Guidelines for the Selection of Biological SSSIs

Part 2: Detailed Guidelines for Habitats and Species Groups

Chapter 13 Lichens and associated microfungi

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Cover note

This chapter updates and replaces the previous lichen SSSI selection guidelines in the non-vascular plant chapter (Hodgetts 1992). It was prepared by Neil Sanderson (consultant lichenologist), Tim Wilkins (Natural England), Sam Bosanquet (Natural Resources Wales) and David Genney (Scottish Natural Heritage), and provides detailed guidance for use in selecting lichen 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 previous lichen guidelines are:

- replacement of the site scoring system (Combination of Species) with habitat-based assemblage scoring (assessment of ecologically coherent assemblages);
- introduction of a new criterion for taxa that are Near Threatened for which Britain has International Responsibility (including endemics and near-endemics);
- refinement of woodland lichen indices, including adoption of new index names;
- adoption of new lichen habitat indices for: heathland and moorland, limestone, maritime rock, watercourses, metalliferous habitats and pinhead lichens (deadwood habitats);
- criteria for lichens that are Threatened on the global IUCN Red List;
- evaluation of species with a Threat status in country-level red data lists (where available); and
- discontinuation of the Schedule 8 species selection criterion.

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 Brian Coppins.

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1 Introduction

1.1 Taxonomic scope and nomenclature

The groups covered are lichens (lichenised fungi) and associated microfungi, including fungi parasitic on lichens (lichenicolous fungi) and non-lichenised fungi that are ecologically associated with lichens and studied by lichenologists. For convenience these are collectively referred to here as lichens.

The taxa covered are principally species, but subspecies and varieties[1] are also included where they have been subject to recent assessments of national status or threat, currently Woods and Coppins (2012).

Nomenclature follows the BLS Taxon Dictionary (British Lichen Society 2017) but lichen nomenclature remains in flux and new species are frequently added, both from revisions of known taxa and from the discovery of totally new taxa. The tables of taxa included in this chapter should be used as provided; users should not add taxa.

1.2 Knowledge of species distributions

Data describing the distribution of British lichens are comprehensive enough to allow comparative assessment of site quality and importance. Distributions of long-established, conspicuous taxa are particularly well known (Seaward 1995 *et seq.*). However, there are still significant under-recorded geographic areas, especially in lichen-poor regions, or where access is constrained by terrain or remoteness.

Species requiring specialist identification techniques, e.g. microscopic examination, and those that are difficult to detect in the field tend to have been under-recorded. For example, in the current GB red list (Woods and Coppins 2012) over 60% of lichenicolous fungi were classed as either Not Evaluated (NE), or Data Deficient (DD).

Most lichen distribution data are publicly available on the National Biodiversity Network Atlas (https://nbnatlas.org/), allowing scrutiny and analysis. A small number of records are available to the public only at a summary resolution because they relate to taxa that are vulnerable to human disturbance or collection.

1.3 Associated interest features

In the past, some important lichen sites were designated on the basis of habitat or vegetation type. This may continue to be appropriate for sites that support moderate lichen interest and do not meet the selection thresholds for lichens (3.5). However, some habitats are disproportionately important for lichens compared with other taxa, and yet this importance may be unrecognised in habitat/vegetation classification systems. As a consequence, the management needs of lichens can be overlooked (e.g. Coppins and Coppins 2005). There is therefore clearly a need for lichen features to be notifiable in their own right.

Habitat guidelines of particular relevance to lichens are: Coastal and Marine habitats (Chapter 1), Woodland (Chapter 2), Veteran trees (included within woodland chapter), Lowland grasslands (Chapter 3), Lowland heathland (Chapter 4), Non-montane rock habitats (Chapter 5), Freshwater habitats (Chapter 6), Upland habitats (Chapter 9) and Artificial habitats (Chapter 10).

1.4 Species status

The current British IUCN Red List for lichens (Woods and Coppins 2012) includes a threat evaluation and a rarity evaluation for almost all known taxa. Rarer lichens are listed as either

[1] Woods and Coppins (2012) assessed varieties and morphs (forms) only where these had ecological significance; in the past, on further investigation, these have often been raised to species level.

Nationally Rare (occurring in 15 or fewer 10km squares in Britain) or Nationally Scarce (occurring in 16 to 100, 10km squares). Although many species are well recorded and genuinely rare, others are undoubtedly under-recorded: some are recently described taxa, or recent arrivals in Britain, whilst others are ephemeral, growing in widely occurring transient habitats. Furthermore, some Nationally Scarce lichens occur in almost 100 hectads and are common across a large part of their geographic ranges. Species rarity is not used, therefore, in isolation to select lichen sites but is included in TNTN (Threatened, Near Threatened, and Notable) assemblage scoring (3.4.7).

The category of Near Threatened (NT) is similarly not used as a site selection criterion independently but in combination with International Responsibility (3.2.3) and also within TNTN assemblage scoring. NT lichens appear to be poor colonists, are usually Nationally Rare or Nationally Scarce, and are confined to habitats known to be threatened or declining (Woods and Coppins 2012). Data Deficient (DD) taxa lack detailed information on population size or range, precluding an accurate assessment of their IUCN threat status. Nonetheless, most taxa in this category are very rare based on existing knowledge (many are known from a single site), hence populations of most DD taxa can be assessed under TNTN assemblage scoring.

Notwithstanding the above, selecting sites for populations of rare and threatened species allows the full range of British taxa to be conserved since common lichens occur alongside these rarities, albeit sometimes in different niches.

Legislation to protect or conserve particular species, e.g. Schedule 8 of the Wildlife and Countryside Act (1981, as amended), can be seen as complementary to site protection legislation, hence there are no criteria for selecting populations of species with such legal status. Nevertheless, many of these species will be Threatened, or belong to key assemblages, so their populations may qualify elsewhere in this chapter.

1.5 Landscape-scale threats to lichen diversity

Ongoing changes in the wider environment impact on the quality, and thus the selection, of sites. Lichen diversity is heavily dependent on air quality, climatic factors and the range of tree species present. This is evident not only at the site level, but also nationally: changes can place a constraint on site selection, with impacts on network ecological coherence (Part 1: 5.11) and potential value (Part 1: 5.12). Site selection should not only make allowance for these threats, but should also consider the degree of recovery that has taken place since past damage.

1.5.1 Air quality

Lichens are well known for their sensitivity to air pollution. Until recently, sulphur dioxide levels determined the distribution of most lichen species over all of central Britain (Farmer *et al* 1992; Hawksworth and Rose 1976). With the very successful control of this pollutant, lichen communities are recovering and some species are returning (Wolseley and Lambley 2004). However, a legacy remains affecting large areas of south-east, central and northern England, south Wales and the central belt of Scotland, where slow-colonising lichens of conservation interest have yet to return (Map 2 shows some of the areas concerned). Currently, nitrogen pollution is a more significant threat nationally (Wolseley and Lambley 2004). Widespread changes in lichen communities have been observed due to eutrophication from ammonia in areas of intensive farming (chiefly in the lowlands), and acidification from more long-distance dispersal of nitrogen oxides penetrating into less intensively farmed areas – e.g. in mid-Wales and the Pennines (van Herk *et al* 2003; Wolseley *et al* 2006). When evaluating the lichen interest of sites affected by, or recovering from, air pollution, the Potential Value criterion (Part 1: 5.12) should be borne in mind.

1.5.2 Tree disease

Tree diseases can have a national impact on lichen diversity. Dutch Elm Disease caused the loss of veteran elms throughout all but the most isolated areas of Britain in the late 20th century. This has resulted in severe declines of several already scarce lichens, in particular specialists of wound-tracks on veteran trees (Watson *et al* 1988; Edwards 2007). With the arrival of Ash Dieback, lichens that declined because of elm loss face a national extinction risk, while a suite of ash-associated species are also under threat (Ellis *et al* 2012; Mitchell *et al* 2014). Since few native trees can host these species, the presence of introduced or naturalised tree species in selected sites may be key (3.1.4).

1.5.3 Climate change

With changes in climate and air quality, large range shifts in lichen species have been observed (e.g. Van Herk *et al* 2002; Aptroot and Van Herk 2007) and further rapid change can be expected. Although assemblages represent a more resilient notification entity than individual species, changes in international responsibilities and threat/rarity statuses may mean that species lists and selection thresholds in this chapter need modification in future.

1.6 Microhabitats

Lichen diversity is strongly dependent on microhabitat diversity (e.g. Ellis *et al* 2015). Lichens occupy more specialised niches than other larger photosynthetic organisms, responding to small-scale habitat variability across sites and through time. This underlying complexity is only partly reflected in the assemblage scoring systems in this chapter; the lists of lichens provided for each habitat are not intended to be comprehensive.

1.7 Artificial habitats

Although SSSI designation may be inappropriate for the built environment, some man-made structures and landscapes, especially in the lowlands, can be important for lichens. For example, more than 600 species, over a third of the British total, have been recorded from churchyards (Gilbert 2000). The most lichen-rich churchyards support over 90 saxicolous species and are of considerable scientific interest. Nevertheless, in most cases designation is unlikely to be necessary or appropriate.

Other notable habitats include: old walls, stone bridges, castles and prehistoric megalithic monuments (e.g. stone circles); old, untreated, worked timber; and post-industrial sites (Chester and Blatchley 2001; Fletcher 2001b; Seaward 2001). The assemblages are overwhelmingly composed of widespread species, but some uncommon and even Threatened species can occur. Old metal mine sites are of outstanding lichenological importance (Simkin, in press) and their selection is treated in 3.4.6.

2 International Responsibility

2.1 Assemblages of international significance

Certain British lichen assemblages are rich compared with equivalents elsewhere in Europe, and are of international importance (Fryday 2002; Coppins and Coppins 2005). This is partly associated with our oceanic climate, but also results from the extent of semi-natural habitat with relatively clean unpolluted air, and significant numbers of old trees[2] in parkland and old growth pasture woodland (e.g. Farjon 2017). This contrasts with large tracts of western Europe (Rose 1992). It is the assemblages of hyperoceanic[3] lichens that are of greatest significance at a European scale, and these are largely confined to woodlands (2.1.1) and montane rock/soil (2.1.2).

[2] Defined here as trees beyond commercial maturity including post-mature trees as well as large and ancient or veteran trees.

[3] The most oceanic climates, with low seasonal temperature fluctuations; generally with high rainfall, high humidity and high cloud cover.

Accordingly, Britain is considered to have international responsibility for the following:

2.1.1 Temperate rainforest

The climate of western Britain and Ireland is strongly influenced by the Atlantic Ocean and Gulf Stream. As a consequence, summers are relatively cool and winters relatively mild, with high rainfall throughout the year. Woodlands along this Atlantic fringe are the European headquarters for lichens with oceanic and, most importantly, hyperoceanic distributions (Maps 2 and 3 show the areas of lowland and upland temperate rainforest lichens). While these species are rare or restricted in Europe as a whole, many are relatively common in parts of Britain and Ireland, although some species have remarkable global range disjunctions – e.g. also occurring in western Pacific America. The relatively large population sizes of the more widespread oceanic species in British hyperoceanic woodland are also significant when many are in rapid decline in the rest of Europe due to habitat loss and pollution.

Old lichen-rich woodlands in the western Scottish Highlands are without parallel elsewhere in Europe (Coppins and Coppins 2005, 2012). These temperate rainforests usually comprise types of long-established mixed and varied continuous cover woodlands with a history of limited management beyond extensive grazing (Smout *et al* 2005), including the unique Atlantic Hazel woods (Coppins and Coppins 2012).

There are three principle hyperoceanic lichen communities[4] which can be split between base-rich bark (*Lobarion pulmonariae*), acid bark (*Parmelion laevigatae*) and smooth bark (undescribed associations within the *Graphidion scriptae*).

Beyond the area of western Scotland from Loch Carron in West Ross, south to West Loch Tarbert on the Kintyre peninsula, at lower altitudes, hyperoceanic rainforest is limited in extent by lower rainfall. However, in western Britain, from northern Scotland to the uplands of south west England, higher rainfall at altitude allows the development of more acid and highly leached upland rainforest (Sanderson, in press[a]), in which the dominant lichen community of interest is the acid bark loving *Parmelion laevigatae*.

2.1.2 Hyperoceanic acid montane rock/soil

The lichen assemblage of British hyperoceanic acid montane rock is unique in Europe and probably the world (Fryday 2002). Associated lichen communities, including the richest elements of the assemblage, are described by Orange (2009). The assemblage occurs in the western Scottish Highlands, partly extending into late snow patch habitats of the eastern Highlands.

2.1.3 Southern oceanic woodland assemblage

Southern oceanic old growth woodland lichen assemblages are outstandingly well-developed in the south of Britain, especially from North Wales south to Devon and Cornwall and east to the New Forest (Map 2) (Rose and James 1974; Sanderson 2010). The range of lichen communities of interest is greater than in the rainforests, consisting of: base-rich bark (*Lobarion pulmonariae* and *Agonimion octosporae*), acid bark (*Parmelion laevigatae*), smooth mesic bark (*Graphidetum scriptae* and *Pyrenuletum chlorospilae*)[5], rough mesic bark (*Pertusarietum amarae*), dry bark and lignum on veteran and dead trees (*Lecanactidetum*

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[4] Lichen communities, such as the *Lobarion pulmonariae* and *Parmelion laevigatae* are found in particular niches, such as base-rich bark or dry overhanging rock. Several communities can co-occur in a habitat, or even on a single tree. Further information can be found in: James *et al* (1977), Ellis *et al* (2015) and Sanderson (in press[a]).

[5] The *Agonimion octosporae* and *Pyrenuletum chlorospilae* are southern Atlantic – Mediterranean lichen communities (Bricaud 2010) not described in James *et al* (1977), but which are core communities for the distinctive elements of the southern oceanic old growth woodland, with characteristic species including *Agonimia octospora*, and *Porina hibernica* and *Enterographa elaborata* respectively.

premneae, *Calicietum hyperelli* and *Calicietum abietinae*) and wound-track lichens (*Gyalectinetum carneoluteae*).

2.1.4 Other internationally notable assemblages
Britain retains a relatively high proportion of certain assemblages that have undergone widespread declines in Europe through habitat loss and pollution, namely those associated with: old trees of open places (Farjon 2017), old growth woodlands in general including those in less oceanic areas such as sub-oceanic[6] and boreal woodland (Rose 1992), non-montane heathland, coastal base-rich dunes and machair, and shingle habitats (Fletcher *et al* 1984; Gilbert 2000; Janssen *et al* 2016; Sanderson 2017a), well-lit acid watercourses with stable rock outcrops and low silt loads (Orange 2013; H. Thüs pers. comm.) and metal-rich (metalliferous) habitats (Gilbert 2000; Janssen *et al* 2016).

2.2 Species of international significance

Some British species are threatened globally, and have 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 lichens can be nominated and assessed for global IUCN red listing: http://iucn.ekoo.se/iucn/summary/. The European lichen red list (Sérusiaux 1989) referred to by Hodgetts (1992) is now considered too outdated.

Lichens for which Britain is considered to have International Responsibility (IR) in the current GB Red List. Following Woods and Coppins (2012), the following definition of IR is used: Britain probably has more than 10% of the extant European and/or world population.

Great Britain clearly has responsibility for its endemic and near-endemic species. Woods and Coppins (2012) identified 34 taxa as endemic to Britain and Ireland and four more as possibly endemic. The list includes a number of little known taxa categorised as Data Deficient, and some very widespread Least Concern species. Since endemics are a subset of IR taxa, selection of their sites is treated together (3.2.3).

3 Site Selection Requirements

3.1 General requirements and considerations

3.1.1 When evaluating and selecting sites for lichens, the principles outlined in Part 1 of the guidelines (Bainbridge *et al* 2013) should be followed. In addition, it is essential to consult the relevant country agency specialist and preferably also a lichenologist because of complexities in relation to taxonomy, population viability and assemblage scoring methods.

3.1.2 Species records
The evaluation of sites should be based on recent data and taxa should be excluded where there is doubt about their continued presence. In the absence of recent surveys, records from the last 25 years may be included. Records that are more than 25 years old should only be used in the assessment of assemblages on sites that are very large and/or remote, and where there is a significant chance that colonies have not been revisited since their first discovery; a 50-year date cut-off should then be applied. However, past data should be subject to scrutiny and may be rejected where: 1) the site has experienced habitat change during this period such that the species is unlikely to be extant; 2) the autecology or distribution of the species suggests its presence was short lived at the site; or 3) recent taxonomic change raises doubts over the identification of the species recorded.

3.1.3 Species translocations
Populations resulting from conservation translocations (introductions, reintroductions and reinforcements) should be considered where these:

[6] Defined here as the least oceanic climates (typically covering the entire hemioceanic zone and the eastern part of the euoceanic zone – see footnotes below).

- are established and increasing;
- have followed IUCN guidelines (currently IUCN /SSC 2013); and
- meet all the relevant requirements of section 3.

3.1.4 Non-native trees
Epiphytic lichens occur widely on non-native trees and, especially when old, such trees can support rare and threatened species. The Potential Value criterion (Part 1: 5.12) should be considered in relation to non-native trees (archaeophytes and neophytes), for example the role of old sycamore as a refuge for some species that otherwise may be lost due to Ash Dieback disease. The value of non-native trees should be assessed against the potential threats to native tree composition. The lichen significance of various tree species is given in Appendix 1.

3.2 Internationally important features

3.2.1 Special assemblages in a global context
Britain's internationally important woodland lichens are covered in Section 4 which should be referred to when evaluating or selecting woodland sites for their lichen interest. Other globally significant assemblages are selected either via habitat indices or assemblage scoring, as guided by Table 1: hyperoceanic acid montane rock/soil, non-montane heathland, coastal base-rich dunes and machair, coastal shingle, acid watercourses, metalliferous habitats and old trees of open places.

3.2.2 Globally threatened taxa
All sites that support viable[7] populations 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 considered for notification at one site in each Area of Search in which they occur, with the largest population prioritised.

3.2.3 'International Responsibility' taxa
Sites that support viable populations of species classed as both Near Threatened (NT) and International Responsibility (IR) on the GB IUCN Red List (abbreviated here to NT-IR) qualify for selection where they meet one of the criteria specified under section 3.3.4. A list of 'International Responsibility' species, including endemics, is given in the supplementary *Appendix 2 Lichen List SSSI Guidelines Mar 2018.xlsx*.

3.3 Threatened lichens in Britain

3.3.1 Sites of Threatened taxa, listed as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) in the GB IUCN Red List for lichens, can qualify for site selection (3.3.4). For convenience the existing list of British Threatened and NT taxa are given in the supplementary *Appendix 2 Lichen List SSSI Guidelines Mar 2018.xlsx* which is based on Woods and Coppins (2012).

3.3.2 Rarity at smaller scales than GB should also be a consideration (Part 1: 5.10.3 and 10.1) and therefore populations of Threatened taxa (CR, EN, or VU) on Country Red Lists are selectable. To date only a red list for Wales has been published (Woods 2010). Where a species has been assessed under multiple Red Lists covering different geographical scales,

[7] Population viability is discussed in Part 1 (5.7.4) of the Guidelines. A viable lichen population is not easily defined due to the long generation times of some species and gaps in our understanding of lichen population biology. In the absence of published research, proxy measures should be used including: population size (bigger is better), extent of distribution within a site (widespread is better), and habitat continuity (stable habitats are better). A further indicator is the taxon's abundance at sites where it has a long-recorded history. Consult the country lichen specialist for further guidance.

the highest level of threat applicable 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 in the GB Red List (and vice versa).

3.3.3 Although species at the edge of their global ranges in Britain can hold scientific interest, lichen site selection should be considered in the context of GB Threat status and international conservation responsibilities (Part 1: 5.10.2 and 5.10.8).

3.3.4 Sites can qualify for the presence of single or multiple Threatened species, or NT-IR species (see 3.2.3), but each species should satisfy one or more of the following conditions:

3.3.4.1 The largest population of the species in each of England, Scotland or Wales so that no Threatened species becomes regionally extinct with respect to each country's devolved biodiversity duties.

3.3.4.2 A viable population of the species in an Area of Search (AoS) supporting a substantial proportion of localities for the species in 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.

3.3.4.3 A viable population on the edge of the species' geographical range, but excluding species known to have expanding ranges.

3.3.4.4 The only or largest viable population of the species in a particular AoS.

3.4 Ecologically coherent lichen assemblages

Sites holding significant ecologically and/or bio-geographically coherent assemblages[8] are of great scientific interest. Assemblages of lichens have traditionally been evaluated by habitat indices in British lichenology (Rose 1976; Wolseley and James 1991; Rose 1992; Hodgetts 1992; Coppins and Coppins 2002). They are intended to measure lichen diversity in a repeatable way, using species strongly associated with high quality and long continuity of habitat. Selection thresholds are assessed against the total number of index species recorded – i.e. each taxon or species pair/grouping in the relevant index table counts as one. A single site survey is unlikely to record all the indicator species present; it is preferable therefore to pool the results of several recent surveys, although very high totals from single surveys may provide enough evidence for sites to be selected.

Indices have not yet been developed for all key lichen habitats. Where they are lacking, TNTN (Threatened, Near Threatened and Notable Species) assemblage scoring can be used (3.4.7). Table 1 summarises the indices and TNTN assemblages that can be used to assess sites.

Table 1. Lichen assemblages, the habitats in which they occur, and the method to use for assessment.

Habitat[†]	Assemblage	Assessment method / Key interest	Threshold[#]	Section
Artificial	Metalliferous habitats*	Metalliferous Habitats Index	10	3.4.6
Coastal	Coastal base-rich dunes and machair*	Lichens should be mentioned in SSSI citations. Southern base-rich dunes can be assessed under TNTN lowland calcareous ground.	-	3.5.3
Coastal	Coastal shingle*	Use the Heathland, Moorland and Coastal Heath Index for *Cladonia*-dominated	-	3.5.2

[8] 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.

Habitat†	**Assemblage**	**Assessment method / Key interest**	**Threshold#**	**Section**
		assemblages; rich sites in NE Scotland should be considered in consultation with the country specialist; otherwise species of interest should be mentioned in SSSI citations		
Coastal	Maritime rock and coastal slope	Maritime Rock and Coastal Slope Index	35 or 25 or 15	3.4.3
Freshwater	Acid watercourses*	Acid Watercourses Quality Index	11	3.4.4
Freshwater	Lakes	TNTN: rocky lake shores	6	3.4.7
Grassland (lowland)	Lowland calcareous ground	TNTN: open calcicolous grasslands without significant outcrops of hard limestone. Includes chalk downland, Breckland grassland, southern base-rich dunes and coastal soft cliffs	6	3.4.7
Heathland (lowland and upland)	Heathland, moorland and coastal heath*	Heathland, Moorland and Coastal Heath Index	20	3.4.2
Non-montane rock	Limestone rock	Limestone Index	30	3.4.5
Non-montane rock	Non-montane acid rock	TNTN: outcrops of acid rocks, including both siliceous rocks and hard basic igneous rocks, sometimes with localised base rich influence, in the forest zone	6 or 10	3.4.7
Non-montane rock	Non-montane mixed siliceous/calcareous rock outcrops	TNTN: rare outcrops with intimate mixtures of acid siliceous and calcareous rocks	10	3.4.7
Upland	Hemioceanic acid montane rock/soil	TNTN: rock and soil on predominately acidic mountains in the eastern central Highlands, east of the Drumochter Pass	40	3.4.7
Upland	Hyperoceanic* and euoceanic acid montane rock/soil	TNTN: rock and soil on predominately acidic north and west Highland mountains, west of the Drumochter Pass	30	3.4.7
Upland	Montane calcareous rock/soil	TNTN: outcrops of calcareous rock in the Scottish Highlands, mainly over 600m in the central Highlands; also at lower altitudes on Tertiary basalts on the west coast of Scotland	40 or 20	3.4.7
Woodland	Boreal woodland*	Boreal Woodland Index: covers native pinewoods and old-growth birch in the eastern and central pinewood zones of the Scottish Highlands, as well as pure native pinewoods in the western pinewood zone	20 or 15	4.5
Woodland	Hyperoceanic woodland (lowland)*	Lowland Rainforest Index: covers hyperoceanic and western euoceanic[9] temperate rainforest in very high rainfall areas in the western Highlands	25	4.2
Woodland	Hyperoceanic woodland (upland)*	Upland Rainforest Index: covers hyperoceanic and euoceanic acidic upland temperate woodland in very high rainfall areas	15 or 10	4.4
Woodland	Old trees of open places	TNTN: well-lit veteran trees in parkland, farmland, waysides and hedgerows	16	3.4.7
Woodland	Pinhead lichens	Pinhead Index: covers standing deadwood and large trees with dry bark crevices	10	3.4.1
Woodland	Southern oceanic woodland*	Southern Oceanic Woodland Index: covers a wide swathe of southern Oceanic Britain	30 or 20	4.1

[9] Less oceanic than hyperoceanic climates, with higher seasonal temperature fluctuations, but rainfall, humidity and cloud cover all still high, and on higher ground, very high.

Habitat†	**Assemblage**	**Assessment method / Key interest**	**Threshold**#	**Section**
Woodland	Sub-oceanic woodland*	Sub-oceanic Woodland Index: covers temperate woodland in the east of Scotland and areas with a similar climate in the north east of England	20 or 15	4.3
† relate to the habitat chapters of Guidelines for Selection of Biological SSSIs; * indicates assemblages of international significance (2.1.1–2.1.4); # alternative index thresholds are explained in the text within each section; for TNTN thresholds refer to Appendix 2.				

For habitats not listed in Table 1, use species criteria to select important populations; species criteria can also be used alongside assemblage scoring.

When judging assemblages against threshold scores, site size needs to be considered: large sites qualify more easily, small sites may fail to qualify. Where possible, guidance is given on the spatial scale applicable to each index. Where the interest is fragmented, occurring in a number of discrete hotspots, it may be more appropriate to treat the areas collectively and evaluate them as a single assemblage.

Threshold values are not absolute: they are for guidance only, to indicate when a site should be considered for SSSI designation. Sites that do not attain the threshold, but which are the best examples in an Area of Search, or are notable atypical variants (see Part 1: 5.4.1), may be selected to ensure the geographic and compositional spread of each assemblage is adequately protected. For example – disjunct occurrences of upland saxicolous[10] lichens in Charnwood Forest (Leicestershire) are of scientific interest despite supporting no nationally Threatened and few Notable species when such assemblages would be unremarkable in the north and west of Britain (Gilbert 2000).

3.4.1 Pinhead Index

Deadwood and living trees large enough to provide crevices sheltered from much of the direct rainfall, support communities of lichens and microfungi that produce powdery spore masses on the tops of pin-shaped fruitbodies. The total number of recorded Pinhead species in the genera: *Calicium*, *Chaenotheca*, *Chaenothecopsis*, *Microcalicium, Mycocalicium* and *Sclerophora* is used as an index score (Selva 1994; Sanderson 2017b). All sites scoring **10 or over** on the Pinhead Index should be considered for notification.

3.4.2 Heathland, Moorland and Coastal Heath Index (HMCHI)

Building on the work of Sanderson (2011, 2015), the *Cetraria*, *Cladonia* and *Pycnothelia* (CCP) index developed for southern England heathland has been augmented to cover all non-montane heaths, including non-montane moorland, coastal heathland, acid dunes and comparable habitats. For hard rock coasts and associated grassland communities, use Maritime Rock and Coastal Slope Index (3.4.3).

The index should be applied to a heathland or moorland area of about 100ha. The index score is calculated by <u>adding</u> the number of recorded taxa[11] in each genus listed in the left-hand column of Table 2 <u>to</u> the number of recorded species in the right-hand column. For example, a site supporting 23 *Cladonia* taxa, two *Cetraria* taxa, *Pycnothelia papillaria* and *Leptogium palmatum*, would score 27.

Sites scoring **20 or more** should be considered for notification.

[10] Saxicolous species grow directly on rock.
[11] Including species that occur on heather stems. In *Cladonia* count all recognised infraspecific taxa. For the *Cladonia chlorophaea* s. lat. group, if possible count *Cladonia chlorophaea* s. str. and *Cladonia grayi* s. str. individually, but treat the remainder of *Cladonia grayi* s. lat. as a single aggregate, (best called the *Cladonia cryptochlorophaea* group).

Table 2. HMCHI genera and species.

Genera	Species
Alectoria	*Leptogium palmatum*
Bryoria	*Ochrolechia frigida*
Cetraria	*Peltigera malacea*
Cladonia	*Stereocaulon condensatum*
Heterodermia	*Stereocaulon glareosum*
Icmadophila	*Usnea articulata*
Pycnothelia	
Teloschistes	
Thamnolia	

3.4.3 Maritime Rock and Coastal Slope Index (MRCSI)

Building on the work of Wolseley and James (1991) and Fletcher (2001a), a maritime rock and coastal slope lichen index has been developed (Edwards and Wolseley, in prep) which covers coastal hard rocks from intertidal rocks to salt-spray limits (potentially over 1km on very exposed coasts) and associated grassland habitats. For coastal heathland, use the Heathland, Moorland and Coastal Heath Index (3.4.2). Regionally restricted communities of particular interest are the *Sclerophytetum circumscriptae* of dry underhangs in SW England and SW Wales, and the *Lobarion* community (normally found in woodland) occurring on sheltered basic or base-enriched rocks in western Scotland and very rarely in England and Wales. Good examples of these communities in particular should be represented in the SSSI series.

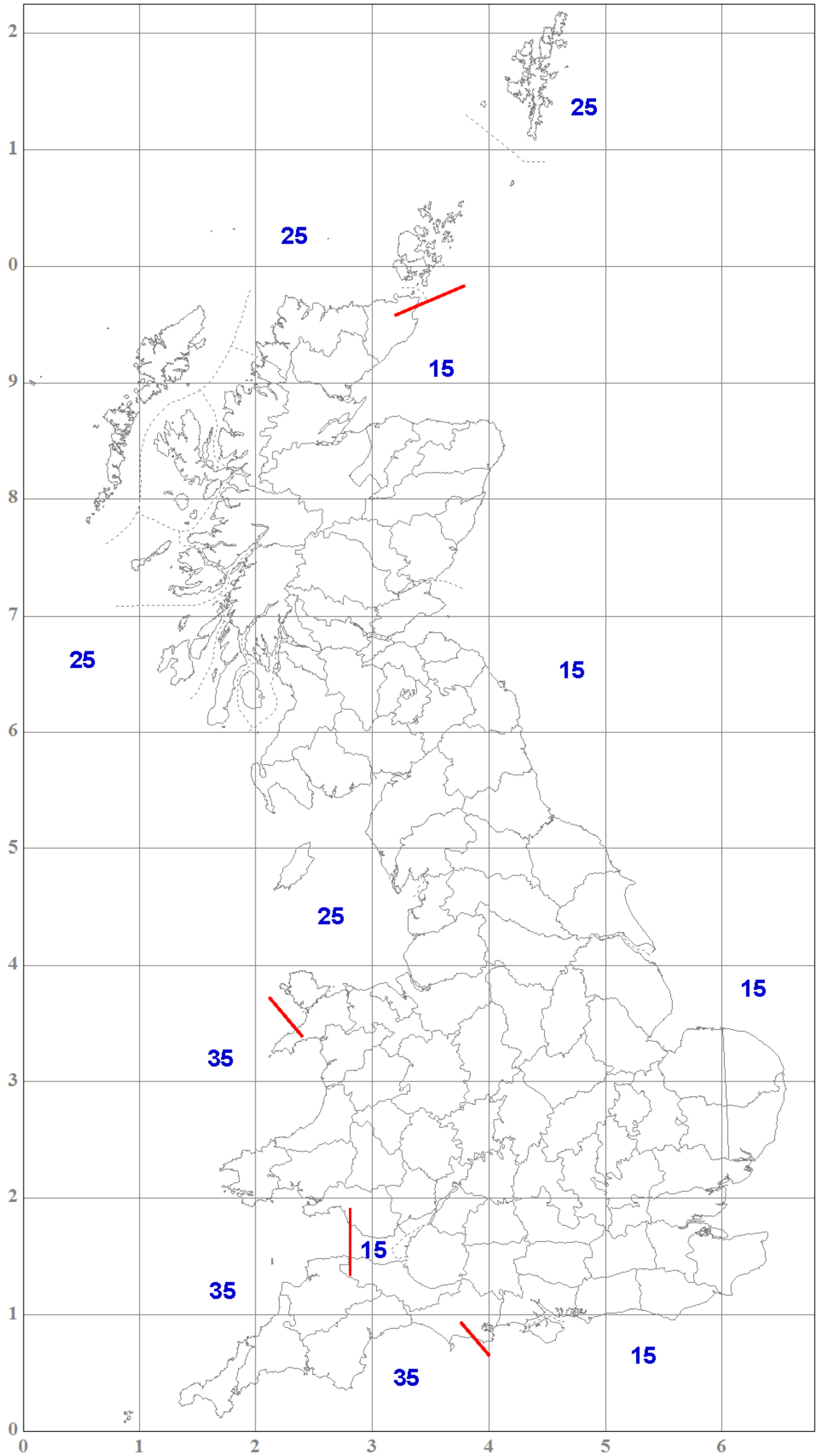
Site selection is based on the number of recorded species or species groupings in Table 3 over a discrete stretch of coastline less than 5km in length. The diversity of hard rock coasts declines from SW to NW Britain, so separate regional thresholds are necessary (Map 1).

Table 3. MRCSI taxa.

Arthonia atlantica	*Halecania ralfsii*	*Pertusaria monogona*
Arthonia endlicheri	*Herteliana gagei*	*Pertusaria pluripuncta*
Arthonia phaeobaea	*Heterodermia leucomelos*	*Physcia clementei*
*Aspicilia epiglypta / A. intermutans**	*Heterodermia obscurata*	*Placidiopsis custnani*[⊕]
Aspicilia leprosescens	*Hypotrachyna britannica*	*Porina curnowii*
Bacidia scopulicola	*Lecania aipospila*	*Protoparmelia montagnei*
Bacidia sipmanii	*Lecania baeomma*	*Pseudocyphellaria aurata*
Buellia coniops	*Lecania fructigena*	*Pseudocyphellaria crocata / P.intricata / P.norvegica**
Buellia leptoclinoides	*Lecanographa dialeuca*	*Ramalina canariensis* or *lacera*
Buellia abstracta[⊕]	*Lecanographa grumulosa*	*Ramalina chondrina*
Buellia subdisciformis	*Lecanora andrewii*	*Ramalina polymorpha*
Caloplaca aractina	*Lecanora fugiens*	*Rinodina beccariana*
Caloplaca arnoldii	*Lecanora ochroidea*	*Rinodina confragosa*
Caloplaca littorea	*Lecanora poliophaea*	*Rinodina conradii / intermedia*
Caloplaca maritima	*Lecanora praepostera*	*Rinodina luridescens*
Caloplaca scopularis	*Lecanora straminea*	*Rinodina roboris* var. *armeriicola*
Caloplaca servidiella	*Lecidea diducens*	*Roccella fuciformis*
Caloplaca cerina var. *chloroleuca*	*Lecidea sarcogynoides*	*Roccella phycopsis*
Caloplaca verruculifera	*Lecidella meiococca*	*Roccellographa circumscripta*[⊕]
Candelariella coralliza	*Leptogium britannicum*	*Sarcogyne clavus*
Cladonia firma	*Leptogium cyanescens*	*Solenopsora holophaea*
Cladonia mediterranea	*Llimonaea sorediata*	*Solenopsora liparina*

Cliostomum tenerum	*Lobaria pulmonaria*	*Solenopsora vulturiensis*
Collema furfuraceum	*Lobaria virens*	*Sticta canariensis* (dufourii)
Collema latzelii	*Moelleropsis nebulosa*	*Sticta canariensis* (green morph)
Collema nigrescens	*Nephroma laevigatum*	*Syncesia myrticola*
Degelia atlantica	*Nephroma tangeriense*	*Teloschistes flavicans*
Degelia ligulata	*Normandina pulchella*	*Toninia mesoidea*
*Degelia plumbea / D. cyanoloma**	*Opegrapha cesareensis*	*Trapeliopsis wallrothii*
Dermatocarpon miniatum	*Opegrapha lithyrga*	*Vahliella atlantica*
Diploschistes caesioplumbeus	*Opegrapha saxigena*	*Vahliella leucophaea*
Diplotomma chlorophaeum	*Opegrapha subelevata*	*Xanthoparmelia delisei / X. loxodes / X. pulla**

* count one only from this group/pair.
⊕ *Buellia sequax* is now *Buellia abstracta*; *Peterjamesia circumscripta* is now *Roccellographa circumscripta*; *Placidiopsis cartilaginea* is now *Placidiopsis custnani*.



Map 1. Coastline and selection thresholds for MRCSI.

3.4.4 Acid Watercourses Quality Index (AQUI)

The Acid Watercourses Quality Index (AQUI) for lichens is applicable to upland acid rock watercourses and covers saxicolous species of the following zones: submerged, fluvial mesic and fluvial xeric stream zones (Giavarini, in press). The index excludes montane streams (above 600m) and non-acid watercourses; for lake margins use TNTN (3.4.7) (AQUI may be applied to lake margins in future since many of the index species can occur in that habitat but at present no selection threshold has been set).

Assessment is based on the number of species and species pairs/groups in Table 4 that have been recorded over a one kilometre stretch. Where entries provide alternative taxa (* in Table 4) only one can be counted even if two or more members of this species group/pair are present. At least three *Verrucaria*/*Hydropunctaria* species must be present to score one (although see exceptions listed under the table), and additional members of these genera do not add further to the total. A site that scores **11 or more** should be considered for notification.

Table 4. AQUI species and species pairs/groupings.

Amygdalaria pelobotryon	*Peltigera lepidophora*[#]	*Porocyphus kenmorensis*[#]
Aspicilia aquatica[#]	*Peltigera polydactylon*[#]	*Porpidia hydrophila*
Aspicilia laevata[#]	*Peltigera scabrosella*[#]	*Protopannaria pezizoides*
Bacidia carneoglauca[#] / *B. trachona*[#]*	*Phylliscum demangeonii*[#]	*Pterygiopsis concordatula*[#] / *P. lacustris*[#]*
Bacidia inundata	*Placopsis gelida*[#] / *P. lambii**	*Pyrenocarpon thelostomum*[#]
Claurouxia chalybeioides[#]	*Placopyrenium cinereoatratum*[#]	*Pyrenopsis subareolata*[#]
Collema dichotomum[#]	*Placopyrenium formosum*[#]	*Rhizocarpon amphibium*[#]
Collema flaccidum	*Placynthium flabellosum*[#]	*Rhizocarpon caesium*[#]
Collema glebulentum[#]	*Placynthium pannariellum*[#]	*Rhizocarpon lavatum*
Collemopsidium angermannicum[#]	*Polyblastia cruenta*	*Rhizocarpon sublavatum*[#]
Dermatocarpon intestiniforme / *D. leptophyllodes*[#] / *D. meiophyllizum*[#]*	*Polyblastia melaspora*[#]	*Rinodina fimbriata*[#]
Dermatocarpon luridum	*Polyblastia quartzina*[#]	*Staurothele fissa*
Endocarpon adscendens[#]	*Polyblastia terrestris*[#]	*Staurothele succedens*[#]
Jamesiella scotica[#]	*Polychidium muscicola*[#]	*Stereocaulon pileatum*
Lecanora achariana[#]	*Porina ahlesiana*[#] / *P. interjungens*[#]*	*Thelidium pluvium*[#]
Leptogium magnussonii[#]	*Porina grandis*[#]	*Thermutis velutina*[#]
Leptogium plicatile	*Porina guentheri* (either var.[#])*	*Verrucaria / Hydropunctaria* (three or more taxa)[†]
Leptogium subtorulosum[#]	*Porina lectissima* / *P. rivalis*[#]*	
Massalongia carnosa	*Porocyphus coccodes*[#]	

* count one only from this pair/group.
[#] a nationally rare or nationally scarce taxon.
† excluding *Verrucaria hydrophila*, *V. elaeina* and *V. dolosa* since they are not true aquatic species.

3.4.5 Limestone Index

The limestone lichen index applies to both rock and associated bare ground habitats in hard limestone landscapes (Edwards and Sanderson, in prep). The list (Table 5) comprises 104 species balanced to cover southern and northern non-montane (below 600m) limestone in Britain; TNTN scoring (3.4.7) should be used for calcareous assemblages above 600m. The index is designed to cover coherent outcrops of limestone in a distinct landscape relationship (spatial, geological or climatic) covering areas of between 100 to 1,000ha. The number of recorded species/species pairs in Table 5 is used to assess sites. A site with **30 or more** should be considered for notification.

Table 5. Limestone Index taxa.

Acarospora cervina	*Dermatocarpon miniatum*	*Placynthium subradiatum*
Acarospora glaucocarpa	*Diploschistes gypsaceus*	*Poeltinula cerebrina*
Acarospora macrospora	*Diploschistes muscorum*	*Polyblastia albida*
Acrocordia conoidea	*Diplotomma hedinii*	*Polyblastia cupularis*
Agonimia globulifera	*Farnoldia jurana*	*Porina byssophila*
Arthopyrenia saxicola	*Fulgensia fulgens*	*Porina ginzbergeri*
Bacidia bagliettoana	*Gyalecta hypoleuca*	*Porina linearis*
Bacidia herbarum	*Gyalecta jenensis* var. *jenensis*	*Protoblastenia calva / P. lilacina**
Belonia calcicola	*Gyalecta ulmi*	*Protoblastenia cyclospora*
Biatorella fossarum	*Hymenelia epulotica*	*Protoblastenia incrustans*
Bilimbia lobulata	*Hymenelia heteromorpha*	*Psora decipiens*
Brigantiaea fuscolutea	*Hymenelia prevostii*	*Psorotichia schaereri*
Bryobilimbia hypnorum[⊕]	*Lecania cuprea*	*Ramonia calcicola*
Caloplaca alociza	*Lecanora agardhiana*	*Rhizocarpon umbilicatum*
Caloplaca chalybaea	*Lecanora pruinosa*	*Rinodina bischoffii*
Caloplaca cirrochroa	*Lecanora semipallida*	*Rinodina immersa*
Caloplaca granulosa	*Lempholemma botryosum*	*Romjularia lurida*
Caloplaca marmorata[⊕]	*Lempholemma cladodes*	*Sagiolechia protuberans*
Caloplaca ochracea	*Lepraria nivalis*	*Solorina saccata*
Caloplaca xantholyta	*Leptogium diffractum*	*Solorina spongiosa*
Catapyrenium cinereum	*Leptogium massiliense*	*Squamarina cartilaginea*
Catapyrenium psoromoides	*Leptogium plicatile*	*Staurothele bacilligera*
Catillaria aphana	*Megaspora verrucosa*	*Staurothele caesia*
Cladonia convoluta	*Merismatium deminutum*	*Staurothele guestphalica*
Cladonia foliacea	*Opegrapha dolomitica*	*Staurothele hymenogonia*
Cladonia symphycarpia	*Opegrapha mougeotii*	*Staurothele rupifraga*
Clauzadea chondrodes	*Opegrapha rupestris*	*Staurothele succedens*
Clauzadea immersa	*Peltigera leucophlebia*	*Synalissa ramulosa*
Clauzadea metzleri	*Peltigera rufescens*	*Thelidium decipiens*
Collema callopismum	*Petractis clausa*	*Thelidium incavatum*
Collema fragile	*Placidiopsis custnani*	*Thelidium papulare*
Collema multipartitum	*Placidium pilosellum*	*Toninia sedifolia*
Collema polycarpon	*Placidium squamulosum*	*Toninia verrucarioides*
Collema undulatum	*Placopyrenium canellum*	*Verrucaria caerulea*
Collolechia caesia	*Placynthium garovaglii*	*Verrucaria dufourii*

* count one only from this pair

[⊕] *Caloplaca lactea* is now *C. marmorata*; *Lecidea hypnorum* is now *Bryobilimbia hypnorum*

3.4.6 Metalliferous Habitats Index (MHI)

The lichen flora of heavy metal mines has been reviewed and an index developed (Simkin, in press). The index is applicable to British sites contaminated by heavy metals (particularly lead, zinc, cadmium and copper) as a result of mining activity and may include disused mines, smeltmills, hushes, opencuts, and also the alluvial gravels downstream of these. Such habitats can support a very high lichen diversity: a collective total of 626 taxa (excluding species that primarily grow on trees) has been recorded, including eight

Threatened and 18 Near Threatened species. Saxicolous and terricolous[12] species are the main interest, principally in areas sparse of vegetation.

The index comprises 49 taxa that are preferentially found in metal-rich habitats, of which 27 are saxicolous and 22 terricolous (Table 6) and applies to individual mine sites or mine complexes that are ecologically coherent. Sites are assessed on the total number of recorded species in Table 6 (saxicolous and terricolous taxa combined). A site supporting **10 or more** should be considered for notification. There is considerable variation between orefields but a single selection threshold applies. Where no sites within an orefield qualify, the richest site within the AoS should be considered.

Table 6. MHI taxa.

Saxicolous taxa	**Terricolous taxa**
Acarospora sinopica	*Absconditella trivialis*
Agonimia repleta	*Baeomyces placophyllus*
Catillaria stereocaulorum	*Belonia incarnata*
Gyalidea subscutellaris	*Cladonia cariosa*
Gyalideopsis crenulata	*Coppinsia minutissima*
Lecanora epanora	*Epilichen scabrosus*
Lecanora gisleriana	*Peltigera neckeri*
Lecanora handelii	*Peltigera venosa*
Lecanora subaurea	*Placynthiella hyporhoda*
Lecidea endomelaena	*Polyblastia agraria*
Lecidea inops	*Sarcosagium campestre* var. *campestre*
Placopsis lambii	*Sarcosagium campestre* var. *macrosporum*
Polycoccum squamarioides	*Steinia geophana*
Polysporina ferruginea	*Stereocaulon condensatum*
Porpidia flavicunda	*Stereocaulon glareosum*
Porpidia flavocruenta	*Taeniolella rolfii*
Porpidia melinodes	*Vezdaea acicularis*
Rhizocarpon cinereovirens	*Vezdaea aestivalis*
Rhizocarpon expallescens	*Vezdaea cobria*
Rhizocarpon furfurosum	*Vezdaea leprosa*
Rhizocarpon oederi	*Vezdaea retigera*
Stereocaulon dactylophyllum var. *dactylophyllum*	*Vezdaea rheocarpa*
Stereocaulon delisei	
Stereocaulon leucophaeopsis	
Stereocaulon nanodes	
Stereocaulon pileatum	
Stereocaulon vesuvianum var. *nodulosum*	

3.4.7 TNTN assemblage scoring

Some lichenologically rich habitats have been insufficiently studied for indicator species lists to be developed – e.g. non-montane acid rock. The TNTN (Threatened, Near Threatened and Notable Species) scoring system is an alternative means of assessment; it is a weighted system that is only effective for assemblage types that can be rich in TNTN species (see Table 1) (Sanderson 2011, in press[b]).

Each assemblage is scored separately, based on taxa (species, subspecies, varieties and morphs) statuses given in the supplementary Appendix 2.

[12] Growing directly on the ground or soil.

Assemblage taxa that have been recorded at the site are each awarded the highest score of one of:

- GB Threatened (CR, EN, VU) – scores 4 points
- GB Near Threatened (NT) – scores 2 points
- Notable (defined below) – scores 1 point
- None of the above – scores nil

A Notable[13] (Nb) taxon has one of the following statuses:

- International Responsibility (IR) but neither Threatened nor NT; or
- Nationally Rare (NR) but neither Threatened nor NT; or
- Nationally Scarce (NS) but neither Threatened nor NT;

Follow the guidance provided in Appendix 2 and use only the taxa and statuses as given in the 'Species List' worksheet. The sum of individual taxa scores gives the assemblage score for comparison with the relevant threshold score in the 'TNTN Assemblages + Thresholds' worksheet (note that regional thresholds apply in some cases). All sites that attain the threshold should be considered for notification, even where there are many qualifying sites within an Area of Search.

3.5 Other lichen-rich habitats

3.5.1 Many vegetation types of conservation value in their own right can support significant lichen diversity locally and yet their sites fail to qualify under the selection criteria in this chapter. Rich lichen assemblages, or prominent covers of macrolichens, can add greatly to the scientific interest of a habitat and should be mentioned in site citations.

3.5.2 Coastal shingle

Early successional stages can have distinctive assemblages of saxicolous lichens – including halophytes – that are more diverse than the associated vascular plant assemblage and can include some rare specialists (Fletcher *et al* 1984; Gilbert 2000). Rich sites and species of interest should be mentioned in citation descriptions, although coastal shingle in NE Scotland can be particularly rich in saxicolous and terricolous species and sites may warrant protection; in such cases the country specialist should be consulted. Long-stabilised shingles that are colonised by *Cladonia*-dominated heathland assemblages can be assessed using the Heathland, Moorland and Coastal Heath Index (3.4.2).

3.5.3 Coastal base-rich dunes and machair

Base-rich northern dunes and uncultivated machair can have diverse assemblages of lichens that add to the interest of the vegetation (Fletcher *et al* 1984; Gilbert 2000). Although most sites do not support Threatened species, rich assemblages and species of interest should be mentioned in citation descriptions. Acid grey dunes with *Cladonia*-dominated vegetation can be assessed using the Heathland, Moorland and Coastal Heath Index (3.4.2).

4 Woodland Lichens

The following indices relate to British woodland types known to support internationally important lichen communities (Sanderson, in press[a]): hyperoceanic woodland (2.1.1), southern oceanic woodland (2.1.3), sub-oceanic woodland and boreal woodland (2.1.4). These represent an updated version of the Indices of Ecological Continuity for Woodland Epiphytic Habitats (Coppins and Coppins 2002), an earlier version of which was used to select SSSIs (Hodgetts 1992). In old growth woodland, the pinhead index (3.4.1) may give an additional means of assessment.

[13] NR and NS species that have been excluded are ruderal, and/or recently described and likely to be widespread, and/or highly data deficient. Some of the excluded species are likely to become TNTN taxa in future, but currently are recorded at so few sites as not to make much difference to site scoring.

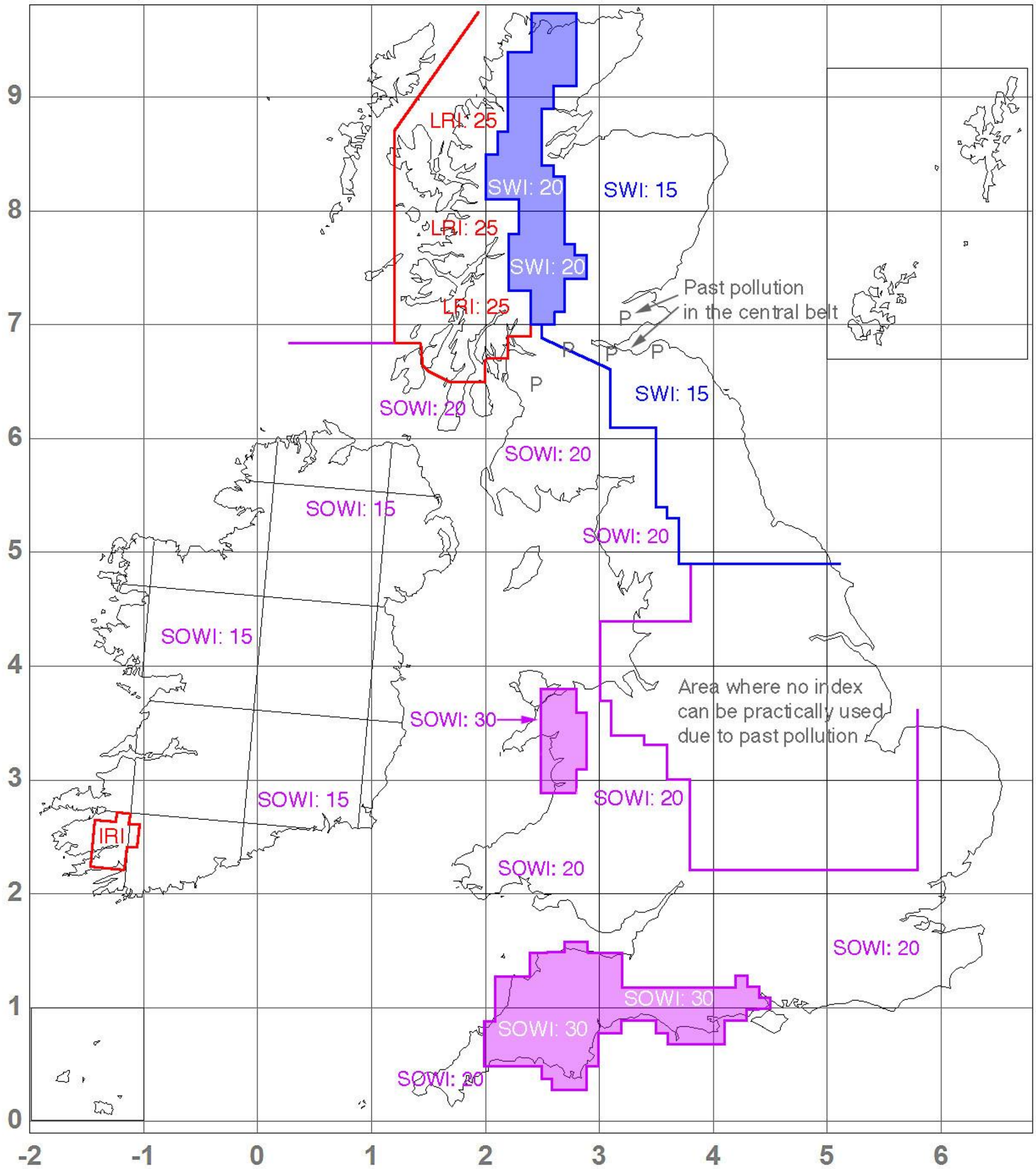
Epiphytic lichen diversity in old growth forest reflects woodland microhabitat heterogeneity and persistence, i.e. a great variety of niches on both veteran and younger trees in close proximity and with high persistence through time (Ellis *et al* 2015). Distinctive lichen communities express the range of microhabitats (James *et al* 1977). Not all of the important communities occur in every site, and some communities are more strongly developed in some sites than in others. Further details on how the indices relate to lichen communities can be found in Sanderson (in press[a]).

The five assemblages listed below should be assessed using the current indices. The indices apply to specific regions: refer to Maps 2 and 3 and the brief descriptions on the following pages (detailed maps and descriptions are provided in Sanderson (in press[a])).

Woodland lichen assemblage	**Current index (Sanderson, in press[a])**	**Previous index (Coppins and Coppins 2002)**
Southern oceanic woodland	Southern Oceanic Woodland Index (SOWI)	New Index of Ecological Continuity (NIEC)
Hyperoceanic woodland (lowland)	Lowland Rainforest Index (LRI)	West of Scotland Index of Ecological Continuity (WSIEC)
Sub-oceanic woodland	Sub-oceanic Woodland Index (SWI)	East of Scotland Index of Ecological Continuity (ESIEC)
Hyperoceanic woodland (upland)	Upland Rainforest Index (URI)	Eu-Oceanic Calcifuge Index of Ecological Continuity (EUOCIEC)
Boreal woodland	Boreal Woodland Index (BWI)	Native Pinewood Index of Ecological Continuity (NPIEC)

Each index should be applied to an interconnected woodland area of about 100ha except for the Boreal Woodland Index (BWI), details of which are given in 4.5. Sites are assessed on the number of recorded species in the relevant table (4.1 to 4.5). Selection thresholds are specified in each section.

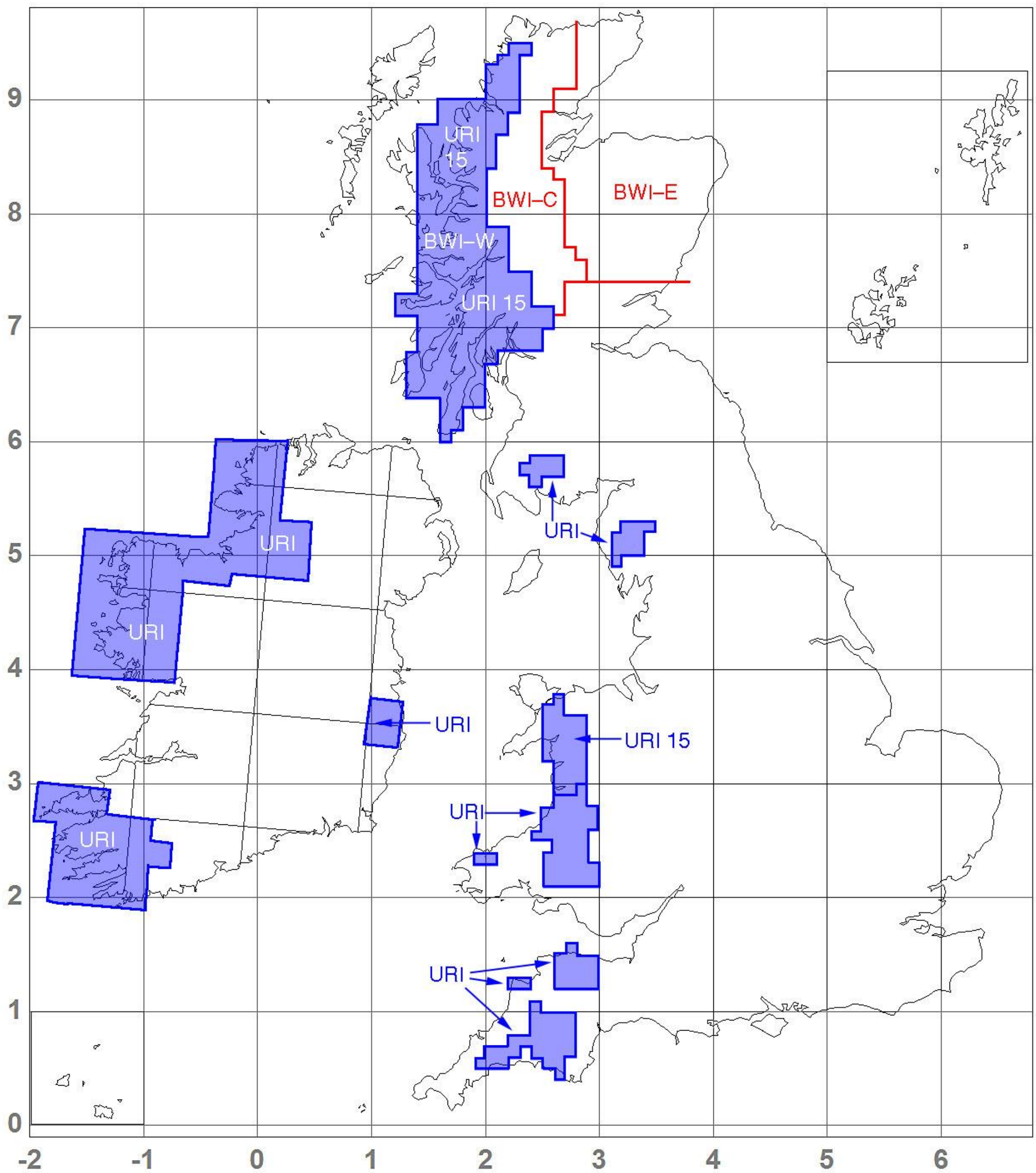
The mapped index boundaries have been determined using a combination of species distributions and bioclimatic maps (Sanderson, in press [a]). The boundaries are only indicative and have been aligned to Ordnance Survey 10km grid squares. If the site occurs on, near, or straddling a boundary/boundaries, both/multiple indices can be applied. In such cases please consult the country specialist.



Map 2. Areas and selection thresholds for the three temperate woodland indices[14].

SOWI = Southern Oceanic Woodland Index (core areas shaded magenta)
LRI = Lowland Rainforest Index
SWI = Sub-oceanic Woodland Index (core area shaded blue)

[14] Map from Sanderson which includes the Ireland Rainforest Index (in press[a]); Ireland is not covered by the *Guidelines for selection of Biological SSSIs*.



Map 3. Areas and selection thresholds for the two upland woodland indices[15].

* The site selection threshold for URI is 10 where not indicated.
URI* = Upland Rainforest Index
BWI = Boreal Woodland Index (E = Eastern pinewood zone, C = Central pinewood zone and W = Western pinewood zone)

[15] Map from Sanderson (in press[a]); Ireland is not covered by the *Guidelines for selection of Biological SSSIs*.

4.1 SOWI – Southern Oceanic Woodland Index

This replaces the New Index of Ecological Continuity (NIEC) (Coppins and Coppins 2002; Hodgetts 1992; Rose 1992). The list (Table 7) is designed to be applied across a wide swathe of southern Oceanic Britain (Map 2).

For the core areas of interest indicated on Map 2 (associated with a strongly southern oceanic climate with clean air, in south west England and north Wales), all sites with scores of **30 or more** should be considered for notification. To the north and east of these areas, in south-east England, the rest of Wales and south-west Scotland (where the more strongly southern oceanic species are rare), all sites with scores of **20 or more** should be selected.

Table 7. SOWI taxa.

Agonimia allobata	*Lecanographa amylacea*	*Parmeliella triptophylla*
Agonimia flabelliformis	*Lecanographa lyncea*	*Parmotrema crinitum*
Agonimia octospora	*Lecanora alboflavida* [#]	*Peltigera collina*
Anisomeridium ranunculosporum	*Lecanora jamesii*	*Peltigera horizontalis*
Arthonia astroidestera	*Lecanora quercicola*	*Pertusaria multipuncta*
Arthonia ilicina	*Lecanora sublivescens*	*Phaeographis dendritica*
Arthonia vinosa	*Leptogium cyanescens*	*Phaeographis inusta*
Bacidia biatorina	*Leptogium lichenoides*	*Phaeographis lyellii*
Buellia erubescens	*Leptogium teretiusculum*	*Phyllopsora rosei*
Catinaria atropurpurea	*Lobaria amplissima*	*Piccolia ochrophora* [#]
Cetrelia olivetorum s. lat.	*Lobaria pulmonaria*	*Porina coralloidea*
Chaenotheca brachypoda	*Lobaria scrobiculata*	*Porina hibernica*
Chaenotheca brunneola	*Lobaria virens*	*Porina rosei*
Chaenotheca chlorella	*Loxospora elatina*	*Punctelia reddenda*
Chaenotheca chrysocephala	*Megalospora tuberculosa*	*Rinodina isidioides*
Chaenotheca hispidula	*Micarea alabastrites*	*Schismatomma niveum*
Chaenotheca stemonea	*Micarea cinerea* f. *cinerea*	*Schismatomma quercicola*
Chaenotheca trichialis	*Micarea pycnidiophora*	*Stenocybe septata*
Cladonia caespiticia	*Mycobilimbia epixanthoides* [#]	*Sticta fuliginosa* s. lat.
Cladonia parasitica	*Mycobilimbia pilularis* [#]	*Sticta limbata*
Collema furfuraceum	*Mycoporum antecellens*	*Sticta sylvatica*
Collema subflaccidum	*Nephroma laevigatum*	*Thelopsis rubella*
Cresponea premnea	*Nephroma parile*	*Thelotrema lepadinum*
Degelia atlantica	*Opegrapha corticola*	*Usnea ceratina*
Degelia cyanoloma	*Opegrapha prosodea*	*Usnea florida*
Degelia plumbea s. str.	*Pachyphiale carneola*	*Varicellaria velata* [#]
Enterographa sorediata	*Pannaria conoplea*	*Wadeana dendrographa*
Heterodermia obscurata [#]	*Pannaria rubiginosa*	
Inoderma subabietinum [#]	*Parmeliella parvula*	

[#] Taxonomic changes since Coppins and Coppins (2002) are: *Biatora epixanthoides* is now *Mycobilimbia epixanthoides*; *Biatora sphaeroides* is now *Mycobilimbia pilularis*; *Heterodermia japonica* is now *Heterodermia obscurata*; *Lecanactis subabietina* is now *Inoderma subabietinum*; *Ochrolechia inversa* is now *Lecanora alboflavida*; *Pertusaria velata* is now *Varicellaria velata;* and *Strangospora ochrophora* is now *Piccolia ochrophora*.

4.2 LRI – Lowland Rainforest Index

This replaces the West of Scotland Index of Ecological Continuity (WSIEC) (Coppins and Coppins 2002; Hodgetts 1992). The list (Table 8) is designed to be applied to hyperoceanic and western euoceanic temperate rainforest in very high rainfall areas in the western Highlands (Map 2). The assemblage occurs in a reduced form eastwards into the Scottish Highlands, in North Wales and the Lake District, but other indexes are more effective in these areas.

All sites with scores of **25 or more** should be considered for notification.

Table 8. LRI taxa.

Arthonia anombrophila	*Leptogium coralloideum*
Arthonia ilicina	*Leptogium hibernicum*
Arthonia ilicinella	*Lobaria amplissima*
Arthonia leucopellaea	*Lobaria scrobiculata*
Arthonia stellaris	*Lopadium disciforme*
Arthonia vinosa	*Megalospora tuberculosa*
Arthothelium lirellans	*Micarea stipitata*
Arthothelium orbilliferum	*Mycobilimbia epixanthoides* #
Bacidia biatorina	*Mycobilimbia pilularis* #
Bactrospora homalotropa	*Nephroma parile*
Buellia erubescens	*Pachyphiale carneola*
Calicium lenticulare	*Parmeliella testacea*
Cetrelia olivetorum s. lat.	*Parmotrema reticulatum* s. lat.
Collema fasciculare	*Peltigera collina*
Collema nigrescens	*Phyllopsora rosei*
Collema subflaccidum	*Piccolia ochrophora* #
Collema subnigrescens	*Pseudocyphellaria crocata*
Crutarndina petractoides #	*Pseudocyphellaria intricata*
Enterographa crassa	*Pseudocyphellaria norvegica*
Fuscopannaria sampaiana	*Punctelia reddenda*
Gomphillus calycioides	*Pyrenula laevigata*
Graphina ruiziana	*Pyrenula occidentalis*
Heterodermia obscurata #	*Rinodina roboris*
Hypotrachyna endochlora	*Schismatomma quercicola*
Hypotrachyna taylorensis	*Sticta canariensis, canariensis* morph
Leptogium brebissonii	*Sticta canariensis, dufourii* morph
Leptogium burgessii	*Thelopsis rubella*
Leptogium cochleatum	*Thelotrema macrosporum*

Taxonomic changes since Coppins and Coppins (2002) are: *Biatora epixanthoides* is now *Mycobilimbia epixanthoides*; *Biatora sphaeroides* is now *Mycobilimbia pilularis*; *Heterodermia japonica* is now *Heterodermia obscurata*; *Strangospora ochrophora* is now *Piccolia ochrophora*; and *Thelotrema petractoides* is now *Crutarndina petractoides*.

4.3 SWI – Sub-oceanic Woodland Index

This replaces the East of Scotland Index of Ecological Continuity (ESIEC) (sub-oceanic temperate woodland) (Hodgetts 1992; Coppins and Coppins 2002). The list (Table 9) is designed to be applied to temperate woodland in the euoceanic and hemioceanic[16] zones in the east of Scotland and areas with a similar climate in the north east of England (Map 2). The assemblage occurs in east Wales and the Marches but sites in these areas can also be assessed using SOWI.

For scoring, the application area is divided into two regions (Map 2). For the hemioceanic parts of the eastern Highlands and all lowland areas, all sites which score **15 or more** should be selected. In the eastern euoceanic areas of the Scottish Highlands, a higher threshold is required, as the wetter climate increases lichen diversity in a transition to the lowland rainforest to the west, and all sites which score **20 or more** should be considered for notification.

Table 9. SWI taxa.

Arthonia cinnabarina	*Lobaria virens*
Arthonia elegans	*Lopadium disciforme*
Arthonia vinosa	*Loxospora elatina*
Bacidia subincompta	*Megalaria grossa*
Biatora beckhausii #	*Megalaria pulverea*
Biatora chrysantha	*Microcalicium ahlneri*
Biatora globulosa #	*Microcalicium disseminatum*
Biatora veteranorum #	*Mycobilimbia epixanthoides*
Calicium salicinum	*Mycobilimbia pilularis*
Catinaria atropurpurea	*Nephroma laevigatum*
Chaenotheca brachypoda	*Nephroma parile*
Chaenotheca brunneola	*Normandina pulchella*
Chaenotheca chlorella	*Pachyphiale carneola*
Chaenotheca chrysocephala	*Pachyphiale fagicola*
Chaenotheca hispidula	*Pannaria conoplea*
Chaenotheca stemonea	*Parmeliella triptophylla*
Chaenotheca trichialis	*Peltigera collina*
Chaenothecopsis species*	*Sclerophora pallida*
Cladonia parasitica	*Sclerophora peronella*
Degelia plumbea s. str.	*Sticta fuliginosa* s. lat.
Flavoparmelia caperata	*Sticta limbata*
Fuscopannaria mediterranea	*Sticta sylvatica*
Lobaria pulmonaria	*Thelotrema lepadinum*
Lobaria amplissima	*Varicellaria hemisphaerica* #
Lobaria scrobiculata	

* count one only from this genus
# Taxonomic changes since Coppins and Coppins (2002) are: *Bacidia beckhausii* is now *Biatora beckhausii*; *Catillaria alba* is now *Biatora veteranorum; Catillaria globulosa* is now *Biatora globulosa;* and *Pertusaria hemisphaerica* is now *Varicellaria hemisphaerica*.

[16] Less oceanic than euoceanic climates, with the highest seasonal temperature fluctuations, with rainfall, humidity and cloud cover all lower than in the other zones.

4.4 URI – Upland Rainforest Index

This replaces the Euoceanic Calcifuge Index of Ecological Continuity (EUOCIEC) (Coppins and Coppins 2002; Hodgetts 1992). The list (Table 10) is designed to be applied to both hyperoceanic and euoceanic acidic upland temperate woodland in very high rainfall areas. In northern Britain, high rainfall upland habitat occurs down to sea-level, where the index may overlap with the LRI. In southern Britain, use of the index may overlap with areas where the SOWI is also applied. This index will however be the only index applicable to upland temperate to temperate-boreal broadleaved rainforest (Map 3).

In the core areas of this habitat (western Scottish Highlands and North Wales) all sites with scores of **15 or more** should be selected. Outside of these areas, in south west England, south Wales and north-west England (Map 3), diversity is generally lower and all sites scoring **10 or more** should be considered for notification.

Table 10. URI taxa.

Arthonia invadens	*Megalaria pulverea*
Arthonia leucopellaea	*Menegazzia subsimilis*
Bryobilimbia sanguineoatra	*Menegazzia terebrata*
Bryoria bicolor	*Micarea alabastrites*
Bunodophoron melanocarpum	*Micarea doliiformis* #
Calicium lenticulare	*Micarea stipitata*
Cetrelia olivetorum s. lat.	*Mycoblastus caesius*
Graphina ruiziana	*Mycoblastus sanguinarius*
Heterodermia obscurata #	*Ochrolechia tartarea*
Hypotrachyna endochlora	*Opegrapha sphaerophoricola*
Hypotrachyna laevigata	*Parmeliella parvula*
Hypotrachyna sinuosa	*Parmelinopsis horrescens*
Hypotrachyna taylorensis	*Pertusaria ophthalmiza*
Japewiella tavaresiana	*Schismatomma quercicola*
Lecanora alboflavida #	*Sphaerophorus globosus*
Lepraria membranacea #	*Stenocybe nitida* #
Lopadium disciforme	*Trapelia corticola*
Loxospora elatina	*Usnea dasopoga* #

Taxonomic changes since Coppins and Coppins (2002) are: *Heterodermia japonica* is now *Heterodermia obscurata*; *Lecidea doliiformis* is now *Micarea doliiformis*; *Leproloma membranaceum* is now *Lepraria membranacea*; *Ochrolechia inversa* is now *Lecanora alboflavida*; *Stenocybe bryophila* is now *Stenocybe nitida*; and *Usnea filipendula* is now *Usnea dasopoga*.

4.5 BWI – Boreal Woodland Index

This replaces the Native Pinewood Index of Ecological Continuity (NPCIEC) (boreal woodland) (Coppins and Coppins 2002, 2006). The list (Table 11) was originally designed to be applied to native pine-dominated woodlands in the Scottish Highlands. This revised list applies to both native pinewoods and old growth birch woods above the limit of oak in the eastern and central pinewood zones of the Scottish Highlands. It also applies to pure native pinewoods in the western native pinewood zone (Map 3); birch woods occurring here are covered by the URI.

In native pinewoods the index works over larger areas than the temperate woodland indices and should be applied to interconnected areas of woodland of several 100ha, whereas for birch woods smaller areas of interconnected stands of about 100ha are applicable.

Major native pinewood complexes scoring **20 or more** should be considered for notification. For old growth birch woods outside of the main pinewood complexes, sites scoring **15 or more** should be considered for notification.

Table 11. BWI taxa.

Alectoria sarmentosa	*Fuscopannaria mediterranea* *	*Microcalicium ahlneri*
Arthonia leucopellaea	*Fuscopannaria sampaiana* *	*Microcalicium disseminatum*
Arthonia vinosa *	*Hertelidea botryosa* #	*Mycoblastus affinis*
Bryoria capillaris	*Hypotrachyna laevigata*	*Mycoblastus alpinus*
Bryoria furcellata	*Imshaugia aleurites*	*Pannaria conoplea* *
Calicium parvum	*Lecanora cadubriae*	*Pannaria rubiginosa* *
Cavernularia hultenii	*Lecidea hypopta*	*Pertusaria borealis*
Chaenotheca brunneola	*Lecidea turgidula*	*Pertusaria ophthalmiza*
Chaenotheca chrysocephala	*Lobaria amplissima* *	*Platismatia norvegica*
Chaenotheca trichialis	*Lobaria pulmonaria* *	*Protoparmelia ochrococca*
Chaenotheca xyloxena	*Lobaria scrobiculata* *	*Pycnora xanthococca*
Chaenothecopsis pusiola	*Lobaria virens* *	*Sclerophora pallida* *
Chrysothrix chrysophthalma	*Lopadium disciforme*	*Sclerophora peronella* *
Cladonia botrytes	*Loxospora elatina*	*Sticta fuliginosa s. lat.* *
Cladonia cenotea	*Megalaria pulverea*	*Sticta limbata* *
Cyphelium inquinans	*Melaspilea lentiginosula*	*Sticta sylvatica* *
Cyphelium tigillare	*Micarea adnata*	*Thelotrema lepadinum* *
Degelia atlantica *	*Micarea alabastrites*	*Xylographa parallela*
Degelia cyanoloma *	*Micarea contexta*	*Xylographa trunciseda*
Degelia plumbea *	*Micarea hedlundii*	*Xylopsora friesii* #
Elixia flexella	*Micarea stipitata*	
Fuscopannaria ignobilis *	*Micarea synotheoides*	

* Species not found on pine bark or pine lignum but on associated broad-leaved trees within the pinewood habitat.

Taxonomic changes since Coppins and Coppins (2002) are: *Hypocenomyce friesii* is now *Xylopsora friesii*; and *Lecidea botryosa* is now *Hertelidea botryosa.*

5 Site Boundaries

5.1. Generic guidance on boundary setting is provided in Section 8 of *Guidelines for the Selection of Biological SSSIs Part 1* (Bainbridge *et al* 2013). Lichens function on different scales to vascular plants and bryophytes, both spatially and temporally. Some species may be confined to very small areas of fixed habitat such as rock outcrops, but depend on qualities of the wider habitat to maintain their populations. In other cases, such as with woodland species, large habitat areas may be required over timescales of centuries to allow for old growth stand succession across sites (Ellis and Coppins 2007).

5.2. High ammonia emissions from farming such as intensive stock rearing units, or slurry applications to grassland, can have severe local impacts on lichen populations. For example, woodland boundary trees can support rich lichen assemblages due to higher light levels but this exposure makes them more susceptible to adjacent land use. Habitat buffer strips such as shelter belts have been shown to mitigate the impacts and should also be a key consideration when boundary setting (Dragosits *et al* 2006; Bealey *et al* 2015).

5.3. In keeping with the Potential Value criterion (Part 1: 5.12), future habitat continuity issues may be averted by including surrounding land. For instance, by including younger stands of trees within a site supporting veteran tree lichen interest; in such cases, consideration should also be given to non-native trees (Section 3.1).

5.4. Where the interest is fragmented, occurring in a number of discrete hotspots, it may be more appropriate to evaluate the 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.

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Appendix 1. Non-native trees

The table below lists some commonly occurring non-native trees and their value for epiphytic lichens.

Non-native trees	Lichen value	Diversity
Sycamore	good	A European 'near native'[17] of major significance in some oceanic woods for base-rich and mesic bark ancient woodland lichen assemblages. It can also be significant for wound track assemblages and field tree lichens in the lowlands. It supports similar assemblages to ash.
Norway maple	good	A similar tree to sycamore but less widespread as an old tree. It provides a valuable lichen substrate, supporting assemblages comparable to those of ash and elm.
Horse chestnut	good	Old parkland trees can be valuable for wound track assemblages.
Sweet chestnut	poor	Of very limited lichen interest; in particular it does not support the ancient dry bark assemblage characteristic of ancient oaks.
Turkey oak	poor	Supports a highly impoverished assemblage, including the absence of the ancient dry bark assemblage characteristic of ancient native oaks.

In addition, the following exotics can support rich lichen assemblages: walnut, tulip tree, holm oak, non-native poplars, other non-native maples.

<u>Beech and hornbeam</u>
The hard-bark trees beech and hornbeam have specialised lichen assemblages that occur within the native range of the tree in southern England but which are absent from the rest of Britain, where the trees are modern introductions.

Beech can be a very rich tree for lichens when ancient (250 years plus) and where it has long been native in old growth woodlands (Fritz *et al* 2008; Sanderson 2010; Wolseley *et al* 2016). However, the distribution of beech is changing in Britain and as a colonist outside of its native range, it largely has a negative impact on existing woodland lichen assemblages – e.g. in North Wales. Some exceptions are starting to occur beyond its accepted native range – e.g. lichen-rich beech is developing in parkland sites in Dorset to Cornwall.

[17] A European species, which is native in western Europe but thrives in the British climate and is probably only absent from Britain due to the vicissitudes of post glacial colonisation.