



European Site Conservation Objectives: Supplementary advice on conserving and restoring site features

**Phoenix United Mine and Crow's Nest Special Area of Conservation (SAC)
Site Code: UK0030238**



Natural England, 2008

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About this document

This document provides Natural England's supplementary advice about the European Site Conservation Objectives relating to Phoenix United Mine and Crow's Nest SAC.

This advice should therefore be read together with the SAC Conservation Objectives available [here](#)

You should use the Conservation Objectives, this Supplementary Advice and any case-specific advice given by Natural England when developing, proposing or assessing an activity, plan or project that may affect this site.

This Supplementary Advice to the Conservation Objectives presents attributes which are ecological characteristics of the designated species and habitats within a site. The listed attributes are considered to be those that best describe the site's ecological integrity and which, if safeguarded, will enable achievement of the Conservation Objectives. Each attribute has a target which is either quantified or qualitative depending on the available evidence. The target identifies as far as possible the desired state to be achieved for the attribute.

The tables provided below bring together the findings of the best available scientific evidence relating to the site's qualifying features, which may be updated or supplemented in further publications from Natural England and other sources. The local evidence used in preparing this supplementary advice has been cited. The references to the national evidence used are available on request. Where evidence and references have not been indicated, Natural England has applied ecological knowledge and expert judgement. You may decide to use other additional sources of information.

In many cases, the attribute targets shown in the tables indicate whether the current objective is to 'maintain' or 'restore' the attribute. This is based on the best available information, including that gathered during monitoring of the feature's current condition. As new information on feature condition becomes available, this will be added so that the advice remains up to date.

The targets given for each attribute do not represent thresholds to assess the significance of any given impact in Habitats Regulations Assessments. You will need to assess this on a case-by-case basis using the most current information available.

Some, but not all, of these attributes can also be used for regular monitoring of the actual condition of the designated features. The attributes selected for monitoring the features, and the standards used to assess their condition, are listed in separate monitoring documents, which will be available from Natural England.

These tables do not give advice about SSSI features or other legally protected species which may also be present within the European Site.

If you have any comments or queries about this Supplementary Advice document please contact your local Natural England adviser or email HDIRConservationObjectivesNE@naturalengland.org.uk

About this site

European Site information

Name of European Site	Phoenix United Mine and Crow's Nest Special Area of Conservation (SAC)
Location	Cornwall
Site Map	The designated boundary of this site can be viewed here on the MAGIC website
Designation Date	01/04/2005
Qualifying Features	See section below
Designation Area	48.72 ha
Designation Changes	N/A
Feature Condition Status	Details of the feature condition assessments made at this site can be found using Natural England's Designated Sites System
Names of component Sites of Special Scientific Interest (SSSIs)	Phoenix United Mine SSSI Crow's Nest SSSI
Relationship with other European or International Site designations	N/A

Site background and geography

This SAC is composed of two sub-sites, Crow's Nest SSSI and Phoenix United Mine SSSI, both located on the south-east edge of Bodmin Moor. The SAC lies within the Cornwall and West Devon Mining Landscape UNESCO World Heritage Site (WHS), sub-site A9 Caradon Mining District, which is characterised by open, exposed granite moorland, mostly above 300m OD. The Caradon Mining District represents the most extensive mining remains within the WHS, dating from a limited period of operation between 1840 and 1890, and reflects the 'boom to bust' Cornish copper mining landscape. The heavy metals formed within the metamorphic aureole surrounding the Bodmin Moor granite. The geology is a complex mix of granite and country rock.

The granite dome of Caradon Hill (404m OD) dominates this area, engine houses, chimneys, associated mine workings and thousands of tonnes of waste rock and old mine waste tips encircle the hill. It is this legacy of metalliferous mining activity and the heavy metal-rich substrates which provide the conditions required to support the rare metallophyte bryophytes (liverworts and mosses). This heavy metal contamination has severely restricted the growth of vascular plants and the lack of competition has enabled colonisation by specialist metallophyte bryophytes are adapted to tolerate the high levels of heavy metals; levels of the phytotoxins arsenic, cobalt and copper are especially high.

The SAC is covered by CROW Open Access Land and also has a few sections of public footpath (PROW), hence it has wide public access.

Phoenix United Mine SSSI lies to the north of Minions, and drains north eastwards via a small tributary to the River Lynher. Both copper and tin were mined at Phoenix United Mine, the occurrence of tin

extended the working life of this mine for some fifteen years beyond that of South Caradon (Crow's Nest). The Prince of Wales engine house (Grade II listed) is a distinctive landmark within the landscape.

Crow's Nest SSSI is located immediately to the south of Minions, within the mining area known as South Caradon. The main part of the site occupies a small valley in the headwaters of the River Seaton catchment (which drains to the south) and is flanked by massive mine waste tips and old mine workings. The bed of the Liskeard and Caradon Railway, built to link the mines with the copper-ore port of Looe on the south coast traverses the west side of the valley and the bed of a horse-drawn tramway track runs eastwards past engine houses at Rule's and Holman's shafts.

Since the historic loss of active mining the toxic metals are leaching out of the surface substrates rendering them progressively less suitable for the rare metallophytes and enabling vegetation succession and colonisation by acid grassland and scrub. Competition from vascular plants and the loss of suitable habitat are major factors in the long-term decline of the rare metallophyte bryophytes. Their long-term survival is dependent on carefully targeted conservation management to maintain and recreate bare, unshaded metalliferous substrates.

In recent years, turf stripping to expose suitable substrates has been successful in significantly increasing the populations of these rare metallophytes. Trial turf-stripping at Phoneix United Mine SSSI in 2015 resulted in a 20-fold increase in the population of *Ditrichum cornubicum* and a consequent four-fold increase in the World population (Callaghan & Ingram 2018 Status, conservation and ecology of the exceptionally rare metallophyte Cornish path-moss *Ditrichum cornubicum* - unpublished, work undertaken as part of the 'Back from the Brink' HLF funded project).

The SAC lies within the [Bodmin Moor National Character Area \(NCA 153\)](#).

About the qualifying features of the SAC

The following section gives you additional, site-specific information about this SAC's qualifying features. These are the natural habitats and/or species for which this SAC has been designated.

Qualifying habitats:

- **H6130 Calaminarian grasslands of the *Violetalia calaminariae* (grasslands on soils rich in heavy metals)**

This site on the south-eastern edge of Bodmin Moor supports internationally-important Calaminarian grassland communities of plants indicative of metal-rich soils (metallophytes). The legacy of a long history of copper and tin extraction survives as mine spoil which has been colonised by a number of metallophytic bryophytes. In particular, the SAC supports the only known sites in the world for the endangered Cornish path-moss *Ditrichum cornubicum*. Other notable metallophytes include the liverworts *Cephaloziella massalongi* and the endemic *C. nicholsonii*, both associated with copper-rich substrates, and the mosses *Pohlia andalusica* and *Scopelophila cataractae*. Many other notable bryophytes have colonised the spoil, including the liverworts *Cephaloziella integerrima*, *C. stellulifera*, *Lophozia sudetica*, *Gymnomitrium obtusum* and *Marsupella funckii*, and the moss *Ditrichum lineare*. The vulnerable liverwort *Cephaloziella calyculata* grows on derelict mine buildings.

Table 1: Supplementary Advice for Qualifying Features: H6130. Calaminarian grasslands of the *Violetalia calaminariae*; Grasslands on soils rich in heavy metals

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Extent and distribution of the feature	Extent of the feature within the site	<p>Restore the total extent of the feature</p> <p>The extent of suitable habitat (ie: could support the feature of interest) for the metallophyte bryophytes needs to be determined</p>	<p>There should be no measurable reduction (excluding any trivial loss) in the extent and area of this feature, and in some cases, the full extent of the feature may need to be restored. The baseline-value of extent given has been generated using data gathered from the listed site-based surveys.</p> <p>Area measurements given may be approximate depending on the methods, age and accuracy of data collection, and as a result this value may be updated in future to reflect more accurate information. The extent of an Annex I habitat feature covers the sum extent of all of the component vegetation communities present and may include transitions and mosaics with other closely-associated habitat features.</p> <p>Where a feature is susceptible to natural dynamic processes, there may be acceptable variations in its extent through natural fluctuations. Where a reduction in the extent of a feature is considered necessary to meet the Conservation Objective for another Annex I feature, Natural England will advise on this on a case-by-case basis.</p> <p>The restore target has been selected because of the amount of coarse vegetation and scrub which has colonised significant areas once supporting rare metallophyte bryophytes or which would have been suitable for their colonisation.</p> <p>Phoenix United Mine about 80% of the site is currently under scrub and woodland cover (Callaghan D. 2011).</p> <p>Habitats supporting the rare metalliferous bryophyte assemblage:</p> <ul style="list-style-type: none"> Exposed metal-rich mine spoil/substrates that have 	<p>CALLAGHAN D. 2011a</p> <p>CALLAGHAN D. 2011b</p> <p>CALLAGHAN D. 2015</p> <p>CALLAGHAN D. 2016</p> <p>CALLAGHAN D. A. & INGRAM M. 2018</p> <p>HOLYOAK D. T. 1998</p> <p>HOLYOAK D. T. 1999</p> <p>HOLYOAK D. T. 2000</p> <p>HOLYOAK D. T. 2005a</p> <p>HOLYOAK D. T. 2005b</p> <p>HOLYOAK D. T. 2007</p> <p>HOLYOAK D. T. 2008</p> <p>HOLYOAK D. T. 2009</p>

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			<p>not been over-grown by coarser vegetation</p> <ul style="list-style-type: none"> • Steep banks beside old mine shafts • Damp mine spoil between rocks and crevices within retaining walls and mine buildings • Banks of streams, wet flushes, wet seepages (humid conditions in these types of locations are particularly suitable for <i>Cephaloziella</i> species and <i>Pohlia andalusica</i>) • Trampled metal rich ground of old mining tracks 	
Extent and distribution of the feature	Spatial distribution of the feature within the site	Restore the distribution and configuration of the feature, including where applicable its component vegetation types, across the site	<p>Distribution includes the spatial pattern or arrangement of this habitat feature, and its component vegetation types, across the site. Changes in distribution may affect the nature and range of the vegetation communities present, the operation of the physical, chemical, and biological processes in the system and the resiliency of the site and its features to changes or impacts.</p> <p>Suitable habitat for the rare metallophyte bryophytes exists in specific parts of the site, where conditions offer exposed, bare metal rich, acidic mine substrates (see suitable habitats listed under 'extent of feature in the site' attribute). Large areas of the sites are unsuitable for these rare metallophytes, such as areas of well-established scrub/woodland. However there are significant areas which could provide suitable habitat with appropriate management.</p>	<p>CALLAGHAN D. 2011a</p> <p>CALLAGHAN D. 2011b</p> <p>CALLAGHAN D. 2015</p> <p>CALLAGHAN D. 2016</p> <p>CALLAGHAN D. A. & INGRAM M. 2018</p> <p>HOLYOAK D. T. 1998</p> <p>HOLYOAK D. T. 1999</p> <p>HOLYOAK D. T. 2000a</p> <p>HOLYOAK D. T. 2005a</p> <p>HOLYOAK D. T. 2005b</p> <p>HOLYOAK D. T. 2007</p> <p>HOLYOAK D. T. 2008</p> <p>HOLYOAK D. T. 2009</p>

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	Adaptation and resilience	Maintain the feature's ability, and that of its supporting processes, to adapt or evolve to wider environmental change, either within or external to the site	<p>This recognises the increasing likelihood of natural habitat features to absorb or adapt to wider environmental changes. Resilience may be described as the ability of an ecological system to cope with, and adapt to environmental stress and change whilst retaining the same basic structure and ways of functioning.</p> <p>Such environmental changes may include precipitation and temperature for example, which are likely to affect the extent, distribution, composition and functioning of a feature within a site. The vulnerability and response of features to such changes will vary.</p> <p>Using best available information, any necessary or likely adaptation or adjustment by the feature and its management in response to actual or expected climatic change should be allowed for, as far as practicable, in order to ensure the feature's long-term viability.</p> <p>The overall vulnerability of this SAC to climate change has been assessed by Natural England (2015) as being low taking into account the sensitivity, fragmentation, topography and management of its habitats. This means that this site is considered to be vulnerable overall but are a lower priority for further assessment and action. Individual species may be more or less vulnerable than their supporting habitat itself. In many cases, change will be inevitable so appropriate monitoring would be advisable.</p> <p>The implications of global warming and other aspects of climate change on these rare metallophyte bryophytes is not fully understood. Further research into the status, ecology and conservation needs is desirable to inform future management, particularly for <i>Ditrichum cornubicum</i>.</p>	<p>CALLAGHAN D. & INGRAM M. 2018</p> <p>NATURAL ENGLAND, 2015b. http://publications.naturalengland.org.uk/publication/4954594591375360</p>

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	Hydrology: Flooding regime	Maintain the timing, frequency, extent and duration of surface flooding commensurate with the maintenance/restoration of the feature	<p>Defining and maintaining the appropriate hydrological regime is a key step in moving towards achieving the conservation objectives for this site and sustaining this feature. Changes in source, depth, duration, frequency, magnitude and timing of water supply can have significant implications for the assemblage of characteristic plants and animals present.</p> <p>This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. Depending on the frequency, timing and duration, such flooding has the potential to cause deleterious vegetation change and unfavourable condition</p> <p>Maintaining the hydrological condition of the valley streams is a key factor for several of the rare metallophyte bryophyte species, significant alterations to the hydrology of the streams and/or associated flushes, springs or seepages, could have a major negative impact on the important bryophyte flora.</p> <p>More extreme weather events due to climate change, such as the increased occurrence of intense/prolonged periods of rainfall, resulting in spates (sudden flood) have the potential to wash away stream banks and metal rich sediments which support important populations of <i>Cephaloziella</i> species.</p> <p>The humid conditions and exposed earthy stream banks, rich in metals provide ideal conditions for several of the <i>Cephaloziella</i> species, which often occur in dense mats of intermixed species (<i>Cephaloziella stellulifera</i>, <i>C. nicholsonii</i> and <i>C. massalongi</i>). <i>Pohlia andalusica</i> occurs in small amounts but some large, pure colonies were found in wet flushes along the stream at Phoenix United Mine (Callaghan 2011a).</p>	CALLAGHAN D. 2011a CALLAGHAN D. 2011b
Structure and function (including its	Soils, substrate and nutrient	Restore the properties of the underlying soil types, including structure, bulk density, total	Soil is the foundation of basic ecosystem function and a vital part of the natural environment. Its properties strongly influence the colonisation, growth and distribution of those	CALLAGHAN D. 2011a CALLAGHAN D. 2011b

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
typical species)	cycling	carbon, pH, soil nutrient status and fungal: bacterial ratio, to within typical values for the habitat.	<p>plant species which together form vegetation types, and therefore provides a habitat used by a wide range of organisms. Soil biodiversity has a vital role to recycle organic matter. Changes to natural soil properties may therefore affect the ecological structure, function and processes associated with this Annex I feature.</p> <p>These rare metalliferous bryophyte species are early colonisers which are restricted to open acidic substrates with high levels of copper and other heavy metals and low nutrient levels. These conditions are provided within the disused metalliferous mine workings and sediments associated with streams/flushes/springs at Phoenix United Mine and Crow's Nest.</p> <p>These rare metalliferous bryophytes are poor competitors, intolerant of shade, and are lost as natural vegetation succession progresses. Leaching of copper and other metals from the 'soil' probably enables other plants which are less tolerant of high levels of metal contamination to become established. At Phoenix United Mine nutrient input (eutrophication) due to sheep dunging was also a factor in the growth of more competitive, common mosses and coarse grasses and the consequent loss of rare metallophytes.</p> <p>Scrub control and turf stripping to re-expose metal-rich substrates is required to restore and create suitable habitat for colonisation by the rare metallophyte bryophytes. Turf stripping combined with fencing to exclude sheep has been successful in restoring habitat for <i>Ditrichum cornubicum</i> at Phoenix United Mine.</p> <p>Callaghan & Bowyer (2011c) suggest that further research is carried out to investigate the soil characteristics (soil analysis) of substrates occupied by healthy populations of metalliferous bryophytes in order to inform management for these rare bryophytes, particularly habitat restoration and creation.</p>	<p>CALLAGHAN D. 2015</p> <p>CALLAGHAN D. 2016</p> <p>CALLAGHAN D. 2018</p> <p>CALLAGHAN D. and BOWYER H. 2011c</p> <p>HOLYOAK D. T. 2000b</p> <p>HOLYOAK D. T. 2005a</p> <p>HOLYOAK D. T. 2005b</p>

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Holyoak (2005b) recommend experimental work to establish the longevity of rhizoidal tubers of <i>Ditrichum cornubicum</i> in the 'soil' (only male plants are known, so reproduction is entirely vegetative).	
Structure and function (including its typical species)	Supporting off-site habitat	Maintain the extent, quality and spatial configuration of land or habitat surrounding or adjacent to the site which is known to support the feature	<p>The structure and function of the qualifying habitat, including its typical species, may rely upon the continued presence of areas which surround and are outside of the designated site boundary. Changes in surrounding land-use may adversely (directly/indirectly) affect the functioning of the feature and its component species. This supporting habitat may be critical to the typical species of the feature to support their feeding, breeding, roosting, population dynamics ('metapopulations'), pollination or to prevent /reduce/ absorb damaging impacts from adjacent land uses e.g. pesticide drift, nutrient enrichment.</p> <p>Changes in surrounding land use which could affect the quantity and/or quality of the water supply (eg: pollution, reduction of heavy metal concentrations and/or nutrient enrichment) might impact on the bryophyte populations, particularly the <i>Cephaloziella</i> species and other species associated with the streams, flushes and seepages. These rare metalliferous bryophytes require low nutrient conditions and acidic metal rich substrates.</p>	
Structure and function (including its typical species)	Supporting off-site supply of heavy metals	Maintain the ability of the surrounding catchment to supply river-borne heavy metals derived upstream from former mines or other metal-enriched substrates	The structure and function of the qualifying habitat, including its typical species, may rely upon the continued presence of areas which surround and are outside of the designated site boundary. Changes in surrounding land-use may adversely (directly/indirectly) affect the functioning of the feature and its component species. This supporting habitat may be critical to the typical species of the feature or to prevent/reduce/absorb damaging impacts from adjacent land uses e.g. pesticide drift, nutrient enrichment.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			<p>The streams and associated flushes, seepages and springs which percolate through and over the metal-rich ground of the disused mine workings carry heavy metals. The metal-rich sediments deposited on the banks of the streams and within flushes/seepages support large populations of several of the <i>Cephaloziella</i> species and small populations of <i>Pohlia andalusica</i>.</p> <p>The stream which flows north to south through Crow's Nest originates outside of the SAC boundaries, hence maintenance of the off-site supply of metal-rich water is a key factor.</p> <p>At Phoenix United Mine the stream flowing north-eastwards through the site emerges from on-site springs.</p>	
Structure and function (including its typical species)	Key structural, influential and/or distinctive species	<p>Restore the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat;</p> <ul style="list-style-type: none"> Constant and preferential plant species of the H4, H7, H8 and H12 NVC vegetation types at this SAC Outstanding assemblage of bryophytes including: <ul style="list-style-type: none"> <i>Ditrichum cornubicum</i> Cornish Path-moss <i>Cephaloziella nicholsonii</i> Greater Copperwort <i>Cephaloziella massalongi</i> 	<p>Some plant or animal species (or related groups of such species) make a particularly important contribution to the necessary structure, function and/or quality of an Annex I habitat feature at a particular site. These species will include;</p> <ul style="list-style-type: none"> Structural species which form a key part of the Annex I habitat's structure or help to define that habitat on a particular SAC (see also the attribute for 'vegetation community composition'). Influential species which are likely to have a key role affecting the structure and function of the habitat (such as bioturbators (mixers of soil/sediment), grazers, surface borers, predators or other species with a significant functional role linked to the habitat) Site-distinctive species which are considered to be a particularly special and distinguishing component of an Annex I habitat on a particular SAC. <p>There may be natural fluctuations in the frequency and cover</p>	<p>CALLAGHAN D. 2011a</p> <p>CALLAGHAN D. 2011b</p> <p>CALLAGHAN D. 2016</p> <p>CALLAGHAN D. A. & INGRAM M. 2018</p> <p>HOLYOAK D. T. 2005</p> <p>HOLYOAK D. T. 2006</p>

Attributes	Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
	<p>Lesser Copperwort</p> <p><i>Pohlia andalusica</i> Roth's Thread-moss</p> <p><i>Scopelophila cataractae</i> Tongue-leaf Copper-moss</p> <ul style="list-style-type: none"> • Assemblage of notable bryophyte species, including: <p><i>Cephaloziella integerrima</i> Lobed Threadwort</p> <p><i>Cephaloziella stellulifera</i> Heath Threadwort</p> <p><i>Lophozia sudetica</i> Hill Notchwort</p> <p><i>Gymnomitrium obtusum</i> White Frostwort</p> <p><i>Marsupella funkii</i> Funk's Rustwort</p> <p><i>Ditrichum lineare</i> Dark Ditrichum</p> <p><i>Cephaloziella calyculata</i> Entire Threadwort</p>	<p>of each of these species. The relative contribution made by them to the overall ecological integrity of a site may vary, and Natural England will provide bespoke advice on this as necessary.</p> <p>The list of species given here for this Annex I habitat feature at this SAC is not necessarily exhaustive. The list may evolve, and species may be added or deleted, as new information about this site becomes available.</p> <p>All of the bryophytes listed under this target are listed in the SAC Citation for Phoenix United Mine and Crow's Nest.</p> <p>In particular the site supports the only known site in the world for the endangered Cornish path-moss <i>Ditrichum cornubicum</i>. Other notable metallophytes include the liverworts <i>Cephaloziella massalongi</i>, and the endemic <i>C. nicholsonii</i>, both associated with copper-rich substrates, and the mosses <i>Pohlia andalusica</i> and <i>Scopelophila cataractae</i>.</p> <p>Many other notable bryophytes have colonised the mine spoil, including the liverworts <i>Cephaloziella integerrima</i>, <i>C. stellulifera</i>, <i>Lophozia sudetica</i>, <i>Gymnomitrium obtusum</i> and <i>Marsupella funkii</i>, and the moss <i>Ditrichum lineare</i>. The vulnerable liverwort <i>Cephaloziella calyculata</i> grows on derelict mine buildings.</p> <p><i>Ditrichum cornubicum</i> should always be present in viable populations, as this SAC site is its only known location in the World.</p> <p><i>Cephaloziella nicholsonii</i> should always be present in viable populations, as this SAC site supports the largest known World population of this endemic British species.</p> <p>Phoenix United Mine and Crow's Nest are the only two sites in the World where <i>Ditrichum cornubicum</i> is known to occur (Callaghan D. 2016). Its overall population is undergoing a</p>	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			<p>general decline due to vegetation succession, proactive management is necessary to provide suitable conditions which support viable populations of <i>Ditrichum cornubicum</i>.</p> <p><i>Cephaloziella nicholsonii</i> is a British endemic with most of its known locations in Cornwall. Both sub-sites of this SAC support strong populations of <i>C. nicholsonii</i>, and Phoenix United Mine supports the largest known population in the World (Callaghan D. 2016).</p> <p>Population monitoring data for <i>Ditrichum cornubicum</i> is collated for the years from 1998 to 2011 (excluding 2001 and 2010) in reports - Callaghan 2011a and 2001b, tables 3. However early estimates of population size/species cover were very inaccurate and the methods used were not reliable for monitoring purposes.</p> <p>Des Callaghan's method of searching for the presence of species in 100m and 10m grid squares, allows for changes in the distribution of species over time, and is most effective for monitoring purposes (refs: Callaghan D. (2011a 2011b) and Callaghan & Ingram (2011)).</p>	
Structure and function (including its typical species)	Vegetation: undesirable species	Restore the frequency/cover of the following undesirable species to within acceptable levels and prevent changes in surface condition, soils, nutrient levels or hydrology which may encourage their spread.	<p>Undesirable non-woody and woody vascular plants species may require active management to avert an unwanted succession to a different and less desirable state. Often they may be indicative of a negative trend relating to another aspect of a site's structure and function. These species will vary depending on the nature of the particular feature, and in some cases these species may be natural/acceptable components or even dominants.</p> <p>Undesirable species include:</p> <ul style="list-style-type: none"> competitive moss and liverwort species, the most commonly occurring are: <i>Ceratodon purpureus</i> Purple fork-moss / Redshank <i>Rhytidiadelphus squarrosus</i> 	<p>CALLAGHAN 2011a</p> <p>CALLAGHAN 2011b</p> <p>CALLAGHAN D. 2018</p> <p>HOLYOAK D. T. 2005a</p> <p>HOLYOAK D. T. 2005b</p> <p>NATURAL ENGLAND 2015a. SIP Profile 173</p>

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			<p>Springy turf-moss</p> <ul style="list-style-type: none"> Grasses - various species Shrubs: <i>Ulex europaeus</i> European gorse, <i>Cotoneaster horizontalis</i> Cotoneaster, <i>Salix cinerea</i> Grey willow / <i>Salix caprea</i> Goat willow, <i>Rhododendron ponticum</i> Rhododendron, <i>Ilex aquilinum</i> Holly, <i>Prunus laurocerasus</i> Cherry laurel <p>Eutrophication resulting from sheep dunging and subsequent growth of competitive mosses (<i>Ceratodon purpureus</i> and <i>Rhytidiadelphus squarrosus</i>) and vascular plants at Phoenix United Mine resulted in the loss/decline of <i>Ditrichum cornubicum</i> / <i>D. lineare</i> populations. Fencing (introduced in 2003) to temporarily exclude sheep, followed by turf stripping and re-exposure of metal rich substrate was successful.</p> <p>Management of undesirable plant species:</p> <ul style="list-style-type: none"> Turf stripping to remove surface vegetation (early succession - competitive species of mosses, liverworts, grasses) and accumulated organic matter Large-scale clearance of scrub (especially gorse and bracken, and in certain locations Cotoneaster, including mine buildings) Maintain moderate grazing pressure with appropriate livestock, while preventing eutrophication (dunging) in sensitive bryophyte locations 	
Supporting processes (on which the feature relies)	Air quality	Maintain as necessary, the concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System	This habitat type is considered sensitive to changes in air quality. Exceedance of these critical values for air pollutants may modify the chemical status of its substrate, accelerating or damaging plant growth, altering its vegetation structure and composition and causing the loss of sensitive typical species associated with it.	More information about site-relevant Critical Loads and Levels for this SAC is available by using the 'search by site' tool on the Air Pollution Information System (www.apis.ac.uk).

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		(www.apis.ac.uk).	<p>Critical Loads and Levels are recognised thresholds below which such harmful effects on sensitive UK habitats will not occur to a significant level, according to current levels of scientific understanding. There are critical levels for ammonia (NH₃), oxides of nitrogen (NO_x) and sulphur dioxide (SO₂), and critical loads for nutrient nitrogen deposition and acid deposition. There are currently no critical loads or levels for other pollutants such as Halogens, Heavy Metals, POPs, VOCs or Dusts. These should be considered as appropriate on a case-by-case basis.</p> <p>Ground level ozone is regionally important as a toxic air pollutant but flux-based critical levels for the protection of semi-natural habitats are still under development. It is recognised that achieving this target may be subject to the development, availability and effectiveness of abatement technology and measures to tackle diffuse air pollution, within realistic timescales.</p> <p>It is possible that the metallophyte bryophytes could be affected by air pollution.</p>	NATURAL ENGLAND 2015a. SIP Profile 173
Supporting processes (on which the feature relies)	Conservation measures	Restore the management measures (either within and/or outside the site boundary as appropriate) which are necessary to restore the structure, functions and supporting processes associated with the feature	<p>Active and ongoing conservation management is needed to protect, maintain or restore this feature at this site. Further details about the necessary conservation measures for this site can be provided by contacting Natural England.</p> <p>This information will typically be found within, where applicable, supporting documents such as Natura 2000 Site Improvement Plan, Site Management Strategies or Plans, the Views about Management Statement for the underpinning SSSI and/or management agreements.</p> <p>Key conservation management measures:</p> <ul style="list-style-type: none"> • Re-expose large areas of metalliferous substrates, 	<p>CALLAGHAN & BOWYER 2011c</p> <p>CALLAGHAN D. & INGRAM M. 2018</p> <p>CALLAGHAN D. 2011a</p> <p>CALLAGHAN D. 2011b</p> <p>CALLAGHAN D. 2015</p> <p>CALLAGHAN D. 2016</p>

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			<p>including turf stripping</p> <ul style="list-style-type: none"> • Maintain the hydrology of the stream valleys • Maintain moderate livestock grazing pressure • Large-scale scrub control <p>The restore target is selected for the following reasons:</p> <p>These rare metallophyte bryophytes are colonists of open habitats, they have poor competitive ability and are intolerant of shade. Their long-term survival depends on carefully targeted conservation management aimed at maintaining expanses of unshaded, bare metal-rich ground. Management requirements are for scrub control, turf stripping and regular disturbance of the substrate in order to re-expose bare metalliferous substrate. Controlled levels of livestock grazing would also help to keep scrub and coarse vegetation in check and disturbance and exposure of bare ground.</p> <p>Callaghan & Bowyer (2011c) suggest that further research is carried out to investigate the soil characteristics (soil analysis) of substrates occupied by healthy populations of metalliferous bryophytes in order to inform management for these rare bryophytes, particularly for habitat restoration and creation.</p> <p>Holyoak 2005b suggested experimental work to establish the longevity of rhizoidal tubers of <i>Ditrichum cornubicum</i> in the 'soil' (only male plants are known, so reproduction is entirely vegetative). Holyoak also suggested genetic studies to investigate whether <i>D. cornubicum</i> is a single clone.</p>	<p>CALLAGHAN D. 2018</p> <p>HOLYOAK D. T. 2005b</p> <p>NATURAL ENGLAND 2015a. SIP Profile 173</p>
<p>Version Control N/A</p>				
<p>Variations from national feature-framework of integrity-guidance: Attribute for Structure and function/Functional connectivity with wider landscape has been deleted as this is not relevant for this feature. Attributes for Vegetation Community composition and Vegetation Community transitions have been removed as this is not relevant as the feature Calaminarian grassland of the <i>Violetalia calaminariae</i> (grasslands on soils rich in heavy metals) is an assemblage of rare metalliferous bryophytes which occur on contaminated mine waste rather than a habitat type.</p>				

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