Guidelines for the Selection of Biological SSSIs

Part 2: Detailed Guidelines for Habitats and Species Groups

Chapter 14 Non-lichenised fungi

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Cover note

This chapter updates and, along with Chapter 12 Bryophytes and Chapter 13 Lichens and associated microfungi, replaces the previous Non-vascular plants SSSI Selection Guidelines chapter (Hodgetts 1992); it also replaces the previous chapter for Grassland Fungi (Genney *et al.* 2009). It was prepared by Sam Bosanquet (Natural Resources Wales), Martyn Ainsworth (Royal Botanic Gardens, Kew), Sean Cooch (Natural England), David Genney (Scottish Natural Heritage) and Tim Wilkins (Natural England), and provides detailed guidance for use in selecting fungal sites throughout Great Britain to recommend for notification as SSSIs. It should be used in conjunction with Part 1 of the SSSI Selection Guidelines, as published in 2013 (Bainbridge *et al* 2013), which details the overarching rationale, operational approach and criteria for selection of SSSIs.

The main changes from the chapters are:

- Only non-lichenised fungi are considered;
- Criteria are provided for selection of SSSIs for fungi of other habitats in addition to grasslands;
- Criteria are provided for selection of populations of individual threatened species listed on global, GB, or country level IUCN red lists;
- Discontinuation of the Schedule 8 species selection criterion.

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This chapter has been subjected to appropriate levels of evidence quality assurance. It is compliant with the JNCC Evidence Quality Assurance Policy 2014, and has been subjected to external peer review by Dr Andy Taylor (James Hutton Institute).

1. Introduction

1.1 The group covered is non-lichenised fungi. Lichens and lichenicolous fungi are covered in Chapter 13. Only a few fungi that spend their entire lives as microscopic structures (microfungi), such as rusts, smuts and 'moulds', are included because of current uncertainties associated with their identification, distribution and status assessment. In future updates, more fungal species (both macrofungi and microfungi) and more assemblages should be included as the evidence base improves. Other organisms traditionally studied by mycologists but now shown to have an ancestry differing from that of true fungi, e.g. slime moulds, and *Phytophthora* and its relatives, are not considered in this chapter.

1.2 This document builds on the non-vascular plant guidelines (Hodgetts, 1992) and the grassland fungi chapter (Genney *et al*., 2009). The non-vascular plant guidelines covered "bryophytes, lichens, fungi and non-marine algae", but "only bryophytes, lichens and charophytes [were] treated in detail" and it was "intended to update the guidelines on site selection for other groups of algae and fungi as and when information [became] available". The grassland fungi chapter is superseded by section 4 herein.

1.3 In the past many sites important for fungi were designated on the basis of habitat or vegetation type, resulting in incidental rather than targeted conservation of their fungal interest. This chapter aims to ensure fungi receive adequate protection through their recognition as features of interest within proposed or existing SSSIs. Some habitats are disproportionately important for fungi compared with other taxa (e.g. Evans *et al*., 2001), notably 'waxcap grassland', and sites may be designated solely for their mycological interest.

1.4 The British mycobiota[1] is relatively well studied and documented compared with the rest of the world, with a British total likely to exceed 12,500 species (FRDBI, 2017). Our understanding of fungal distribution has been largely built on records of fruitbodies, increasingly supported by molecular studies of fresh and preserved collections. However DNA-based detection of fungi in environmental samples, such as roots, soil and water, highlights that fruitbody recording only provides a partial picture of fungal distribution and that some fungi rarely if ever fruit. Future revisions of this chapter should make more use of DNA-based data, in particular DNA-based selection thresholds.

1.5 While we will continue to gather more data and improve our understanding of fungal ecology and distribution, our knowledge is now sufficient to allow a chapter specific to fungi because:

[1] All of the fungi present in the geographic area concerned.

- Taxonomic monographs are available for many of the larger British fungal genera.

- Guidelines for the grassland assemblage have already been published (Genney *et al.*, 2009); updated selection requirements are given in section 4.

- Fungal assemblages of several other habitats have been the subject of detailed study (Knowles & Wilkins, in press). These habitats include Caledonian pinewoods, sand dunes and sites with ancient/veteran trees.

- The fungi of many sites in England, Scotland and Wales have been recorded, including some with detailed surveys.

- National databases of fungal records comprise a large information resource.

- Status and threat evaluations (official and unofficial) using IUCN criteria have been carried out for some fungal taxa at a range of geographic scales.

- Molecular techniques are helping to resolve taxonomic and identification issues, for example allowing improved species concepts and redetermination of vouchers to inform red listing.

1.6 Despite these advances, some constraints remain, including those originally outlined by Hodgetts (1992) and Genney *et al*. (2009), which are inherent to the study of fungi as a group:

- Fungi are primarily cryptic organisms living within substrates e.g. within soil, dead wood or living plants, and are only detectable by field mycologists/surveyors when they produce fruitbodies and/or spores. Our knowledge of the distribution and status of many species is based on above-ground, macroscopic fruitbody appearance, despite recent advances in molecular techniques, and many fungal species are therefore 'under-recorded' and difficult to evaluate.

- For most species, the appearance of fruitbodies is erratic, unpredictable and usually of short duration. They are not necessarily produced every year and when they are, they may only remain for a few days.

- The abundance of fruitbodies and their frequency of production does not necessarily reflect the number of fungal individuals living within the substrate. Routine detection of different fungal individuals within a naturally occurring population is in its infancy. It is not currently possible to define the number of fungal individuals which constitute a viable population size for site selection, nor to provide a standard method of assessment in the field.

- Most fungi require microscopic examination to confirm their identification. This is increasingly being augmented by DNA-based checking as appropriate reference sequences become available.

- The taxonomy and nomenclature of our mycobiota is in a period of great flux and it is likely that some of the species named in this chapter will be affected in future as a result of further phylogenetic (DNA) analyses and their interpretation by skilled taxonomists.

- DNA studies are revealing 'cryptic taxa': the existence of a number of genetically distinct entities that look morphologically identical. To facilitate field recording and site evaluation, it is sometimes preferable to treat cryptic taxa as belonging to an aggregate of species (see 3.8 for an example).

- Although there has been an encouraging increase in the number of skilled field mycologists in recent years, there are still relatively few people who are able to identify fungi accurately, particularly in habitats other than grassland and some types of woodland. Moreover, skills in microscopy and laboratory analysis are as essential as field skills for the identification of many fungal groups and confirmation of records usually involves input from more than one mycologist.

- Data on the distribution of many species is inadequate, so it is sometimes difficult to determine what is rare and what is merely rarely recorded.

1.7 Fungi perform critical ecosystem services, including nutrient cycling, maintaining soil health and food provision. However, these functions operate effectively at large (landscape) scales and their relevance to site selection is not considered here. A complete series of SSSIs designated for their fungal interest cannot be expected to deliver these ecosystem services in isolation.

2. International responsibility

2.1 Britain is considered to have international importance for a number of habitat-based fungal assemblages, either because their habitats are internationally restricted, e.g. ancient/veteran trees (Rackham, 1990; Farjon, 2017), grassland (Veen *et al*., 2009), and oceanic habitats (e.g. Coppins & Coppins, 2012), or because there is evidence that British sites have some of the highest levels of species diversity recorded within such assemblages across Europe.

2.2 Accordingly, internationally important elements of our mycobiota are:

- Lignicolous saprotrophic[2] fungi on beech (Ainsworth, 2004b) and oak (Ainsworth, 2017a).

- Grassland fungi. Sites rich in grassland fungi are scarce and threatened on a world scale, and the extent of this habitat in northern Europe has declined dramatically (Veen *et al*., 2009). Relative to these losses, Britain retains a high number of species-rich waxcap grasslands (Newton *et al*., 2003; Evans, 2004; Griffith *et al*. 2013), for which we clearly have an international responsibility. Furthermore the global IUCN Red List of Threatened Species (see below) includes two British *Hygrocybe s.l.* (*H. citrinovirens* VU and *H.* (*Neohygrocybe*) *ingrata* VU), and additional species have been proposed under The Global Fungal Red List Initiative.

- Montane heath mycorrhizal[3] fungi (Hesling, 2013).

- Fungi of Atlantic hazel (Coppins & Coppins, 2012) and Atlantic oak woodland (Watling, 2005; O'Hanlon & Harrington, 2012).

- Species threatened globally, namely those with a threat status of VU, EN or CR on the global IUCN Red List http://www.iucnredlist.org/. The Global Fungal Red List initiative provides an important international platform by which fungi can be nominated and assessed for global IUCN red listing: http://iucn.ekoo.se/iucn/summary/.

- Species of conservation concern in Europe, that are more abundant in Britain than elsewhere and are well documented as such (e.g. Dahlberg & Croneborg, 2003; Fraiture & Otto, 2015).

[2] Saprotrophic fungi, or saprotrophs, derive their nourishment from dead/decaying organic matter – e.g. deadwood or leaf litter.

[3] Mycorrhizal fungi are symbiotic with plant roots, enhancing the plant's supply of water and nutrients whilst the plant feeds the fungus with photosynthetically generated carbohydrates.

3. Site selection requirements

3.1 When evaluating and selecting sites for non-lichenised fungi, the principles outlined in Part 1 of the guidelines (Bainbridge *et al* 2013) should be followed. It is also advisable to consult the country specialist and an expert mycologist because of the taxonomic and ecological complexities of fungi.

3.2 Adequate survey is needed to identify important fungal sites (Tofts & Orton 1998). While a minimum recording period is not stipulated, e.g. a site may qualify after a single visit, the persistence of populations is important and carrying out several targeted species/assemblage surveys is advisable.

3.3 Although site selection should be based on recent mycological records, many sites lack up-to-date surveys. To make allowance for this and the sporadic appearance of fruitbodies of some fungi, species records from the last 50 years may be included when evaluating sites. The 50 year rule follows Ainsworth *et al*. (2013) as the length of time required before a fungal species is assessed as Extinct in Britain providing there have been no records and there is evidence that appropriate efforts have been made to refind it. This rule should be used with care as it may be inappropriate where: 1) the site has experienced habitat change during this period such that the species is unlikely to be extant; 2) a species has only been recorded once and there is no evidence of persistence; 3) the life history or distribution of the species suggests its presence was short lived; or 4) recent taxonomic change raises doubts over the identification of the species recorded.

3.4 Selection thresholds are based on fungal fruitbody data but not on mycelial DNA survey data. Thresholds should therefore only be applied to site species lists derived from fruitbody records. In future, criteria and thresholds for mycelial DNA surveys and studies should be developed. It is good practice to retain dried voucher material and detailed identification notes and photographs, particularly for difficult to identify taxa. Where possible, and as technology becomes more accessible, identification should be verified by DNA barcode analysis.

The main requirements for site selection are as follows:

3.5 Internationally important features

3.5.1 All persistent fruiting populations[4] of species listed as Critically Endangered on the global IUCN Red List of Threatened Species http://www.iucnredlist.org/ should be considered for notification. Species listed as Endangered or Vulnerable on the global Red List should be selected at one site in each Area of Search in which they occur, with the largest[5] persistent fruiting population prioritised.

3.5.2 Internationally significant assemblages for which scoring systems are given in this chapter, namely: waxcap grasslands, beechwood saprotrophs (beech deadwood fungi), and oakwood saprotrophs (oak deadwood fungi) (see Table 1 for section references).

3.5.3 The fungi of montane heath and Atlantic woodland habitats lack equivalent methods of evaluation and therefore selection of their sites will depend on available evidence and expert judgement.

3.5.4 Populations of the following species considered of conservation concern in Europe and with a) a large part of their European population in GB (Fraiture & Otto, 2015) – *Porpolomopsis* (*Hygrocybe*) *calyptriformis*, *Podoscypha multizonata*, and *Tulostoma niveum*, or b) a significant part of a Europe-wide declining population in GB – *Poronia punctata*. The largest persistent fruiting population of each taxon in the Areas of Search in which it occurs should be selected.

3.6 Ecologically coherent assemblages[6] of fungi

3.6.1 The fungi of certain habitats have been studied in sufficient detail that lists of characteristic species and scoring systems can be drawn up (Table 1). Species assemblages defined in this chapter do not list all fungal taxa for each habitat but identify a characteristic subset considered appropriate for site selection.

3.6.2 These threshold values are not absolute; they are for guidance only, to indicate when a site should be considered for SSSI designation. For example, sites that do not attain the threshold after multiple visits, but which are the best examples in an Area of Search, or are

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[4] A persistent fruiting population is one that is well established, producing fruitbodies over a number of (not necessarily consecutive) years, suggesting that the population is viable (see also 3.4).

[5] The largest population is defined using IUCN criteria (Dahlberg & Mueller 2011): for soil-dwelling fungi this is the largest number of recorded localities georeferenced as 10m apart or greater, and for wood-inhabiting fungi, the number of recorded 'occupied trees' (proxy individuals). If no information on population sizes is currently available, then targeted survey of a suite of sites may be necessary to gather such data.

[6] An ecologically coherent assemblage is a habitat-based species assemblage that should be assessed as a single entity across an entire site. However only species of microhabitats / ecological niches that truly belong to the assemblage habitat type should be included within it.

notable atypical variants (see part 1 paragraph 5.4.1), may be selected to ensure the geographic and compositional spread of each assemblage is adequately protected.

3.6.3 Where the interest is fragmented, occurring in a number of discrete hotspots (see 5.5), it may be more appropriate to treat the areas collectively and evaluate them as a single assemblage.

3.6.4 Additional fungal assemblages that are considered important in a British context but for which scoring systems have not yet been devised due to insufficient knowledge, are given in Table 2. Further investigation may reveal other important fungal assemblages, including those which do not produce above-ground macroscopic fruitbodies, but evidence would be needed to show that a site was sufficiently special to warrant selection.

3.6.5 It is anticipated that as further work on assemblages is published, Tables 1 & 2 will be revised, and new scoring systems appended to the chapter. Until that time the selection of sites supporting these assemblages will depend on available evidence and expert judgement.

3.6.6 Fungi play vital roles in all ecosystems, and recognition of mycological diversity in SSSIs selected for habitats or vegetation types is important even if the habitat/plant community is not identified as supporting fungi of particular conservation concern. For example, *Helianthemum* beds support a mycobiota that is an interesting element of the biodiversity of base-rich grasslands. Diverse fungal assemblages that fail to qualify for selection should be recognised in SSSI citations by including them as attributes of the habitat.

3.6.7 Some mycologically rich habitats are more ephemeral and the direct product of site management - e.g. herbivore dung or burnt vegetation. Although these have been excluded from Tables 1 & 2, they are part of the scientific interest of sites, and significant populations should be mentioned in citations; note that *Poronia punctata* can qualify on other grounds (see 3.5.4).

Table 1. Fungal assemblages with scoring systems. See paragraph number for details.

Fungal assemblage	Scope and evaluation	Paragraph/section reference
Coastal sand dune fungi	Includes mobile dune, slack & dune scrub but not grassland on the landward side of dunes which should be assessed as waxcap grassland	3.7
Tooth fungi associated with oak, beech or sweet chestnut	Stipitate hydnoid fungi predominantly mycorrhizal with *Quercus, Castanea* and *Fagus*. Habitats include woodland, lowland heath and other habitats where the host trees occur	3.8

Caledonian pinewood fungi	Restricted to ectomycorrhizal species, including stipitate hydnoid fungi, of *Pinus sylvestris* but includes pine plantations	3.9
Beech deadwood fungi	Saprotrophs of beech in parkland, wood pasture, or woodland	3.10
Oak deadwood fungi	Saprotrophs of oak in parkland, wood pasture, or woodland	3.11
Grassland fungi	Nutrient-poor unimproved and semi-improved grasslands	Section 4

Table 2. Important fungal assemblages currently lacking scoring systems.

Fungal assemblage	**Description**
Atlantic woodland fungi	Includes fungi of *Quercus*, *Corylus* and other woody plants in coastal, predominantly western, habitats under strong Atlantic influence
Inland dune/sandy soil fungi	Steppe-like/Breckland grassland and sandy soil assemblage, particularly gasteromycetes
Upland birch woodland fungi	Mycorrhizal and saprotrophic associates of *Betula* in upland Britain
Alder woodland fungi	Mycorrhizal and saprotrophic associates of *Alnus* in wet woodland
Willow woodland fungi	Mycorrhizal and saprotrophic associates of *Salix* in wet woodland
Calcareous beech woodland fungi	Diversity of ectomycorrhizal fungi: *Cortinarius* (subgenus *Phlegmacium*), *Inocybe*, *Tricholoma* and other relevant genera, including hypogeous fungi
Calcareous woodland saprotrophs	Diversity of saprotrophs: *Lepiota* spp. and allies
Base-rich fen fungi	Fungi associated with vascular plants and bryophytes in fen
Reedbed fungi	Fungi in *Phragmites* beds
Montane heath fungi	Mycorrhizal species on *Arctostaphylos* spp., *Salix* spp. & *Betula nana*
Dryas fungus communities	Mycorrhizal species on *Dryas octopetala*
Boletes of wood pasture and parkland	Thermophilous boletes: species of Boletaceae in warm, open sites with short ground cover; these tend to occur in open woodland or parkland

3.7 Coastal sand dune fungi

3.7.1 Building on the work of Rotheroe (1993), Evans & Roberts (2015, in press) defined the dune fungal assemblage as follows. The number of recorded species in Table 3 is used to assess sites. A site should be considered for notification if the total reaches or exceeds **10**.

Table 3. Dune fungal assemblage

Agaricus devoniensis	*Inocybe heimii*
Bovista aestivalis	*Inocybe impexa*
Bovista pusilla (*B. limosa*)	*Inocybe inodora*
Campanella caesia	*Inocybe pruinosa*
Chrysomyxa pyrolata	*Inocybe serotina*
Clitocybe barbularum	*Inocybe vulpinella*
Conocybe dunensis	*Laccaria maritima*
Coprinopsis ammophilae	*Lepiota brunneolilacea*
Cortinarius ammophilus	*Lepiota erminea*
Cyathus stercoreus	*Leucoagaricus barssii*
Entoloma nigellum	*Marasmius anomalus*
Entoloma phaeocyathus	*Melanoleuca cinereifolia*
Entyloma eryngii sens. auct. Brit.	*Melanoleuca pseudoluscina*
Geastrum elegans	*Mycocalia duriaeana*
Geastrum marginatum (*G. minimum*)	*Omphalina galericolor*
Geastrum schmidelii	*Omphalina subhepatica*
Geoglossum littorale	*Peziza ammophila*
Geopora arenicola	*Peziza boltonii*
Hebeloma ammophilum	*Peziza pseudoammophila*
Hebeloma dunense	*Phallus hadriani*
Hebeloma psammophilum	*Poronia erici*
Hebeloma vaccinum	*Psathyrella ammophila*
Helvella leucopus	*Psathyrella dunensis*
Hohenbuehelia bonii	*Psathyrella flexispora*
Hohenbuehelia culmicola	*Rhodocybe popinalis*
Hygrocybe aurantiolutescens	*Sabuloglossum arenarium*
Hygrocybe conicoides	*Simocybe centunculus* var. *maritima*
Hygrocybe olivaceonigra	*Stropharia halophila*
Inocybe agardhii	*Trichoglossum rasum*
Inocybe arenicola	*Tulostoma brumale*
Inocybe dunensis	*Tulostoma melanocyclum*
Inocybe heimiana	*Tulostoma simulans*

3.8 Tooth fungi associated with oak, beech or sweet chestnut

3.8.1 Following Ainsworth (2004a) and Smith (2012) this assemblage comprises mycorrhizal stipitate hydnoid fungi (*Hydnellum*, *Phellodon* and *Sarcodon*) associated with trees in the family *Fagaceae* – principally oak, sweet chestnut and beech (Table 4). Recent molecular taxonomic work (e.g. Ainsworth *et al*., 2010) has resulted in some changes to species concepts and the creation of a number of as yet unnamed taxa. For the purposes of scoring, three species and four aggregate (agg.) species are included in the table below alongside key details of status and morphology. The number of recorded assemblage species/aggregates is used to assess sites. Sites in south-central or south-eastern England[7] should be considered for notification if they have a total count of **five** or above; a lower threshold of **three** applies outside this area so that sites on the edge of the range of the assemblage can be selected.

Table 4. Assemblage of tooth fungi associated with oak, beech or sweet chestnut*

Species/aggregate	Notes
Hydnellum concrescens agg.	Includes “rosy” (I) and “fulvous” (V) species and specimens previously assigned to *H. scrobiculatum*
Hydnellum spongiosipes	
Phellodon confluens	
Phellodon melaleucus agg.	Includes “lilac” (I), “yellow” (IX) and “PM5” (II) species
Phellodon niger agg.	The British species with *Fagaceae* is probably not *P. niger* in the original sense
Sarcodon scabrosus agg.	The British species with *Fagaceae* probably do not include *S. scabrosus* in the original sense
Sarcodon joeides	

*Roman numerals and descriptors in inverted commas are as used in Ainsworth *et al*. (2010)

[7] South-central or south-eastern England is defined as England south of the River Thames and extending as far west as the western border of Hampshire (Vice-counties 11 & 12) and Berkshire (Vice-county 22).

3.9 Caledonian pine wood (ectomycorrhizal) fungi

3.9.1 Eighteen ectomycorrhizal fungi were identified by Holden (in press) as indicative of a rich pine wood mycobiota (Table 5). The number of recorded species in Table 5 is used to assess sites, which can be native pine woods or pine plantations. A site should be considered for notification if the total count reaches or exceeds **nine**. Forty additional rarely fruiting, or difficult to identify, pine ectomycorrhizal fungi are regarded as part of the special interest of the assemblage (Table 6) and should be mentioned in the site citation, however they do not count towards the assemblage scoring.

Table 5. Caledonian pinewoods fungal assemblage – species to be used in scoring assessment

Bankera fuligineoalba	*Leccinum vulpinum*
Cantharellus aurora	*Phellodon tomentosus*
Cortinarius caperatus	*Russula decolorans*
Cortinarius traganus	*Russula vinosa*
Hydnellum aurantiacum	*Sarcodon scabrosus* sens.str.
Hydnellum caeruleum	*Sarcodon squamosus*
Hydnellum ferrugineum	*Suillus flavidus*
Hydnellum peckii	*Tricholoma equestre*
Lactarius musteus	*Tricholoma focale*

Table 6. Caledonian pinewoods fungal assemblage – additional species of interest

Boletopsis perplexa	*Lactarius mammosus*
Boletus pinophilus	*Lactarius resimus*
Cortinarius purpureus	*Phellodon melaleucus* agg. group I*
Cortinarius claricolor	*Phellodon niger* agg. group V*
Cortinarius fervidus	*Ramaria suecica*
Cortinarius gentilis	*Rhizopogon roseolus*
Cortinarius limonius	*Russula adusta*
Cortinarius mucosus	*Russula badia*
Cortinarius quarciticus	*Russula cessans*
Cortinarius scaurus	*Russula integra*
Cortinarius subtortus	*Russula paludosa*
Hebeloma cylindrosporum	*Russula turci*
Hydnellum concrescens agg. group I*	*Tricholoma albobrunneum*
Hydnellum cumulatum	*Tricholoma apium*
Hydnellum gracilipes	*Tricholoma arvernense*
Hydnellum sp. group III*	*Tricholoma colossus*
Hygrophorus camarophyllus	*Tricholoma guldenii*
Inocybe jacobi	*Tricholoma pessundatum*
Inocybe ovatocystis	*Tricholoma portentosum*
Lactarius deliciosus	*Tricholoma stans*

*Roman numerals refer to the notation used in Ainsworth *et al*. (2010)

3.10 Beech deadwood fungi

3.10.1 The beech wood saprotroph assemblage was drawn up by Ainsworth (2004b, 2005) and consists of 30 indicator species (Table 7). The number of recorded assemblage species is used to assess sites. A site should be considered for notification if the total count reaches or exceeds **15**.

Table 7. Beech deadwood fungal assemblage

Ascomycetes	**Poroid fungi**
Camarops polysperma	*Aurantiporus alborubescens*
Eutypa spinosa	*Aurantiporus fissilis*
	Ceriporiopsis gilvescens
Gilled fungi	*Coriolopsis gallica*
Flammulaster limulatus sens. lat.	*Fomitiporella* (*Phellinus*) *cavicola*
Flammulaster muricatus	*Ganoderma pfeifferi*
Hohenbuehelia auriscalpium	*Gelatoporia* (*Ceriporiopsis, Gloeoporus*) *pannocincta*
Hohenbuehelia mastrucata	*Inonotus cuticularis*
Lentinellus ursinus	*Mensularia* (*Inonotus*) *nodulosa*
Lentinellus vulpinus	*Oxyporus latemarginatus*
Ossicaulis lignatilis sens. auct. Brit.	*Spongipellis delectans*
Phyllotopsis nidulans	*Spongipellis pachyodon*
Volvariella bombycina	
	Others
	Gloeohypochnicium (*Hypochnicium*) *analogum*
	Hericium cirrhatum
	Hericium coralloides
	Hericium erinaceus
	Mycoacia nothofagi
	Phleogena faginea
	Scytinostroma portentosum sens. auct. Brit.

3.11 Oak deadwood fungi

3.11.1 The oak wood saprotroph assemblage was developed by Ainsworth (2017a) and comprises 16 fungi found entirely or primarily on veteran oak wood (Table 8). The number of recorded assemblage species is used to assess sites. A site should be considered for notification if the total count reaches or exceeds **eight**.

Table 8. Oak deadwood fungal assemblage

Buglossoporus (*Piptoporus*) *quercinus*	*Grifola frondosa*
Daedalea quercina	*Gymnopus* (*Collybia*) *fusipes*
Fistulina hepatica	*Hymenochaete rubiginosa*
Fomitiporia (*Phellinus*) *robusta*	*Laetiporus sulphureus*
Fuscoporia (*Phellinus*) *torulosa*	*Mycena inclinata*
Fuscoporia (*Phellinus*) *wahlbergii*	*Podoscypha multizonata*
Ganoderma lucidum	*Pseudoinonotus* (*Inonotus*) *dryadeus*
Ganoderma resinaceum	*Riopa* (*Ceriporia*) *metamorphosa*

3.12 Threatened species in Britain

3.12.1 For site selection, Threatened species should be considered to include all species classified as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) on published, Agency-approved, GB or country-level IUCN-compliant Red Lists.

3.12.2 Where a species has multiple statuses on Red Lists covering different geographical scales, the highest level of threat pertinent to the site locality should be used. Thus, for site selection purposes, a taxon listed as CR at country level should be treated as such, even though it may not be Threatened on the GB list (and vice versa).

3.12.3 In the absence of country-level IUCN-compliant Red Lists, consideration should also be given to the lists of 'priority species' under Section 41 of the Natural Environment and Rural Communities Act 2006 (England), Section 7 of the Environment (Wales) Act 2016, and Section 2(4) of The Nature Conservation (Scotland) Act 2004. For priority species that are poorly represented in the SSSI series, populations should be considered for selection.

3.12.4 All localities for Threatened species should be considered, but assessment against the following criteria is advised. Sites can qualify for single or multiple Threatened species but each species should satisfy one or more of the following conditions:

- The largest persistent fruiting population (see Footnotes on page 8) of the species in each of England, Scotland or Wales.

- A persistent fruiting population of the species in an Area of Search (AoS) supporting a substantial proportion of localities for the species in Great Britain. Preference should be given to stronghold populations, or clusters of localities in the AoS, that maximise resilience, especially in the face of climate change.

- A persistent fruiting population on the edge of the species' geographical range, but excluding species known to have expanding ranges.

- The only or largest persistent occurrence of a Threatened species in a particular AoS.

4. Grassland fungi

4.1 Grassland fungi are typically associated with unimproved and certain types of semi-improved grasslands; these include meadows and pastures both in the lowlands and uplands of Britain, but also ancient lawns, cemeteries, old mineral workings and reservoir embankments. These fungi show a strong preference for undisturbed grassland that is regularly grazed or mown, and without any significant applications of artificial fertiliser or other chemical treatments (Griffith & Roderick, 2008). Although waxcaps, the genus *Hygrocybe sensu lato*, tend to form the most conspicuous and recognisable constituent of these grasslands, other fungi can be of equal, or greater, conservation importance (Table 10). Some mycologically rich grasslands appear to support a relatively low diversity of vascular plants (Holden, 2013; Öster, 2008) and as a consequence may have been overlooked previously in the SSSI selection process. Five groups of grassland fungi – the CHEGD[8] groups – have traditionally been assessed (Rotheroe, 2001; Genney et al., 2009) and these continue to be the focus of site assessment individually, although an overall CHEGD score is not used here.

4.2 Two methods of selecting sites are given below (4.3 and 4.4), based on those used by Genney et al. (2009). A third method (4.5) is provided based on quality indicators, but this should only be used to prioritise sites for further survey rather than as a direct selection criterion. Each taxon listed in the 'taxon for scoring' column of Tables 9, 11 and 12 scores one point. Further divisions of these taxon concepts do not score additional points, so varieties that are not listed in the 'taxon for scoring' column do not add to the score.

4.3 Waxcap species count.

4.3.1 Recent changes in taxonomy have led to a revision of the *Hygrocybe s.l.* scoring system used by Genney et al. (2009). The genus *Hygrocybe s.l.* has been split, and six genera are now recognised as occurring in British grassland (Lodge *et al.*, 2014). Coupled with this, recent research has shown a large number of cryptic taxa in these genera in the UK (Anon, 2013). In comparison to the taxa used by Genney et al. (2009), five additions have been made. By maintaining the *Hygrocybe* concepts of Boertmann (1995, 2010) for site evaluation, further changes to the scoring systems should be unnecessary.

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[8] CHEGD is a widely used scoring system for rapidly assessing the quality of waxcap grasslands (e.g. Rotheroe, 1999, 2001; McHugh *et al.* 2001). Due to recent changes in taxonomy and a wish to prevent an ever-growing acronym, the five broad CHEGD groups comprise the following currently accepted genera: **C** (Clavarioid fungi): *Clavaria*, *Clavulinopsis*, *Ramariopsis*; **H** (*Hygrocybe* s.l.): *Cuphophyllus*, *Gliophorus*, *Gloioxanthomyces*, *Hygrocybe* s. str., *Neohygrocybe*, *Porpolomopsis*; **E** (*Entoloma*):*Entoloma* s.l.; **G** (Geoglossoid fungi): *Geoglossum*, *Glutinoglossum*, *Microglossum*, *Sabuloglossum*, *Trichoglossum*; **D** (*Dermoloma* etc.): *Dermoloma*, *Porpoloma* (*Pseudotricholoma metapodium*), *Camarophyllopsis*, *Hodophilus*.

4.3.2 A site should be considered for notification if the total count of taxa in the left-hand column of Table 9 reaches or exceeds **19**. Sites that fail to reach this threshold but have records of 12-18 taxa should be prioritised for resurvey (multiple visits; see Section 3.2); regional importance may also be a consideration (see 3.6.2).

Table 9. Grassland waxcap (*Hygrocybe s.l.*) assemblage based on taxa described in Boertmann (1995, 2010), with current names and high diversity indicator species.

Taxon for scoring (as defined in Boertmann, 2010 unless otherwise stated)	**Current name**[9] (following Ainsworth & Henrici, 2016; Ainsworth, 2017b)	**High diversity indicator?**
Hygrocybe acutoconica var. *acutoconica* (excl. *H. aurantiolutescens*, a sand dune sp.)	*Hygrocybe acutoconica* var. *acutoconica*	
Hygrocybe acutoconica var. *konradii* (incl. f. *subglobispora*)	*Hygrocybe acutoconica* var. *konradii*	
Hygrocybe aurantia	*Cuphophyllus aurantius*	
Hygrocybe aurantiosplendens	*Hygrocybe aurantiosplendens*	Y
Hygrocybe calciphila	*Hygrocybe calciphila*	
Hygrocybe calyptriformis	*Porpolomopsis calyptriformis*	Y
Hygrocybe canescens	*Cuphophyllus canescens*	Y
Hygrocybe cantharellus	*Hygrocybe cantharellus* (s. Boertmann and British authors)	
Hygrocybe ceracea	*Hygrocybe ceracea*	
Hygrocybe chlorophana	*Hygrocybe chlorophana*	
Hygrocybe citrinovirens	*Hygrocybe citrinovirens*	Y
Hygrocybe coccinea (excl. *H. marchii* s. Boertmann, 1995)	*Hygrocybe coccinea*	
Hygrocybe colemanniana	*Cuphophyllus colemannianus*	Y
Hygrocybe conica var. *conica*	*Hygrocybe conica*	
Hygrocybe constrictospora	*Hygrocybe constrictospora*	
Hygrocybe flavipes (excl. *H. radiata*)	*Cuphophyllus flavipes*	Y
Hygrocybe fornicata var. *fornicata*	*Cuphophyllus fornicatus*	
Hygrocybe fornicata var. *lepidopus*	*Cuphophyllus lepidopus*	
Hygrocybe glutinipes	*Hygrocybe glutinipes*	
Hygrocybe helobia	*Hygrocybe helobia*	
Hygrocybe ingrata	*Neohygrocybe ingrata*	Y
Hygrocybe insipida	*Hygrocybe insipida*	
Hygrocybe intermedia	*Hygrocybe intermedia*	Y
Hygrocybe irrigata	*Gliophorus irrigatus*	

[9] In most cases, the names are unchanged or merely reflect a move to a new genus. However, it should be borne in mind that these current names are merely a snapshot taken in a period of relatively rapid taxonomic change. The recognition of further species that are morphologically similar (but phylogenetically different) to one another is anticipated.

Hygrocybe lacmus	*Cuphophyllus lacmus*	Y
Hygrocybe laeta	*Gliophorus laetus*	
Hygrocybe marchii (s. Boertmann, 1995)	*Hygrocybe marchii* (s. Boertmann, 1995)	
Hygrocybe miniata	*Hygrocybe miniata*	
Hygrocybe mucronella	*Hygrocybe mucronella*	
Hygrocybe nitrata	*Neohygrocybe nitrata*	Y
Hygrocybe ovina	*Neohygrocybe ovina*	Y
Hygrocybe phaeococcinea	*Hygrocybe phaeococcinea*	
Hygrocybe pratensis var. *pratensis*	*Cuphophyllus pratensis*	
Hygrocybe pratensis var. *pallida*	*Cuphophyllus pratensis* var. *pallidus*	
Hygrocybe psittacina var. *psittacina*	*Gliophorus psittacinus*	
Hygrocybe psittacina var. *psittacina* unnamed form	*Gliophorus reginae*	
Hygrocybe psittacina var. *perplexa*	*Gliophorus europerplexus*, *G. perplexus* aff.	
Hygrocybe punicea	*Hygrocybe punicea*	Y
Hygrocybe quieta	*Hygrocybe quieta*	
Hygrocybe radiata (s. Boertmann, 1995)	*Cuphophyllus radiatus*	
Hygrocybe reidii	*Hygrocybe reidii*	
Hygrocybe russocoriacea	*Cuphophyllus russocoriaceus*	
Hygrocybe spadicea	*Hygrocybe spadicea*	Y
Hygrocybe splendidissima	*Hygrocybe splendidissima*	Y
Hygrocybe subpapillata	*Hygrocybe subpapillata*	Y
Hygrocybe substrangulata	*Hygrocybe substrangulata*	
Hygrocybe turunda	*Hygrocybe turunda*	Y
Hygrocybe virginea	*Cuphophyllus virgineus*	
Hygrocybe vitellina	*Gloioxanthomyces vitellinus*	

4.4 Count of other grassland fungal species.

4.4.1 Some sites may be exceptionally rich in other fungal groups (Table 10) despite not reaching the *Hygrocybe s.l.* selection threshold. Each group is assessed by a cumulative species count. The taxonomy of geoglossoid and clavarioid fungi has also recently changed; lists of the morphologically identifiable taxa for use in assessment are given in the left-hand columns of Tables 11 and 12, alongside currently accepted names. A number of semi-cryptic *Microglossum* species have recently been recognised (e.g. Kučera et al. 2017) although their relevance to the British mycobiota has yet to be established; two *Microglossum* aggregates are included. Sites that reach or exceed one or more of the thresholds in Table 10 should be considered for notification.

Table 10. Selection thresholds for grassland fungi other than *Hygrocybe* s.l.

Group, genus or genera	English name	Threshold
Clavarioid fungi	clubs, spindles and corals	7
Entoloma s.l.	pinkgills	15
Geoglossoid fungi	earthtongues	5
Dermoloma, *Camarophyllopsis*, *Hodophilus*, *Porpoloma* (*Pseudotricholoma metapodium*)	crazed caps, fanvaults and meadowcaps	3

Table 11. Earthtongue (geoglossoid fungi) list for scoring – grassland earthtongues as defined by Spooner (1998), alongside their current names.

Taxon for scoring	Current name
Geoglossum barlae	*Geoglossum barlae*
Geoglossum cookeanum	*Geoglossum cookeanum*
Geoglossum elongatum	*Geoglossum elongatum*
Geoglossum fallax	*Geoglossum fallax*
Geoglossum littorale	*Geoglossum littorale*
Geoglossum nigritum	*Geoglossum nigritum*
Geoglossum simile	*Geoglossum simile*
Geoglossum starbaeckii	*Geoglossum starbaeckii*
Geoglossum umbratile	*Geoglossum umbratile*
Geoglossum vleugelianum	*Geoglossum vleugelianum*
Geoglossum glutinosum	*Glutinoglossum glutinosum*
Geoglossum atropurpureum	*Microglossum atropurpureum* agg.
Microglossum olivaceum	*Microglossum olivaceum* agg.
Trichoglossum hirsutum	*Trichoglossum hirsutum*
Trichoglossum rasum	*Trichoglossum rasum*
Trichoglossum tetrasporum	*Trichoglossum tetrasporum*
Trichoglossum variabile	*Trichoglossum variabile*
Trichoglossum walteri	*Trichoglossum walteri*

Table 12. Clubs, spindles and corals (clavarioid fungi) list for scoring – grassland clavarioid fungi as defined by Roberts (2015), alongside their current names (Legon & Henrici).

Taxon for scoring	Current name
Clavaria acuta	*Clavaria falcata* agg.
Clavaria amoenoides	*Clavaria inaequalis*
Clavaria asperulispora	*Clavaria asperulispora*
Clavaria atroumbrina	*Clavaria atroumbrina* s. auct. Brit.
Clavaria fragilis	*Clavaria fragilis* agg.
Clavaria fumosa	*Clavaria fumosa*
Clavaria greletii	*Clavaria greletii*
Clavaria incarnata	*Clavaria incarnata*
Clavaria rosea	*Clavaria rosea*
Clavaria straminea	*Clavaria flavipes*
Clavaria tenuipes	*Clavaria tenuipes*

Clavaria zollingeri	*Clavaria zollingeri*
Clavulinopsis corniculata	*Clavulinopsis corniculata*
Clavulinopsis fusiformis	*Clavulinopsis fusiformis*
Clavulinopsis helvola	*Clavulinopsis helvola*
Clavulinopsis laeticolor	*Clavulinopsis laeticolor*
Clavulinopsis luteoalba	*Clavulinopsis luteoalba*
Clavulinopsis luteonana	*Ramariopsis luteonana*
Clavulinopsis umbrinella	*Clavulinopsis umbrinella*
Ramariopsis crocea	*Ramariopsis crocea*
Ramariopsis kunzei	*Ramariopsis kunzei*
Ramariopsis minutula	*Ramariopsis minutula*
Ramariopsis pulchella	*Ramariopsis pulchella*
Ramariopsis subtilis	*Ramariopsis subtilis*
Ramariopsis tenuiramosa	*Ramariopsis tenuiramosa*

4.5 High diversity indicators

4.5.1 Certain species of grassland fungi tend to be recorded at sites that support a high overall grassland fungal diversity, and are referred to here as 'high diversity indicators'. The 'high diversity indicator' list has been adapted from Newton *et al* (2003) through expert opinion to cover the whole of Britain. Future studies will be needed to corroborate this list if it is ever to be used for the purposes of site selection. If a site fails to reach any of the above selection thresholds but supports any of the 'high diversity indicator' waxcap species (Table 9) and/or other 'high diversity indicator' fungi[10], the site should be prioritised for resurvey (multiple visits). These species have been chosen on grounds of their rarity/scarcity, strong association with ancient grassland sites, UK-wide distribution and international status. It should be emphasised that the list does not equate to an alternative means of site selection but such species should be mentioned in site citations; in some cases, populations of these 'high diversity indicator' fungi may be individually selectable.

[10] The 'priority species' (see 3.12.3) *Clavaria zollingeri*, *Entoloma bloxamii* agg., *Geoglossum* (*Microglossum*) *atropurpureum* agg. and *Microglossum olivaceum* agg. should be treated as high diversity indicators.

5. Boundary setting

5.1 When drawing site boundaries for SSSIs being designated partly or wholly on account of their fungal interest, consideration should be given to generic guidance on boundary-setting provided in Bainbridge *et al*. (2013).

5.2 Fungi function in different ways to plants and animals, and are largely hidden from view. Fruiting hotspots can be highly localised while the corresponding mycelia may occur across a much larger area (Taylor *et al.*, 2014). Although DNA sampling may in future be used for routinely mapping the extent and composition of a population, this information is currently unlikely to be available. As such, while site selection should be based on fruitbody records, site boundaries should be based on the extent of suitable habitat, including known fruitbody areas.

5.3 Further advantages may stem from incorporating surrounding habitat. In keeping with the Potential Value criterion (Bainbridge *et al*., 2013), future habitat continuity issues may be averted – e.g. by including younger cohorts of trees within a site supporting veteran tree fungal interest. A broader site perimeter can also buffer the impacts of operations on adjacent land: for instance, tree belts have been shown to reduce the incursion of aerial ammonia to sites (Dragosits *et al.*, 2011) which could adversely affect ectomycorrhizal and grassland fungal communities (e.g. Arnolds, 2010; Moore *et al.*, 2008; Senn-Irlet *et al.*, 2007).

5.4. SSSI boundaries need to reflect the fungi they are protecting. In some cases a tighter boundary will be appropriate, especially where the interest is confined to a small area – e.g. a field supporting a rich waxcap assemblage – although entire management units are preferable.

5.5 Where the interest appears fragmented, fruitbodies occurring in a number of discrete hotspots, it may be more appropriate to treat areas collectively and notify them as a single site. However, hotspots need to be ecologically coherent (as a whole) and situated relatively close to one another – e.g. saprotrophic fungi within a large parkland or forest.

5.6 It is critical that expert mycologists are consulted when site boundaries are drawn up, so that fungal ecology and population biology can be accounted for.

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