*, occasionally fruiting near *Betula*, *Picea*, *Pinus*, *Ilex* or *Corylus* and found mostly in native woodland. (Pegler *et al.* 1997, Kibby 2012 [as *Craterellus cinereus*]).

Bailey *et al.* (2015) assessment: LC but based on 980+ mature individuals (based on monad counting only) and so could be amended to VU D1 or NT but should be re-assessed at a finer resolution.

***Cantharellus ferruginascens* P.D. Orton**

This assessment: DD

Previous assessments: V (1992), NT (2006)

Scottish Biodiversity List

Extant mature individuals: 390

Assessment if assumed to represent a single taxon: 1–10 fruit bodies recorded per visit to each of 39 unique georeferenced sites (390 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

British collections named as this show a widespread distribution in Britain and a wide range of tree hosts and associated soil pH. Most are associated with *Fagus* and *Quercus* although some are found fruiting near *Betula* and *Pinus*. However, there is some taxonomic uncertainty around the paler chanterelles and a several names have been used in Europe. Pegler *et al.* (1997) treat *C. ferruginascens* as a synonym of *C. pallens* whereas CBIB, acknowledging that *C. pallens* sensu Pegler *et al.* is *C. ferruginascens*, regards *C. pallens* in the original sense as a synonym of *C. cibarius*. Watling & Turnbull (1998) and Kibby (2012) differ in recognising *C. cibarius*, *C. ferruginascens* and *C. pallens* as three distinct British species. Other names in use elsewhere in Europe that have been applied to British material, for example in online fungal identification forums, include *C. subpruinosis* which was distinguished and described by Eyssartier & Buyck (2000).

Unpublished molecular data (I. Olariaga pers. comm.) indicate that material identified as *C. ferruginascens* in Britain belongs to at least three species: *C. cibarius*, *C. ferruginascens* and *C. pallens*. Hence due to widespread and ongoing taxonomic confusion, it is not possible to assess the conservation status of *C. ferruginascens* in Britain until a resolved taxonomy has been published, British material has been sequenced and the historical record data have been reinterpreted where possible. Clearly *C. ferruginascens* in the sense of British authors (several taxa) can be assessed as VU D1. In the more restricted and original sense (the type was collected in Norbury Park), *C. ferruginascens* would necessarily be assessed at the same, or a greater, level of threat, but without further detailed studies, it is not possible to assign this species to any category other than DD. A separate assessment for *C. pallens* (possibly the larger component of *C. ferruginascens* sensu. auct. Brit.) will also be required.

Bailey *et al.* (2015) assessment: 280 mature individuals VU D1 but several taxa are likely to have been included.

***Cantharellus friesii* Quél.**

This assessment: EN D

Previous assessments: V (1992), VU B (2006)

Scottish Biodiversity List

Section 41 species

Extant mature individuals: 130

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–10 fruit bodies recorded per visit to each of 13 unique georeferenced sites (130 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 250, therefore this is treated as a very small population (Criterion D) assessed as EN D.

A species with a limited but widespread distribution in Britain, mainly associated with *Fagus* and *Betula*, probably with a Scottish stronghold and possibly confined to northern Britain (Pegler *et al.* 1997, Kibby 2012). Sequences obtained from two Scottish specimens preserved in K clustered with a corresponding sequence derived from Swiss material (SRP 2014).

Bailey *et al.* (2015) assessment: 60 mature individuals EN D.

***Cantharellus melanoxeros* Desm.**

This assessment: EN D

Previous assessments: NE (1992), VU D2 (2006)

Scottish Biodiversity List

Section 41 species

Extant mature individuals: 180

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–6 fruit bodies recorded per visit to each of 18 unique georeferenced sites (180 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 250, therefore this is treated as a very small population (Criterion D) assessed as EN D.

A species with a limited but widespread distribution in Britain, associated with various broadleaved and coniferous trees, mostly in native woodland, but also found in conifer plantations. (Pegler *et al.* 1997, Kibby 2012).

An ITS sequence was obtained from a Scottish (Loch Eilt) collection held in K (Taylor *et al.* 2014) and, in the absence of publicly available authentic reference sequences, it was compared with sequences obtained by LMS (SRP 2014) from English (Dunsfold, Fishbourne, Loddiswell, New Forest (two sites)) and Italian (two sites) collections held in K. All sequences formed a single cluster.

Bailey *et al.* (2015) assessment: 210 mature individuals EN D.

***Cantharellus tubaeformis* Fr.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Craterellus cornucopioides* (L.) Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Pseudocraterellus undulatus* (Pers.) Rauschert**

This assessment: LC (see Table 1)

Previous assessments: V (1992 as *P. sinuosus*), LC (2006)

Bailey *et al.* (2015) assessment: LC.

Assessments for *Hericiaceae*

***Dentipellis fragilis* (Pers.) Donk**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 1?

Assessment: A single fruit body recently discovered (Henrici 2006) on a *Carpinus* log at one site in Britain (Putt Wood, E. Kent) and assumed to represent a single mature individual. Current distribution data should therefore be regarded as preliminary and

further verified collections, preferably over at least a ten year period, are required to provide adequate information for a sound status assessment. There are three subsequent English records from E. Gloucestershire and N. Wiltshire and an earlier one from N. Somerset made in 1987 but these remain unverified and doubtful. This is a wood-inhabiting resupinate tooth fungus and is a member of an assemblage of indicator species used to rank dead beech habitat quality in Denmark (Heilmann-Clausen & Christensen 2000), Sweden (Nitare 2010) and elsewhere in continental Europe.

Assessed as DD in Bailey *et al.* (2015) and therein (p.12) erroneously referred to as “recently described” and “first described in 19622 which is the year of Donk’s recombination. The name is based on Persoon’s *Hydnum fragile* published in 1801 and sanctioned by Fries.

***Hericium abietis* (Weir ex Hubert) K.A. Harrison**

This assessment: NA

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 1

Assessment: Recorded once in GB (and Europe) in 2002 fruiting on imported *Pseudotsuga* timber in Kent (Henrici 2013). This was assumed to represent a single mature individual and an introduction (probably from N. America). Britain is currently regarded as lying outside the natural range of this wood-inhabiting species and so a regional assessment is Not Applicable. This was sequenced (as *H. alpestre* (cf.)) by Brock *et al.* (2009) and redetermined as *H. abietis* in Hallenberg *et al.* (2013).

Excluded from the assessment of Bailey *et al.* (2015).

***Hericium cirrhatum* (Pers.) Nikol.**

This assessment: VU D1

Previous assessments: V (1992 as *Creolophus cirrhatum*), LC (2006)

Extant mature individuals: 326

Category of mature individual: Lignicolous fungus of large centralized decay columns

Assessment: Based on personal field observations, an occupied tree (assumed to be inhabited by a single genet) might occasionally fragment into two physically separated elements (ramets or mature individuals sensu IUCN), each bearing fruit bodies. The 163 known occupied British trees (Jan. 1965 to Dec. 2014) were therefore

assumed to represent 326 extant mature individuals. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

A species with a mostly southern distribution in GB usually fruiting on mature *Fagus sylvatica* but rarely for more than 1–3 consecutive years on a particular trunk or branch (Boddy *et al.* 2011). It has been used to indicate important sites for beech deadwood fungi (Ainsworth 2005a) and it also fruits occasionally on *Acer*, *Aesculus*, *Betula*, *Carpinus*, *Fraxinus*, *Quercus* and *Ulmus*. Of the sequences in Brock *et al.* (2009), one of the two labelled as *H. cirrhatum* clustered with those of *H. erinaceus* and with those of the latter species subsequently generated by LMS (SRP 2014). The corresponding specimen, obtained from a Surrey (Croham Hurst) collection, has now been redetermined as *H. erinaceus*.

See Section 3.2 for comments on methodology of Bailey *et al.* (2015).

***Hericium coralloides* (Scop.) Pers.**

This assessment: EN D

Previous assessments: V (1992), NT (2006)

Section 41 species

Extant mature individuals: 210

Category of mature individual: Lignicolous fungus of large centralized decay columns

Assessment: Based on personal field observations, an occupied tree (assumed to be inhabited by a single genet) might occasionally fragment into several physically separated elements (ramets or mature individuals sensu IUCN), each bearing fruit bodies. Mycelia of *H. coralloides* are usually more extensive than those of *H. cirrhatum* and so each occupied tree is assumed to represent three, rather than two, mature individuals. This is an estimate of the average number of ramets per occupied tree. Most mycelia of this species are thought to remain as a single ramet until the resource is exhausted, but occasionally an occupied tree may shatter into several occupied fragments. An exceptional example was encountered during a survey of Epping Forest beech pollards by AMA when an old, top-heavy, lapsed pollard that had collapsed during the previous year was inspected. *H. coralloides* was found fruiting on no less than ten fragments of the shattered main branches (Ainsworth 2007) lying on the forest floor.

Applying the assumption that each occupied tree represents three mature individuals, the 70 known occupied British trees (Jan. 1965 to Dec. 2014) were therefore assumed to represent 210 extant mature individuals. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 250 (84 occupied trees minimum), therefore this is treated as a very small population (Criterion D) assessed as EN D.

Within GB, this species has thus far been found in England only. It has been used to indicate important sites for beech deadwood fungi (Ainsworth 2005a) and has a predominantly southern distribution with a national stronghold in the New Forest. Fruiting on mature *Fagus sylvatica* and occasionally on *Fraxinus excelsior*, it is rarely observed for more than 5 consecutive years on a particular trunk or branch (Boddy *et al.* 2011). ITS sequence barcodes (Brock *et al.* 2009) from specimens collected from Cambridgeshire and W. Sussex clustered with those obtained by LMS (SRP 2014) for specimens from Berkshire, E. Suffolk, Hertfordshire and S. Hampshire. The corresponding sequence derived from a specimen from E. Gloucestershire (SRP 2014) clustered with those of *H. erinaceus* and this specimen has now been redetermined. See Section 3.2 for comments on methodology of Bailey *et al.* (2015).

***Hericium erinaceus* (Bull.) Pers.**

This assessment: VU D1

Previous assessments: V (1992), LC (2006)

Section 41 & 42 species

Wildlife & Countryside Act Schedule 8 species

Extant mature individuals: 441

Category of mature individual: Lignicolous fungus of large centralized decay columns

Assessment: Based on personal field observations, an occupied tree (assumed to be inhabited by a single genet) might occasionally fragment into several physically separated elements (ramets or mature individuals *sensu* IUCN), each bearing fruit bodies. As for *H. coralloides* (see above), mycelia are usually more extensive than those of *H. cirrhatum* and so each occupied tree is assumed to represent three, rather than two, mature individuals.

The 147 known occupied British trees (Jan. 1965 to Dec. 2014) were therefore assumed to represent 441 extant mature individuals. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

Within GB, this species is mostly found in England, although there are two occupied trees known in Wales. It has been used to indicate important sites for beech deadwood fungi (Ainsworth 2005a) and has a predominantly southern distribution with a national stronghold in the New Forest (Ainsworth 2008a). It is almost always seen fruiting on trunks and larger branches of *Fagus sylvatica* and can fruit intermittently on the same tree for over 20 and possibly 40 y (Boddy *et al.* 2011). It has also occasionally been recorded on other genera of broadleaved trees of which *Quercus* is the most frequent (incl. *Q. cerris*).

Hericium erinaceus is sometimes commercially cultivated as an edible mushroom, often using mycelium of N. American origin. This carries some risk of inadvertent introduction of, and thence establishment and potential replacement of, native stock in the wild, but the naturally-occurring fruit bodies of this species are currently legally protected in Britain (Schedule 8, Wildlife and Countryside Act 1998). ITS sequence barcodes (Brock *et al.* 2009) from specimens collected from S. Hampshire and Surrey cluster with each other and those obtained by LMS (SRP 2014) for specimens from Berkshire, E. Kent, Middlesex, S. Essex, S. Hampshire, Surrey and W. Cornwall. Published sequences (Brock *et al.* 2009) obtained from a specimen identified as *H. cirrhatum* and one identified as *H. coralloides* (see above) also clustered with those of *H. erinaceus* and the relevant specimens have now been redetermined. See Section 3.2 for comments on methodology of Bailey *et al.* (2015).

***Laxitextum bicolor* (Pers.) Lentz**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: >33

Assessment: The British population cannot be estimated because this species is relatively poorly known within the selection of taxa assessed herein. It is a widespread, mainly resupinate corticioid (patch- or crust-forming) wood-inhabiting

fungus that fruits on several genera of broadleaved trees (?predominantly *Betula* and *Fagus*) in gardens or more natural woodland. Its fruit bodies are relatively inconspicuous and macroscopically resemble those of several common species, such as *Stereum* spp., and it is perhaps likely to be overlooked on organised forays unless it is brought to the attention of a specialist or surveyor who is aware of its existence. Work for a recently-published photographic guide to the resupinate fungi of Hampshire, for example, yielded three new sites within the county (Hugill & Lucas 2015). There are no known national strongholds for this species, although repeated recording in an area (Warwickshire) by those familiar with it can create the impression of a stronghold. It is expected that many more fruiting records would be made if this species was widely targeted, but it is not currently possible to estimate the number of occupied trees that might exist nationally based on historical patterns of recording effort. Based on the size of its fruit bodies and its occurrence on branches of varying diameters, it may be assumed that, like many common stereoid species, several conspecific mycelia may coexist in close proximity. However, in the absence of any population studies or even basic field observations of territorial interaction zones in naturally-decayed wood, it is currently not possible to estimate the numbers of genets and ramets per branch or trunk for this species. Treating it as a “terrestrial patch-forming fungus”, Bailey *et al.* (2015) assessed it as VU D1.

Assessments for *Bankeraceae*

***Bankera fuligineoalba* (J.C. Schmidt) Pouzar**

This assessment: LC (see Table 1)

Previous assessments: E (1992), LC (2006)

Scottish Biodiversity List

Section 41 species (although thought likely to be Extinct in England)

Two ITS sequence barcodes (Brock *et al.* 2009) from specimens collected in Mid Perthshire and Morayshire are similar to each other and to sequences obtained by LMS from collections from Easternness and Morayshire (SRP 2014) and to those derived from Scottish material in Van der Linde *et al.* (2008).

Bailey *et al.* (2015) assessment: NT but based on 1240 mature individuals and so should be amended to LC.

***Bankera violascens* (Alb. & Schwein.) Pouzar**

This assessment: NA

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 340

Assessment: Recorded fruiting, and with over 1,000 fruit bodies seen on one site visit (S. Taylor pers. comm.), within *Picea* plantations in Scotland and presumably introduced with living tree roots as an ectomycorrhizal partner. Britain is currently regarded as lying outside the natural range of this species (and *Picea*) and so a regional assessment is Not Applicable.

Bailey *et al.* (2015) assessment: 130 mature individuals EN D.

***Boletopsis perplexa* Watling & J.Milne**

This assessment: EN D

Previous assessments: V (1992), VU D2 (2006)

Scottish Biodiversity List (as *B. leucomelaena*)

Extant mature individuals: 40

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–few fruit bodies recorded per visit to each of four unique georeferenced sites (40 mature individuals) and associated with *Pinus* in Scotland. The total number of mature individuals (including those that are extant but not yet recorded) might be expected to exceed 50, therefore this is treated as a very small population (Criterion D) assessed as EN D.

Further molecular studies are required to investigate whether *Boletopsis perplexa* should be treated as a later synonym of *B. subsquamosa* (Taylor *et al.* 2014), but this would not affect the assessment. There is also one recent English *Boletopsis* collection from the New Forest which requires further sequencing work before it can be identified. Should this prove to be yet another distinct species, it too will require assessment (currently qualifying for CR D).

Bailey *et al.* (2015) assessment: 40 mature individuals CR D.

***Hydnellum aurantiacum* (Batsch) P. Karst.**

This assessment: VU D1

Previous assessments: E (1992), VU B (2006)

Scottish Biodiversity List

Extant mature individuals: 890

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–50 fruit bodies recorded per visit to each of 89 unique georeferenced sites (890 mature individuals) and associated with *Pinus* in Scotland. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

Bailey *et al.* (2015) assessment: 360 mature individuals VU D1. They also provided an assessment of *H. auratile* (DD) but this species is excluded from the online checklist of British & Irish *Basidiomycota* (CBIB) and so is not assessed in the current report.

***Hydnellum caeruleum* (Hornem.) P. Karst.**

This assessment: VU D1

Previous assessments: V (1992), NT (2006)

Scottish Biodiversity List

Extant mature individuals: 850

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–50 fruit bodies recorded per visit to each of 85 unique georeferenced sites (850 mature individuals) and mainly associated with *Pinus* in Scotland. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

Two Scottish sequences in Parfitt *et al.* (2007) cluster with those obtained from Scottish material by Van der Linde *et al.* (2008).

Bailey *et al.* (2015) assessment: 560 mature individuals VU D1.

***Hydnellum conrescens* (Pers.) Banker**

This assessment: see below

Previous assessments: V (1992), LC (2006)

Scottish Biodiversity List

Section 41 & 42 species

Assessment background: Despite the large number of apparently occupied 1km grid squares (Table 1), this species cannot readily be assigned to the LC category as was done in 2006. Using the available morphological and molecular data obtained from British collections (Parfitt *et al.* 2007, Ainsworth *et al.* 2010), the taxonomic and identification issues are such that it is currently not possible to confirm that *H. conrescens*, as neotypified by Maas Geesteranus (1974), is a British species. Collections named *H. conrescens* in the sense of British authors (*sensu auct. Brit.*) clearly comprise several species, some of which are likely to be undescribed. Currently it is not possible to state whether *H. conrescens* s.str. has been collected in Britain because there are no neotype reference sequences available for comparison with our “unknowns”. The British taxon representing the most plausible candidate, based on morphological considerations, is designated as *H. ?conrescens* in this assessment pending further molecular studies.

Furthermore, and despite being assessed as a species of Least Concern in 2006, there is currently no known British material filed as *H. scrobiculatum* which agrees with its neotypified concept. To compound the confusion surrounding *H. conrescens*, much of the British material determined as *H. scrobiculatum*, and probably all of the English component, represents the same pool of taxa as detected within *H. conrescens sensu auct. Brit.* A recent combined morphological and molecular analysis of *H. conrescens sensu auct. Brit.* indicated that at least five component taxa are involved (Ainsworth *et al.* 2010). Three are now recognised as Scottish species and morphologically distinguishable: *H. cumulatum*, *H. gracilipes* (Ainsworth 2011) and a potentially undescribed species *Hydnellum* sp. (Group III in Ainsworth *et al.* 2010). The two remaining species with overlapping macroscopic characters and indistinguishable spores are considered herein as *Hydnellum* sp. and *H. ?conrescens* (Groups I and V respectively in Ainsworth *et al.* 2010). Although the former species, characterised by rosy tints when immature (and possibly described as *H. tardum* in Maas Geesteranus 1975), occurs in Scotland and England, the latter, characterised by more fulvous tints when immature, might be more southern in distribution as it has only been detected in England to date.

It is not possible, based on currently available molecular sequencing data, to untangle the historical collections (let alone the unvouchered records) of *H. conrescens sensu auct. Brit.* and *H. scrobiculatum sensu auct. Brit.* and correctly allocate them to either

Hydnellum sp. (Group I) or *H. ?concrescens* (Group V). Hence our knowledge of their distribution in Britain is currently unreliable and their conservation assessments are as follows:

***Hydnellum* sp. (Group I, rosy tints when immature)**

This assessment: DD

***Hydnellum ?concrescens* (Group V, fulvous tints when immature)**

This assessment: DD

Bailey *et al.* (2015) assessment of *H. concrescens*, presumably based on records for both taxa above: LC.

***Hydnellum cumulatum* K.A. Harrison**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 220

Assessment: 1–15 fruit bodies recorded per visit to each of 22 unique georeferenced sites (220 mature individuals) and associated with *Pinus* in Scotland. As this species has only been verified as British in 2010 (Ainsworth 2011), it is too early to estimate whether the total number of mature individuals (including those that are extant but not yet recorded) exceeds 250 or 1,000. An assessment should be carried out in or after 2020 once ten years of recording has elapsed. This taxon, with others, had formerly been recorded as *H. scrobiculatum* in Scotland.

Bailey *et al.* (2015) placed this species on their excluded list but assessed it nonetheless. They assessed it as VU D1 but, as this was based on 160 mature individuals, this should be amended to EN D.

***Hydnellum ferrugineum* (Fr.) P. Karst.**

This assessment: VU D1

Previous assessments: E (1992), NT (2006)

Scottish Biodiversity List

Section 41 species (although thought likely to be Extinct or never recorded in England)

Extant mature individuals: 500

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–30 fruit bodies recorded per visit to each of 50 unique georeferenced sites (500 mature individuals) and mainly associated with *Pinus* in Scotland. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

If this species ever occurred in England, it was likely to have been as a short-lived introduction with planted pines as is thought to have occurred with *Bankera fuligineoalba* in nineteenth-century Berkshire. However, in the absence of any verified English collections and considerable taxonomic confusion surrounding this taxon, we have assumed that the few historical English records were based on misdeterminations and all English records are therefore doubtful and excluded from this assessment. Three Scottish sequences in Parfitt *et al.* (2007) cluster with each other and with those derived from Scottish material in Van der Linde *et al.* (2008).

Note on *H. ferrugineum*: Dahlberg & Mueller (2011) noted that field observations of the mycelium of this species indicate that it exists as a dense unfragmented mat (Hintikka & Näykki 1967; AMA pers. obs.) inferring that a single genet would equate to a single ramet (mature individual). Furthermore, Dahlberg & Mueller (2011) suggested that each functional individual “would be counted as two mature individuals to be conservative”, presumably in contrast to other stipitate hydroids for which the “terrestrial patch-forming” rules would apply (see above) and which would yield five times as many mature individuals per functional individual. Such exceptional treatment for one species compared to all the congeneric taxa and other stipitate hydroids with which it usually fruits hardly seems warranted given that many stipitate hydroids often fruit in very close proximity. Furthermore, such an approach does not seem to receive support within the IUCN red-listing Guidelines (IUCN 2014) which highlight the importance of identifying entities of comparable “extinction proneness” for assessment purposes. In these Guidelines, the ramet (mature individual) of a terrestrial fungus is treated more as a theoretical, rather than a physical, entity: the smallest entity that the mycelium could “be divided into without causing its death or preventing reproduction”. Since it is not clear how such a theoretical entity would differ for *H. ferrugineum* when compared with that of other stipitate hydroids, in this assessment we have pragmatically categorised them all as terrestrial patch-forming fungi and applied a uniform assessment treatment.

Bailey *et al.* (2015) assessment: 490 mature individuals VU D1.

***Hydnellum gracilipes* (P. Karst.) P. Karst.**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 130

Assessment: 1–few fruit bodies recorded per visit to each of 13 unique georeferenced sites (130 mature individuals) and associated with *Pinus* in Scotland. As this species has only been verified as British in 2010 (Ainsworth 2011), it is too early to estimate whether the total number of mature individuals (including those that are extant but not yet recorded) exceeds 250. An assessment should be carried out in or after 2020 once ten years of recording has elapsed. This taxon, with others, had formerly been recorded as *H. scrobiculatum* in Scotland.

Bailey *et al.* (2015) assessment: 90+ mature individuals DD.

***Hydnellum peckii* Banker**

This assessment: LC (107 monads from FRD plus CATE2 but many more collections georeferenced in FRD at finer resolution, >1,100 mature individuals)

Previous assessments: E (1992), LC (2006)

Scottish Biodiversity List

Three Scottish sequences in Parfitt *et al.* (2007) cluster with each other and with those derived from Scottish material in Van der Linde *et al.* (2008).

Bailey *et al.* (2015) assessment: LC.

***Hydnellum scrobiculatum* (Fr.) P. Karst.**

This assessment: NA

Previous assessments: E (1992), LC (2006)

Scottish Biodiversity List

Section 41 & 42 species

Assessment background (see discussion under *H. conrescens*): Despite the large number of apparently occupied 1km grid squares (FRDBI), this species cannot readily be assigned to the LC category. Using the available morphological and molecular data (Parfitt *et al.* 2007, Ainsworth *et al.* 2010), there is currently no known British material named as *H. scrobiculatum* which fully accords with its neotypified concept.

The examined material deviates with respect to spore size, shape and ornamentation when compared with material authenticated by R.A. Maas Geesteranus. Microscopic examination of mature spore size and ornamentation (from spore prints) and analysis of sequencing data indicate that specimens formerly identified as *H. conrescens* sensu auct. Brit. and *H. scrobiculatum* sensu auct. Brit. constitute a single pool comprising two different but overlapping suites of taxa occurring in Scotland and elsewhere in GB. In Scotland, the former choice between naming material as either *H. conrescens* or *H. scrobiculatum* is now replaced by a choice from the following four currently recognised taxa:

- *Hydnellum cumulatum*
- *Hydnellum gracilipes*
- *Hydnellum* sp. (Group I, rosy tints when immature)
- *Hydnellum* sp. (Group III)

In England, the current choice is between the two following taxa:

- *Hydnellum* sp. (Group I, rosy tints when immature)
- *Hydnellum ?conrescens* (Group V, fulvous tints when immature)

Therefore, since there is no known molecular or spore-based evidence supporting the continued inclusion of *H. scrobiculatum* on the British list, it is categorised as NA in this assessment.

Bailey *et al.* (2015) assessment of *H. scrobiculatum*, presumably based on records for several of the “bulleted” taxa above: LC.

***Hydnellum* sp. (Group III)**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: unknown

Assessment: Thus far, this species has only been found fruiting associated with *Pinus* in Scotland. As this species has yet to be formally described, few recorders are aware of its existence and it is therefore too early to estimate the total number of mature individuals. When the species has been described, an initial assessment should be carried out preferably after ten years of recording in suitable habitat. This taxon, with others, had formerly been recorded as *H. scrobiculatum* in Scotland.

Taxon not recognised by Bailey *et al.* (2015) and records of this probably included in their assessment of *H. scrobiculatum*.

***Hydnellum spongiosipes* (Peck) Pouzar**

This assessment: NT

Previous assessments: R (1992), LC (2006)

Scottish Biodiversity List

Section 41 & 42 species

Extant mature individuals: 950

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–12 fruit bodies recorded per visit to each of 95 unique georeferenced sites (950 mature individuals) and mainly associated with *Fagaceae*. The total number of mature individuals (including those that are extant but not yet recorded) might be expected to exceed 1,000, therefore this is treated as a widely distributed but very small population (Criterion D) assessed as NT.

Three ITS sequence barcodes (Brock *et al.* 2009) from specimens collected in E. Kent, Merionethshire and S. Hampshire cluster with each other, with a sequence obtained by LMS from a collection from Surrey (SRP 2014) and with one obtained by Parfitt *et al.* (2007) from a Berkshire collection.

Bailey *et al.* (2015) assessment: 1140+ mature individuals LC.

***Phellodon confluens* (Pers.) Pouzar**

This assessment: NT

Previous assessments: E (1992), LC (2006)

Scottish Biodiversity List

Section 41 & 42 species

Extant mature individuals: 680

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–? fruit bodies recorded per visit to each of 68 unique georeferenced sites (680 mature individuals) and associated with *Fagaceae* and occasionally *Betula*. Based on the existing recording data, the total number of mature individuals (including those that are extant but not yet recorded) might not be expected to reach 1,000 and therefore this could be treated as a very small population (Criterion D) assessed as VU D1. However, due to its predominantly southern distribution in

Britain, the assessment for this species is based almost exclusively on English recording data. Compared with the recent survey work on related hydroid fungi in Scotland, involving much detailed georeferencing of fruit body positions and documentation of fruiting abundance, English hydroid recording has generally been at a much lower level of resolution, often in the form “species X is fruiting somewhere at site Y”. Therefore, the numbers of genets per site cannot be as accurately ascertained for this, predominantly English species, as for related species subjected to more rigorous recording schemes. We concluded that our enumeration of extant mature individuals of *P. confluens* was an underestimate when compared to the corresponding values of related (stipitate hydroid) species with a Scottish presence. For example, the more detailed Scottish GPS and abundance data (mainly gathered by S. Taylor) available for *P. niger* and *P. tomentosus* resulted in ratios of currently occupied monads to extant mature individuals of 66:1060 and 67:1850 respectively. For the largely English *P. confluens*, the corresponding ratio is 57:680 reflecting the lack of fine-scale record data. The conservation assessment was therefore downgraded by one category to reflect this uncertainty.

The total number of mature individuals (including those that are extant but not yet recorded) might be expected to exceed 1,000 and therefore this should be treated as a very small population (Criterion D) assessed as NT. Two ITS sequence barcodes (SRP 2014) from specimens collected in Dorset and S. Hampshire cluster with each other and with sequences obtained by Parfitt *et al.* (2007) from collections from Berkshire, Buckinghamshire, Morayshire, S. Hampshire and W. Kent. Furthermore, these cluster with sequences from two Mid Perthshire collections in Van der Linde *et al.* (2008).

Bailey *et al.* (2015) assessment: 710 mature individuals VU D1.

***Phellodon melaleucus* (Sw.) P. Karst.**

This assessment: see below

Previous assessments: V (1992), LC (2006)

Scottish Biodiversity List

Section 41 & 42 species

Assessment background: *P. melaleucus* in the sense of British authors (*sensu auct. Brit.*) comprises at least three species which, although often showing distinguishing fruit body pigmentation during their maturation in the field, unfortunately are almost

always indistinguishable in the dried state. This confounds the morphological assignment of most of the older records and collections to the names on the currently-accepted British *Phellodon* list. However, some ITS barcode sequencing work has been carried out on fruit bodies collected from its British strongholds (in Scotland and England) and a site in Sweden (Parfitt *et al.* 2007, Van der Linde *et al.* 2008, Ainsworth *et al.* 2010). Swedish results are of particular importance in this context because the material supporting the original description by Elias Fries was found “in pinetis” in Femsjö, Småland (Maas Geesteranus 1975). Although further sampling is required for confirmation, the results thus far indicate that the species with lilac-tinted fruit bodies when young and found in Scotland, England and Sweden in coniferous or broadleaved woodland is most likely to be *P. melaleucus* in the original sense (*sensu stricto*) and this has been assumed herein. Parfitt *et al.* (2007), Van der Linde *et al.* (2008), Ainsworth *et al.* (2010) and SRP (2014) have provided molecular and morphological evidence supporting the presence of this taxon in Berkshire, Easternness, Moray, S. Aberdeen, S. Hampshire, Surrey and W. Kent.

The species whose immature fruit bodies frequently show yellowish rather than lilaceous tints and thus far only found with broadleaved trees and with an apparently more central or southern European distribution is likely to be undescribed. This is referred to in this assessment as *Phellodon* sp. (Group IX, yellow-tinted form) and preliminary British distribution data indicate that this is much rarer than *P. melaleucus* s. str. Within GB, it has only been detected in England and from the following vice-counties: Berkshire, Buckinghamshire, S. Hampshire and W. Kent (Parfitt *et al.* 2007, Ainsworth *et al.* 2010, SRP 2014).

There is a third species (coded Group II, PM5 in Parfitt *et al.* (2007), Ainsworth *et al.* 2010) which was found on the bank of a ditch in the New Forest and confirmation of its sequence and further work on its identification has been hampered by its lack of fruiting since it was first collected in 2004. Preliminary data (SRP 2014) suggest that it might have been rediscovered at a site in Pembrokeshire (Wyndrush Pastures) and seems very close to the N. American species *P. ellisianus* and *brunneoolivaceus* sequenced by Baird *et al.* (2013).

Assessment: There are 2080 extant mature individuals based on 208 unique georeferenced fruiting patches, however these data do not distinguish between *P.*

melaleucus s. str. and *Phellodon* sp. (Group IX, yellow-tinted form) and do not take into account the possibility of further finds of “PM5”. Based on currently available distribution data, all, or almost all, of the many Scottish records are likely to refer to *P. melaleucus* s. str. Further south in GB, *Phellodon* sp. (Group IX) is found with broadleaved trees but is expected to have a smaller population than *P. melaleucus* s. str. Using these assumptions, over half of the 2080 extant mature individuals are expected to represent *P. melaleucus* s. str. and so this species is assessed as of Least Concern. As the remaining two taxa in this species complex have yet to be formally described, few recorders are aware of them and it is therefore not possible to estimate the total number of mature individuals with any confidence. Further progress should be possible following modern fruit body surveys at known sites coupled with molecular verification of the more “morphologically difficult” specimens. Hence the current assessments for these three taxa in the *P. melaleucus* complex are:

***Phellodon melaleucus* s. str.**

This assessment: LC

***Phellodon* sp. (Group IX)**

This assessment: DD

***Phellodon* sp. (Group II, PM5)**

This assessment: DD

Bailey *et al.* (2015) assessment of *P. melaleucus*, presumably based on records for the three preceding taxa: LC.

***Phellodon niger* (Fr.) P. Karst.**

This assessment: see below

Previous assessments: R (1992), LC (2006)

Section 41 species

Assessment background: *P. niger* sensu auct. Brit. comprises at least two species with strikingly similar fruit body characters in both the fresh and dry state. This species as interpreted in the original sense shares its Swedish type locality with *P. melaleucus* in the coniferous forests of Femsjö, Småland (Maas Geesteranus 1975). Corresponding ITS barcode sequencing work carried out on fruit bodies collected from England, Scotland and Sweden (Parfitt *et al.* 2007, Van der Linde *et al.* 2008, Ainsworth *et al.*

2010) indicate that the species associating with conifers (pine) is most likely to be *P. niger* sensu stricto and this has been assumed herein. Parfitt *et al.* (2007), Van der Linde *et al.* (2008), Ainsworth *et al.* (2010) and SRP (2014) have provided molecular and ecological evidence supporting the presence of this taxon in Scotland (Easternness and S. Aberdeen) but thus far nowhere else in GB.

The species associating with broadleaved trees (mostly *Fagaceae*) and thus far found in England with two known collections from Scotland is likely to be an undescribed taxon. This is referred to in this assessment as *Phellodon* sp. (Group VII) and has been molecularly confirmed within Berkshire, Mid Perthshire (Comrie), Moray (Loch of Blairs), S. Hampshire and W. Kent (Parfitt *et al.* 2007, Ainsworth *et al.* 2010 and unpubl.).

Based on currently available evidence regarding their ecological preferences for *Pinaceae* and *Fagaceae* respectively, the historical recording data were used to assign *P. niger* sensu lato records to *P. niger* sensu stricto and *Phellodon* sp. (Group VII). This resulted in an almost 50:50 split of the estimated number of *P. niger* sensu lato genets between the two newly-recognised segregate species leading to the following assessments:

***Phellodon niger* s. str.**

This assessment: VU D1

Extant mature individuals: 500

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–15 fruit bodies recorded per visit to each of 50 unique georeferenced sites (500 mature individuals) and associated with *Pinus* in Scotland. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

***Phellodon niger* (Group VII)**

This assessment: VU D1

Extant mature individuals: 560

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1—several fruit bodies recorded per visit to each of 56 unique georeferenced sites (560 mature individuals) and associated with broadleaved trees (mostly *Fagaceae*) in England with very few known Scottish sites. There are no known extant populations in Wales. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1. Bailey *et al.* (2015) assessment of *P. niger*, presumably based on records for the two preceding taxa: LC.

***Phellodon tomentosus* (L.) Banker**

This assessment: LC

Previous assessments: E (1992), LC (2006)

Scottish Biodiversity List

Section 41 & 42 species

Extant mature individuals: 1850

Assessment: 1—140 fruit bodies recorded per visit to each of 185 unique georeferenced sites (1850 mature individuals). The total number of mature individuals exceeds 1,100, therefore this cannot be treated as a very small population (Criterion D) and is assessed as LC.

Bailey *et al.* (2015) assessment: LC.

***Sarcodon glaucopus* Maas Geest. & Nannf.**

This assessment: NA

Previous assessments: NE (1992), NE (2006). (There is a 2006 assessment of VU B for *S. glaucopus* but the evaluated taxon was *S. scabrosus*, see below).

Scottish Biodiversity List

Assessment background: A comparison of Scottish sequences obtained by Van der Linde *et al.* (2008), Brock *et al.* (2009), SRP (2014) and Ainsworth *et al.* (unpubl.) with those of Nitare & Högberg (2012) indicate that the pine-associated Scottish taxon currently known as *S. glaucopus* (e.g. Pegler *et al.* 1997) has been misdetermined and should be referred to *S. scabrosus* sensu str. Indeed Maas Geesteranus & Nannfeldt (1969) drew attention to the fact that although the Swedish *Sarcodon* species known at the time were all associated with conifers and “especially mossy spruce woods”, *S. scabrosus* differed in that it seemed to prefer pine woods. These authors neotypified the taxon from a spot that was believed to be a few

kilometres from Fries' type locality "in pinetis montanis" in Femsjö, Småland (Maas Geesteranus & Nannfeldt 1969). We conclude that, following the interpretation of Nitare & Högberg (2012), the sequenced British collections named as *S. glaucopus* are misdetermined *S. scabrosus*. Furthermore, until evidence to the contrary is forthcoming, we do not regard *S. glaucopus* as a British species and the appropriate conservation assessment is therefore NA.

Bailey *et al.* (2015) assessment: 490 mature individuals VU D1, but the assessed taxon was not *S. glaucopus*.

***Sarcodon joeides* (Pass.) Bataille**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: >10?

Assessment: Ca. 6 fruit bodies recorded at one georeferenced site (10 mature individuals). It is likely to be associated with *Castanea* and/or *Quercus* at its single English (Berkshire, Windsor Great Park) site. As this species has only been verified as British in 2008, it is too early to estimate whether the total number of mature individuals (including those that are extant but not yet recorded) might exceed 50. An assessment should be carried out in or after 2018 once ten years of recording has elapsed. Material from the only known British site was collected in 2008 and 2010 and the derived ITS sequences clustered with that obtained from an Italian specimen associated with *Castanea* collected by F. Boccardo (Ainsworth *et al.* unpubl.) and also with that of a Swedish collection (Nitare & Högberg 2012).

Likely to be one of the most threatened species in the current report but excluded from the assessment of Bailey *et al.* (2015).

***Sarcodon regalis* Maas Geest.**

This assessment: RE

Previous assessments: Ex (1992), EX 1969 (2006)

Extant mature individuals: 0

Assessment: This species was originally described in 1975 from collections made on a grassy bank under *Quercus* and *Castanea sativa* on the edge of a *Tsuga heterophylla* plantation in Swinley Park (Swinley Forest), a part of the Windsor Crown Estate overlying sandy soils and dominated by conifer plantations interspersed with patches of formerly-coppiced *Castanea* and ancient parkland *Quercus*. Maas Geesteranus

(1975) made the type collection while visiting the area with E.E. Green in 1968. He made a second visit during the following year and collected more material of *S. regalis* together with what he identified as *S. scabrosus*.

Based on twenty years' study of the Crown Estate hydroid sites (AMA), it is almost certain that the material identified as *S. scabrosus* from this area would correspond to the taxon assigned to *Sarcodon* sp. 1 (with *Fagaceae*) herein. Maas Geesteranus (1975) maintained a fine morphological distinction between *S. regalis* and his concept of *S. scabrosus*. The latter was distinguished by having a more prominently scaly cap and lacking violet tints at the stipe base. The western margins of Swinley Forest including the type locality for *S. regalis* were unfortunately destroyed as housing developments progressively spread around Bracknell and encroached on former Crown Estate forestry. No further British records of *S. regalis* have ever been made and the species was assessed as Extinct in GB in 1992 and 2006. The British status of this species remains unchanged and it is categorised as Regionally Extinct RE in this assessment.

Excluded from the assessment of Bailey *et al.* (2015).

***Sarcodon scabrosus* (Fr.) P. Karst.**

This assessment: LC

Previous assessments: E (1992, but *Sarcodon* sp. 1 (with *Fagaceae*) was also included in this evaluation, see below), VU B (2006, as *S. glaucopus* see above). (There is a 2006 assessment of NT for *S. scabrosus* (2006) but *Sarcodon* sp. 1 (with *Fagaceae*) was evaluated under this name, see below).

Scottish Biodiversity List

Section 41 species (but this taxon is probably not present in England following the taxonomic interpretation of Nitare & Högberg (2012)).

Extant mature individuals: 1070

Assessment background: Following the taxonomic concepts of Nitare & Högberg (2012), we conclude that *S. glaucopus* sensu auct. Brit. is misdetermined *S. scabrosus* (see *S. glaucopus* "Assessment background" above). British (Scottish) records with *Pinus* named as *S. scabrosus* are accepted as *S. scabrosus* sensu stricto and were added to those of *S. glaucopus* sensu auct. Brit. for this assessment. However, British records (mostly English records with *Castanea* or *Quercus*) named as *S. scabrosus* are interpreted herein as *Sarcodon* sp.1 (with *Fagaceae*) and assessed separately (see below).

Assessment: 1–37 fruit bodies recorded per visit to each of 107 unique georeferenced Scottish sites (1070 mature individuals) and most frequently recorded as *S. glaucopus*. The total number of mature individuals (including those currently unique to CATE2 and those that are likely to be extant but not yet recorded) might be expected to exceed 1,100, (an extra four fruiting patches required) therefore this was downgraded from being considered as a Near Threatened very small population (Criterion D) to LC.

Bailey *et al.* (2015) assessment: 290 mature individuals VU D1 (but a different taxon was assessed probably comprising mostly *Sarcodon* sp. 1, see below). Their assessment of *S. glaucopus* is likely to be mostly based on records of *S. scabrosus*.

***Sarcodon* sp. 1 (with *Fagaceae*)**

This assessment: EN D

Previous assessments: E (1992) but this assessment (as *S. scabrosus*) applied to this taxon together with *S. scabrosus* sensu str., NT (2006) but this assessment (as *S. scabrosus*) included those records of *S. scabrosus* sensu str. associated with pine in Scotland.

Section 41 species (as *S. scabrosus* sensu auct. Brit. p.p.)

Extant mature individuals: 170

Category of mature individual: Terrestrial patch-forming fungus

Assessment background: A comparison of English sequences obtained by Brock *et al.* (2009), SRP (2014) and Ainsworth *et al.* (unpubl.) with those of Nitare & Högberg (2012) failed to produce any close matches. Therefore the English taxon associated with *Fagaceae* (*Castanea* and *Quercus*) which was formerly recognised as *S. scabrosus* in part by British authors (e.g. Pegler *et al.* 1997) cannot be identified without further molecular work. English sequences also clustered with that of an American specimen determined as *S. scabrosus* by Baird *et al.* (2013). Nevertheless, it is still possible to distinguish *Fagaceae*- and *Pinaceae*-associated records of *S. scabrosus* sensu auct. Brit. and carry out an assessment of the two distinct species.

Assessment: 1–12 fruit bodies recorded per visit to each of 17 unique georeferenced English fruiting patches (170 mature individuals). Records from Crown Estate sites in Swinley Forest, Berkshire, have been omitted from the assessment as these *Sarcodon* sites (including the type locality for *S. regalis*) have been destroyed by housing development. The total number of mature individuals (including those that are extant

but not yet recorded) is not expected to exceed 250, therefore this cannot be treated as a very small population (Criterion D) and is assessed as EN D.

***Sarcodon* sp. 2**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: >10?

Assessment: Ca. 6 fruit bodies recorded per visit (two visits) to one georeferenced site (10 mature individuals). It is likely to be associated with *Castanea* and/or *Quercus* at its single English (Berkshire, Windsor Great Park) site. Fruit body material was collected in 2008 and 2010 and sequenced (Ainsworth *et al.* unpubl.). These clustered with each other but failed to do so with any ITS sequences in Nitare & Högberg (2012) or in any publicly available database and so the species remains unidentified at present.

Hence it is too early to estimate whether the total number of mature individuals (including those that are extant but not yet recorded) might exceed 50. An assessment should be carried out in or after 2018 once ten years of recording has elapsed.

Taxon not recognised by Bailey *et al.* (2015).

***Sarcodon squamosus* (Schaeff.) Quél.**

This assessment: LC (see Table 1)

Previous assessments: V (1992) as *S. imbricatus* (a misdetermination), LC (2006)

Bailey *et al.* (2015) assessment: LC.

Assessments for selected members of Agaricaceae: *Battarrea*, *Bovista*, *Lycoperdon* and *Tulostoma*

***Battarrea phalloides* (Dicks.) Pers.**

This assessment: VU D1

Previous assessments: E (1992), NT (2006)

Section 41 species

Wildlife & Countryside Act Schedule 8 species

Extant mature individuals: 420

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–50+ fruit bodies recorded per visit to each of 42 unique georeferenced sites (420 mature individuals). The fruit bodies are relatively durable and their stalks persist long after the spores have been dispersed. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small and restricted extant population (Criterion D) assessed as VU D1.

Battarrea phalloides is found in dry sandy sites and often on hedgebanks near various trees such as *Fraxinus*, *Ilex*, *Pinus*, *Quercus*, *Salix*, *Sambucus*, *Taxus* and *Ulmus* with a southern distribution in England. It is a species vulnerable to habitat damage or loss and fruit body destruction due to inappropriate hedgerow and roadside management. If *B. stevenii* is considered to be synonymous, then it will provide an earlier name for the species (Pegler *et al.* 1995). An ITS sequence barcode (Brock *et al.* 2009) from a specimen collected in Narborough clusters with corresponding sequences obtained by LMS from collections from Caversham, Norwich and Street (SRP 2014). Bailey *et al.* (2015) assessment: 770 mature individuals VU D1.

***Bovista aestivalis* (Bonord.) Demoulin**

This assessment: VU D1

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 400

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–12 fruit bodies recorded per visit to each of 40 unique georeferenced sites (400 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small and restricted extant population (Criterion D) assessed as VU D1.

This puffball is widespread in GB and found on calcareous/sandy soil, often associated with coastal dunes although also occasionally recorded on chalk downs and in woodland.

Bailey *et al.* (2015) assessment: 290 mature individuals VU D1.

***Bovista limosa* Rostr.**

This assessment: NA

Previous assessments: V (1992), NT (2006) but the evaluated taxon was *B. pusilla* (see below).

Assessment background: Larsson *et al.* (2009) provided molecular, ecological and morphological evidence for distinguishing *B. pusilla*, which was lectotypified and epitypified, from *B. limosa*. The former name was previously considered to be a *nomen ambiguum* in Britain (Pegler *et al.* 1995) and its use was discontinued (CBIB). Larsson *et al.* (2009) recognised that *B. pusilla* (formerly classified as *B. cf. limosa* in Larsson & Jeppson 2008) had the more southerly distribution of the two species and was not found northwards beyond ca. 60° N. Furthermore, they concluded that the description and photograph (of specimens at Ynyslas) in Pegler *et al.* (1995) referred to *B. pusilla*.

Sequences obtained by LMS (unpubl.) from collections from Newborough Warren, Oxwich Burrows, Pembrey and Stackpole Warren clustered with those of *B. pusilla* in Larsson *et al.* (2009). These British collections formerly assigned to *B. limosa* sensu Pegler *et al.* (1995) are now redetermined as *B. pusilla*. Based on this evidence, all British *B. limosa* is assessed as *B. pusilla* herein (see below). Until contradictory evidence is forthcoming, *B. limosa* s. str. is to be excluded from the British list and is therefore assessed as NA.

Bailey *et al.* (2015) assessment: 120 mature individuals EN D, however it is likely that the assessed taxon was *B. pusilla*.

***Bovista nigrescens* Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Bovista paludosa* Lév.**

This assessment: EN D

Previous assessments: Ex (1992), EN B (2006)

Section 41 species

Extant mature individuals: 40

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–6 fruit bodies recorded per visit to each of 3 unique georeferenced sites (30 mature individuals) plus one unconfirmed record from a woodland (40

mature individuals at most). The total number of mature individuals (including those that are extant but not yet recorded could reach 50 but is not expected to reach 250, therefore this is treated as a very small and restricted population (Criterion D) assessed as EN D.

This species is found in wet calcareous open ground such as fens or near alkaline flushes in otherwise acidic moorland. Confirmed British records are from northern England and East Anglia.

Bailey *et al.* (2015) assessment: 20 mature individuals CR D.

***Bovista plumbea* Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Bovista pusilla* (Batsch) Pers.**

This assessment: EN D

Previous assessments: VU (1992 as *B. limosa*), NT (2006 as *B. limosa*)

Extant mature individuals: 130

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–6 fruit bodies recorded per visit to each of 13 unique georeferenced sites (130 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 250, therefore this is treated as a very small population (Criterion D) assessed as EN D.

British collections are known from English and Welsh sand dunes in sparse vegetation and were previously assigned to *B. limosa* (see above for further details).

Bailey *et al.* (2015) assessment: 120 mature individuals EN D (as *B. limosa*) although *B. pusilla* excluded from their assessment.

***Lycoperdon atropurpureum* Vittad.**

This assessment: EN D

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 60

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–few fruit bodies recorded per visit to each of 5 unique georeferenced sites (50 mature individuals) plus one unconfirmed record regarded as “uncertain” by the collector (60 mature individuals at most). However, only two post-1963 collections (S. Devon) are preserved as vouchers at Kew and so this species could be even rarer than indicated by existing records. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 250, therefore this is treated as a very small population (Criterion D) assessed as EN D.

Apparently thermophilous, this species favours southern sites often near *Quercus*. Elsewhere in Europe, it is common in Mediterranean oak woods (Pegler *et al.* 1995). Bailey *et al.* (2015) assessment: 40+ mature individuals DD.

***Lycoperdon caudatum* J. Schröt.**

This assessment: EN D

Previous assessments: E (1992), VU D2 (2006)

Scottish Biodiversity List

Extant mature individuals: 120

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–few fruit bodies recorded per visit to each of 12 unique georeferenced sites (120 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 250, therefore this is treated as a very small population (Criterion D) assessed as EN D.

However, only two post-1964 collections (Mid Perths. & Dumfries) are preserved as vouchers at Kew and Edinburgh and so this species could be rarer than indicated by existing records. Indeed, this species has only been confirmed from southern Scotland within GB and voucher specimens to support its recognition in England are required. The Scottish collections were made on track or woodland edges near *Fagus*, *Betula* and *Pinus*. Elsewhere in Europe, it is a boreal-continental species favouring calcareous habitats (Pegler *et al.* 1995).

Bailey *et al.* (2015) assessment: 50 mature individuals EN D.

***Lycoperdon decipiens* Durieu & Mont.**

This assessment: EN D

Previous assessments: V (1992), EX 1923 (2006)

Extant mature individuals: 40

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–few fruit bodies recorded per visit to each of 4 unique georeferenced sites (40 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded could reach 50 but is not expected to reach 250, therefore this is treated as a very small and restricted population (Criterion D) assessed as EN D.

However, only one post-1964 collection (W. Sussex) is preserved as a voucher at Kew and so this species could be rarer than indicated by existing records. Furthermore, the FRDBI documents 13 English sites (1984–2008) for this species recorded by a single collector/identifier. In view of the fact that this species was unofficially assessed as Extinct in Britain (Evans *et al.* 2006) and no vouchers representing any of these 13 sites have been deposited in a national collection, we have concluded that these records should be disregarded pending confirmation (although their inclusion would not alter the assessment categorisation). Within GB, this species has only been confirmed from England and further voucher specimens are required. These collections were made in woodland or grassland but it is difficult to discern a favoured habitat from the available data. Elsewhere in Europe, it is thermophilous and mostly fruits in calcareous turf (Pegler *et al.* 1995).

Bailey *et al.* (2015) assessment: 50 mature individuals EN D.

***Lycoperdon dermoxanthum* Vittad.**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 940

Assessment: 1–few fruit bodies recorded per visit to each of 94 unique georeferenced sites (940 mature individuals). Pegler *et al.* (1995) considered this species under the name *Bovista dermoxantha* (Vittad.) De Toni and stated that the subgleba is “absent or rarely present as a trace”. However, Moyersoen & Demoulin (1996) and Larsson *et al.* (2009) pointed out that this name had been applied to two species. The presence or absence of a subgleba is a key morphological character with which *L. dermoxanthum* (subgleba present) can be separated from *B. furfuracea* Pers. (subgleba absent). The latter is currently not British, but no morphological or molecular studies have been carried out to date to investigate whether both species occur in Britain and, if so, how

they might be distributed. Until such studies can be carried out, the current level of uncertainty justified an assessment of DD.

Bailey *et al.* (2015) assessment: 550 mature individuals VU D1.

***Lycoperdon echinatum* Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Lycoperdon ericaeum* Bonord.**

This assessment: CR (Possibly Extinct in GB)

Previous assessments: Ex (1992), EX 1883 (2006)

Extant mature individuals: 30?

Assessment: 1–few fruit bodies recorded per visit to each of 3? unique georeferenced sites (30? mature individuals). The total number of extant mature individuals cannot be estimated because there are no known publicly-accessible vouchers for study.

There are two nineteenth century British records which were made in 1878 (Mortenhall, Edinburgh) and 1883 (Hawnby Hill, N.E. Yorkshire). The latter was accepted as the last authentic record of a species that was assessed as Extinct in GB (Evans *et al.* 2006). Although records from at least three “new” post-1964 sites have been uploaded to national databases (FRDBI & CATE2), no further voucher specimens have been traced. These localities are:

- 1991, Laymoor Quag, West Gloucestershire
- 1997, Barry Links, Angus
- 1999, Holkham Dunes, West Norfolk
- 2001, same hectad as 1999

It is imperative that any future sightings from these or any other localities are supported by voucher material deposited in a national fungarium. It is unfortunate that the data are of insufficient quality in this case to decide whether this species is extinct (RE) or extant and threatened (CR or EN). As there is no verified extant population in Britain, the assessment CR tagged “Possibly Extinct in GB” was preferred to DD.

Bailey *et al.* (2015) assessment: 30 mature individuals DD.

***Lycoperdon excipuliforme* (Scop.) Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Lycoperdon lambinonii* Demoulin**

This assessment: DD

Previous assessments: V (1992), NE (2006)

Extant mature individuals: 20?

Assessment: 1–few fruit bodies recorded per visit to each of two unique georeferenced sites (20? mature individuals). The total number of extant mature individuals from GB cannot be estimated because there are no known publicly-accessible vouchers for study. This species was accepted within Britain and Ireland and included in Pegler *et al.* (1995) and CBIB on the basis of a 1977 record from Eire (no voucher details). Although this record is beyond the geographical scope of the current assessment, there is a specimen named as this preserved at Edinburgh (from Knockroy, Mull in 1968) and a 1995 English record (Russell's Inclosure, Forest of Dean) in the national databases (FRBI & CATE2), neither of which has received checklist (CBIB) treatment. Therefore there are potentially two known extant unique georeferenced sites (20 mature individuals) but this species is assessed as DD pending further investigation of the two post-1964 collection/records from GB. A more precise assessment cannot be made until *L. lambinonii* is confirmed as definitely occurring in GB.

Excluded from the assessment of Bailey *et al.* (2015).

***Lycoperdon lividum* Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Lycoperdon mammiforme* Pers.**

This assessment: VU D1

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 550

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–abundant fruit bodies recorded per visit to each of 55 unique georeferenced sites (550 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small and restricted extant population (Criterion D) assessed as VU D1.

A widespread species in England and Wales (v. few Scottish records) associated with calcareous broadleaved woodland.

Bailey *et al.* (2015) assessment: 430 mature individuals VU D1.

***Lycoperdon molle* Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Lycoperdon nigrescens* Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Lycoperdon perlatum* Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

A well-known and common species, presumably accidentally omitted from the Bailey *et al.* (2015) assessment.

***Lycoperdon pratense* Pers.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Lycoperdon pyriforme* Schaeff.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Lycoperdon radicum* Durieu & Mont.**

This assessment: CR (Possibly Extinct in GB)

Previous assessments: Ex (1992, as *Bovistella radicata*), EX 1952 (2006, as *B. radicata*)

Extant mature individuals: 0?

Category of mature individual: Terrestrial patch-forming fungus

Assessment: Vouchered and confirmed as British from North Wiltshire (Spye Park) in 1853 and from Surrey (Richmond Park near White Lodge) in 1952 and currently unofficially assessed as Extinct (Evans *et al.* 2006). The assessment CR tagged “Possibly Extinct in GB” was preferred to RE because we are not aware of any attempts to revisit and survey either of the two historic sites and so reasonable doubt remains whether the last individual in Richmond Park has died (IUCN 2014).

Likely to be one of the most threatened species in the current report but excluded from the assessment of Bailey *et al.* (2015).

***Lycoperdon umbrinum* Pers.**

This assessment: VU D1

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 700

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–abundant fruit bodies recorded per visit to each of 70 unique georeferenced sites (700 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small and restricted extant population (Criterion D) assessed as VU D1.

A widespread species associated with acidic soils and often fruiting in or near coniferous woodland.

Bailey *et al.* (2015) assessment: 590 mature individuals VU D1.

***Lycoperdon utriforme* Bull.**

This assessment: LC (see Table 1)

Previous assessments: NE (1992), NE (2006)

Bailey *et al.* (2015) assessment: LC.

***Tulostoma brumale* Pers.**

This assessment: DD

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 1050?

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–abundant fruit bodies recorded per visit to each of 105 unique georeferenced sites (1050 mature individuals). Preliminary molecular data indicate that *T. brumale* s. auct. Brit. is a species complex. The two specimens named as this and sequenced by Brock *et al.* (2009) are members of two distinct ITS-based clusters and are likely to be representatives of two distinct taxa. No morphological or molecular studies have been carried out to date to investigate the distributions of these two species in Britain and we currently do not know whether one or both are undescribed. Until such taxonomic resolution has been completed, the high level of taxonomic uncertainty around this species complex precludes any assessment other than DD. Members of the complex are usually found fruiting with mosses in coastal sandy areas, but can also occur with moss cushions on wall-tops.

Bailey *et al.* (2015) assessment: LC but taxonomic issues not acknowledged.

***Tulostoma fimbriatum* Fr.**

This assessment: NA

Previous assessments: NE (1992), NE (2006)

Extant mature individuals: 0

Assessment: Although not yet treated in CBIB, this species was recently recognised in GB (2011) from sand dunes in West Wales (Hobart 2012). Two samples of the collected material were sequenced for this project (LMS, unpubl.) and the consistent result was that the collection was misdetermined *T. brumale* s. auct. Brit. (see above). *Tulostoma fimbriatum* is therefore currently excluded from the British list and is assessed as NA.

Bailey *et al.* (2015) assessment: CR D based on uncritical acceptance of single collection (see above) now redetermined.

***Tulostoma melanocyclum* Bres.**

This assessment: VU D1

Previous assessments: R (1992), EN B (2006)

Section 41 & 42 species

Extant mature individuals: 250

Category of mature individual: Terrestrial patch-forming fungus

Assessment: 1–20+ fruit bodies recorded per visit to each of 25 unique georeferenced fruiting patches (250 mature individuals). The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

Tulostoma melanocyclum is found in coastal sand dunes and often associated with *Tortula*, either growing alone or amongst sparse *Ammophila* and/or *Salix repens*. ITS sequence barcodes (Brock *et al.* 2009) from specimens collected from S. Lancashire (Formby) and W. Norfolk (Holme) cluster with each other and with those obtained by LMS (SRP 2014) from specimens collected from Glamorganshire (Merthyr Mawr, Porthcawl), Merionethshire (Morfa Dyffryn), W. Norfolk (Burnham Overy Staithe) and Westmorland (Sandscale Haws).

Bailey *et al.* (2015) assessment: 100 mature individuals VU D1.

***Tulostoma niveum* Kers**

This assessment: VU D1

Previous assessments: V (1992), VU D2 (2006)

Scottish Biodiversity List

Extant mature individuals: ca.320

Category of mature individual: Moss-cushion-associated fungus

Assessment: ca. 320 occupied moss patches (ca. 320 mature individuals) on scattered montane limestone boulders and on a dry-stone wall within two discrete locations (based on detailed recording data supplied by E.M. Holden & D. Genney). The original site at Inchnadamph NNR extends over 2.3 km with outlying occupied boulders up to 2 km from the main site (Fleming *et al.* 1998), whereas the more recently-discovered site at Craig Leek SSSI extends over 1.5 km with a few outliers (Holden 2011). The total number of mature individuals (including those that are extant but not yet recorded) of the Scottish populations, repeatedly well-surveyed since the discovery at Inchnadamph in 1989, is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

This species almost qualifies as VU D2 having < 5 locations, however it is less clear that there is a plausible future threat that could “suddenly” or “in a very short time” (usually interpreted as one or two generations) drive the taxon to CR or RE. Although there is a potential threat to the Scottish populations from cessation of grazing and shading of mossy boulders by encroaching birch saplings, currently this does not seem to represent a threat that could reduce the number of mature individuals to <50 in a sufficiently short time to satisfy the D2 subcriterion.

This species is currently being assessed at a larger regional scale (Europe) and worldwide (see GFRLI website). Its inclusion in this initiative is mainly justified by its status as a European endemic whose distribution is restricted to Finland, Norway, Sweden and the UK. The majority of the known world population is in Sweden where it is considered to be slightly decreasing and it is red-listed in all countries in which it is found (GFRLI).

See Section 3.2 for comments on methodology of Bailey *et al.* (2015).

Assessments for selected members of *Fomitopsidaceae*: *Piptoporus*

***Piptoporus betulinus* (Bull.) P. Karst.**

This assessment: LC (>367 monads from FRD and so, assuming three ramets per occupied tree as for *P. quercinus*, there are >1,100 mature individuals)

Previous assessments: NE (1992), NE (2006)

One of the most frequently-recorded wood-inhabiting fungi in Britain.

Bailey *et al.* (2015) assessment: LC.

***Piptoporus quercinus* (Schrad.) P. Karst.**

This assessment: VU D1

Previous assessments: E (1992), LC (2006)

Section 41 & 42 species

Scottish Biodiversity List

Wildlife & Countryside Act Schedule 8 species

Extant mature individuals: 825

Category of mature individual: Lignicolous fungus of large centralized decay columns

Assessment: Based on personal field observations, an occupied tree (assumed to be inhabited by a single genet) might occasionally fragment into several physically

separated elements (ramets or mature individuals sensu IUCN), each bearing fruit bodies. As for *H. coralloides* and *H. erinaceus* (see above), mycelia are usually more extensive than those of *H. cirrhatum* and so each occupied tree is assumed to represent three, rather than two, mature individuals. The 275 known occupied British oak trees (Jan. 1965 to Dec. 2014), of which no less than 100 occur on the Windsor Crown Estate (Ainsworth unpubl.), were therefore assumed to represent 825 extant mature individuals. The total number of mature individuals (including those that are extant but not yet recorded) is not expected to reach 1,000, therefore this is treated as a very small population (Criterion D) assessed as VU D1.

Within GB, this species is mostly found in England, although there are two extant sites known in Wales and one in Scotland (Crockatt *et al.* 2010). ITS sequence barcodes obtained by LMS (SRP 2014) for specimens from Berkshire (Windsor Crown Estate), Derbyshire (Calke Park, Chatsworth), E. Suffolk (Captain's Wood), Herefordshire (Moccas Park), Leicestershire (Bradgate Park), N. Somerset (Ashton Court), S. Hampshire (New Forest), Surrey (Ashted Common, Richmond Park) and W. Sussex (Petworth Park) were all very similar or identical.

DNA sequences derived from this species do not cluster with the generic type (*P. betulinus*), therefore it is likely that it will revert to *Buglossoporus* (the genus under which it is listed in Sch. 8 of the Wildlife & Countryside Act) in the next British checklist update.

See Section 3.2 for comments on methodology of Bailey *et al.* (2015).

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