Definition of Favourable Conservation Status for Caves not open to the public

Defining Favourable Conservation Status Project

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NATURAL ENGLAND

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Contents

About the DFCS project

Natural England's Defining Favourable Conservation Status (DFCS) project is defining the minimum threshold at which habitats and species in England can be considered to be thriving. Our FCS definitions are based on ecological evidence and the expertise of specialists.

We are doing this so we can say what good looks like and to set our aspiration for species and habitats in England, which will inform decision making and actions to achieve and sustain thriving wildlife.

We are publishing FCS definitions so that you, our partners and decision-makers can do your bit for nature, better.

As we publish more of our work, the format of our definitions may evolve, however the content will remain largely the same.

This definition has been prepared using current data and evidence. It represents Natural England's view of FCS based on the best available information at the time of production.

Introduction

This document sets out Natural England's view on the contribution England needs to make to achieve Favourable Conservation Status (FCS) for **Caves Not Open to the Public (H8130)**. It is the aim of the Habitats Directive to achieve and maintain FCS. The England contribution is defined in terms of the natural range and area of the habitat and the structures and functions necessary for its long-term maintenance in England.

This section contains the summary statement of the England contribution. Sections 2 – 5 describe the evidence considered when defining FCS for each of the three parameters. Annex 1 sets out the UK and England position in the 3rd Habitats Directive report.

This document does not include any action planning, or describe actions, to achieve FCS where the habitat is not considered to be in FCS. These will be presented separately, for example within restoration strategies.

Defining the England contribution to Favourable Conservation Status describes the Natural England approach to defining the England contribution and lists the key information sources used to produce this definition.

2. FCS in England

This habitat comprises natural caves which are not routinely exploited for tourism ("show caves"), and which host specialist or endemic cave species or support important populations of Annex II species.

These caves are only found where there is suitable geology and in England are largely associated with areas of limestone. Because there is a long timescale for cave formation - cave enlargement is known to take tens or hundreds of thousands of years – there is no scope to increase the natural range or extent of this habitat.

Caves can be adversely affected by structural changes as well as changes to their environment, such as changes to light levels, air flows, air and water quality, and hydrological regime.

Because there is no scope to increase the extent of this habitat, and limited scope to restore degraded habitat, FCS requires maintenance of the existing resource in a good state and avoidance of further loses.

More specifically, achievement of FCS requires:

- Maintenance of the current extent of the habitat throughout its range

- Ensure that 95% of the habitat meets the structure and function requirements

Definition and ecosystem context

3.1 Habitat definition

Caves are formed by the erosion of soluble rocks, such as limestones. They typically form the subterranean components of a distinctive 'karst' landscape, and are associated with various topographic features, including gorges, dry valleys, 8240 Limestone pavements, and dolines (surface depressions and hollows). Many caves are protected under the Wildlife and Countryside Act 1981(as amended) as Sites of Special Scientific Interest (SSSIs); these are mainly notified for geological reasons. More rarely they are protected as a qualifying feature within Special Areas of Conservation (SACs), under the Habitats Directive, relating to the protection of bat species.

Caves not open to the public are, in the UK, those natural caves which are not routinely exploited for tourism ("show caves"), and which host specialist or endemic cave species or support important populations of Annex II species (JNCC, 2017). Show caves are excluded from this habitat because of the impact of artificial light, increased CO2 levels and disturbance on cave features and fauna. A number of studies have shown that the greatest internal impacts on subterranean ecosystems come from intensive and uncontrolled tourism and from recreational caving. The negative impact of increased CO2 levels associated with respiration on delicate speleothems (cave decoration) has been documented (Baker and Genty, 1998). Pools with underlying fine silt, usually near to some sort of groundwater flow, for example below active speleothems, are the main habitats for aquatic cave fauna, although they can also be found amongst stones in cave streams (Knight, undated). Changes to water flow and other disturbances to speleothems will have a negative impact on this fauna.

Although show caves are excluded from this habitat, where they form part of more extensive systems, those parts that are not routinely exploited for tourism are included within the scope of this definition. This includes caves visited by recreational cavers.

Sources:

http://jncc.defra.gov.uk/ProtectedSites/SACselection/habitat.asp?FeatureIntCode=H8310 [last checked 27/01/2017]
BAKER, A. & GENTY, D. 1998. Environmental pressures on conserving cave speleothems: effects of changing surface land-use and increased tourism. Journal of Environmental Management 53: 165–175.
Knight, L. Undated. Cave life in Britain. Booklet from the Freshwater Biological Association. Available from https://www.fba.org.uk/downloads [last checked 18/08/2017]

3.2 Ecosystem context

Caves lack natural illumination, and therefore support species which are able or which are adapted to live in the dark. Some are permanent residents, others are seasonal visitors and others use the caves for part of their day or their life cycle. Many species feed on detritus derived from the surface; others are carnivorous. Caves vary widely in their microclimatic conditions and the nature of their relationship with the surface environment, such as water flow, air movement and the availability of nutrients, which impact on the composition of the cave fauna and flora.

Cave-dwelling species (cavernicoles) can be divided into three categories (after Knight, undated):

- Terrestrial species that are only found underground are known are troglobites (aquatic species are known as stygobites). British examples include amphipods of the genus Niphargus (known as Well Shrimps), a few species of Collembola (springtails), and the fungus gnat *Speolepta leptogaster*.
- Terrestrial species that live in a cave and often complete their lifecycles there, although they are not limited to this habitat and are found elsewhere in other habitats are known as troglophiles (the aquatic species equivalent is stygophile). British examples include many springtails and mites , plus a few beetles and spiders
- Terrestrial species that visit caves but do not complete their lifecycle there are known as trogloxenes. Many species across all animal groups fall into this category.

None of the species listed below are solely reliant on caves not open to the public, although the larva of the fungus gnat *Speolepta leptogaster* has not yet been found outside caves.

The cavernicolous flora and fauna of the UK and other parts of northern Europe is highly impoverished relative to that associated with southern European caves. One reason for this is that most karst areas in the UK (except for parts of southern England) were glaciated during the Pleistocene, and many species are recent colonists. Southern Europe escaped glaciation and consequently has a richer fauna of highly-specialised relict troglobites.

Typical species

Typical cave fauna found in England (collated from Chapman, 1993 and the Hypogean Crustacean Database, 2015)

	Species
Trogloxenes	*Rhinolophus ferrumequinum* – Greater horseshoe bat
	Rhinolophus hipposideros – Lesser horseshoe bat
	Barbestella barbastellus - Barbastelle
	Plecotus auritus - Brown long eared bat
	Myotis brandtii – Brandt's bat
	Myotis nattereri - Natterer's bat
	Myotis daubentoni - Daubenton's bat
	Myotis bechsteinii - Bechstein's bat
	Myotis mystacinus – Whiskered bat
	Scoliopteryx libatrix – Herald moth
	Triphosa dubitat – Tissue moth
	Culex pipiens

	Stenophylax permistus
Troglophiles	*Meta menardi*
	Meta merianae
	Androniscus dentiger – pink woodlouse
	Discus rotundatus – Rounded snail
	Oxychilus cellarius – Cellar glass-snail
	Speleolepta leptogater – fungus gnat
	Folsomia sp
	Onychiurus sp
	Nanogona polydesmoides
	Brachychaetuma melanops
	Trechus micros
Stygophiles	*Gammarus pulex*
	Paracyclops fimbriatus
	Acanthocyclops vernalis
	Acanthocyclops viridis
Troglobites	*Oligaphorura schoetti*
	Oligaphorura dunarius
	Deuteraphorura inermis
	Disparrhopalites patrizii
Stygobites	*Acanthocyclops sensitives*
	Antrobathynella stamen
	Bathynella natans
	Niphargus aquilex
	Niphargus fontanus
	Niphargus kochianus
	Niphargus glenniei
	Microniphargus leruthi
	Proasellus cavaticus
	Crangonyx subterraneus

In caves and groundwaters south of the Devensian glacial limit, and generally south of the Anglian glacial limit, five species of Amphipoda (*Niphargus aquilex, N. fontanus, N. kochianus*

and *N. glenniei*) and one species of Isopoda (*Proasellus cavaticus*) are found. *Niphargus glenniei* is restricted to Devon and Cornwall and is one of only a very few British endemic species. By far the most common aquatic species in caves which were glaciated in the Pleistocene is the amphipod *Gammarus pulex* which maintains permanent populations in some caves. It is very likely that Copepoda are also common and important though they have not yet been studied in detail.

All the bat species listed above are known to regularly shelter in caves, although they may also use man-made substitutes (Chapman, 1993). Some species, for example Greater horseshoe bat, are far more reliant on caves than others.

In England, caves are particularly characteristic of the limestone areas of the North Pennines, the Peak District, and the Mendips. Examples also occur in Devon.

Sources:

Chapman, P. 1993. Caves and Cave Life. The New Naturalist, 79. Harper Collins, London.

Hypogean Crustacea Database (November 2015) http://hcrs.freshwaterlife.org/hcrs-database [last checked 16/08/2017].

Knight, L. Undated. Cave life in Britain. Booklet from the Freshwater Biological Association. Available from https://www.fba.org.uk/downloads [last checked 18/08/2017]

Natural range and distribution

4.1 Range metric

National Character Areas (NCAs).

NCA has been chosen as the metric because NCA boundaries reflect the underlying geology which is a key determinant of the occurrence of caves.

The NCAs have been selected based upon cave records from SSSIs, SACs and the Hazelton Database of cave biology records.

4.2 Historic range

The timescales for cave formation are long and inception rates unknown, but cave enlargement can take tens or hundreds of thousands of years (see Waltham et al, 1997). Limestone quarrying has a direct impact on caves through their removal, as well as impacting on karst processes and groundwater systems. Gunn and Gagen (1989) have estimated that during the 20th century quarrying has been responsible for the removal of over 900 million tonnes of limestone from the Peak District, although how many caves have been removed during this period is unknown.

Small numbers of caves have been converted into tourist attractions as show caves. Mother Shipton's Cave in Yorkshire claims to be England's oldest tourist attraction, being open to the paying public since 1630 (Mother Shipton's Cave, 2014). Many show caves were first developed in Victorian times, for example Ingleborough in 1837 and Cheddar in 1838, but have only had frequent visitors in more recent times. Many show caves only use a small portion of the cave, for example at Ingleborough around 500m of cave passage is open to the public out of a total of 4,200m. . As few caves are open to the public as show caves and the public access such a small part of these cave systems, the notion of 'caves not open to the public' has limited practical use and is here treated as the same as 'caves'.

The first documented cave survey in Britain (and probably the world) is that of Pen Park Hole in 1682 (Mullen, 1993), although serious cave research and exploration (and therefore the discovery of more caves and cave passages) did not commence until the late1800s (Waltham et al, 1997). The rate of cave and additional cave passage discovery increased in the 1950s and 1960s with the formation of several recreational caving clubs around the country, although many cave entrances would have been known previously. The discovery of new caves or passages within known caves continues at a slow rate.

As rates of cave formation are best expressed in geological rather than in human terms, the natural range of caves may be taken as static and the low rate of discovery is expected to have limited impact on the *known* range of caves.

Sources:

Mother Shipton's Cave. 2014. http://www.mothershipton.co.uk/ [last checked 17/12/2020]

Mullen, G.J. 1993. Pen Park Hole, Bristol: A reassessment. Proceedings of the University of Bristol Spelaeological Society. 19.3. pp.291-311.

Gunn, J. & Gagen, P.J. 1989. Limestone quarrying as an agency of landform change. In Resource Management in Limestone Landscapes: International Perspectives, edited by D. S. Gillieson & D.

I. Smith, Canberra: Department of Geography and Oceanography, University College, Australian Defence Force Academy (Special Publication 2)

Waltham, A.C., Simms, M.J., Farrant, A.R. and Goldie, H.S. (1997) Karst and Caves of Great Britain, Geological Conservation Review Series, No. 12, Chapman and Hall, London, 358 pp

***Confidence**: Moderate*

4.3 Current range

The range map below includes all the caves which are within designated sites and many of those which lie outside designated sites in England.

For SSSIs, this is largely based on geological sites as selected through the Geological Conservation Review for caves (Waltham et al, 1997). One SSSI (Pridhamsleigh Caves) is now notified for the Section 41 priority species *Niphargus glenniei*, as well as geological features. A second (Pen Park Hole SSSI) has been notified for *Niphargus kochianus, N. fontanus and Microniphargus leruthi*. The SACs selected for this habitat have been identified for their bat populations rather than truly subterranean taxa. For caves outside designated sites, data is based upon the Hazelton Database of biological records (BCRA, 2015).

NCAs with known caves (based on cave SSSIs, SACs and the Hazelton Database (BCRA, 2015)) are shown in the following table.

NCAs with fewer than five known caves	NCAs with 5 or more known caves
Orton Fells	North Pennines
South Cumbria Low Fells	Morecambe Bay Limestones
Pennine Dales Fringe	Yorkshire Dales
North Yorkshire Moors and Cleveland Hills	White Peak
Vale of Pickering	Southern Pennines
Southern Magnesian Limestone	Forest of Dean and Lower Wye
Bowland Fells	Cotswolds
Derbyshire Peak Fringe and Lower Derwent	Mendip Hills
Dark Peak	Devon Redlands
Manchester Pennine Fringe	South Devon
Bristol, Avon Valleys and Ridges	
South Downs	
Quantock Hills	
Exmoor	
Vale of Taunton and Quantock Fringes	
Dartmoor	

Waltham et al, 1997 estimated the maximum surface area of karst (which potentially could have caves beneath it) in England as approximately 10,000 km^2. Around 1,000 km^2 related to the Palaeozoic limestone, which hosts numerous caves and the Magnesian Limestone (including oolite) which contains fewer caves. Around 9,000 km^2 related to the Chalk, which has very limited cave development, although it has wider significance due its aquifer which crustacean species inhabit.

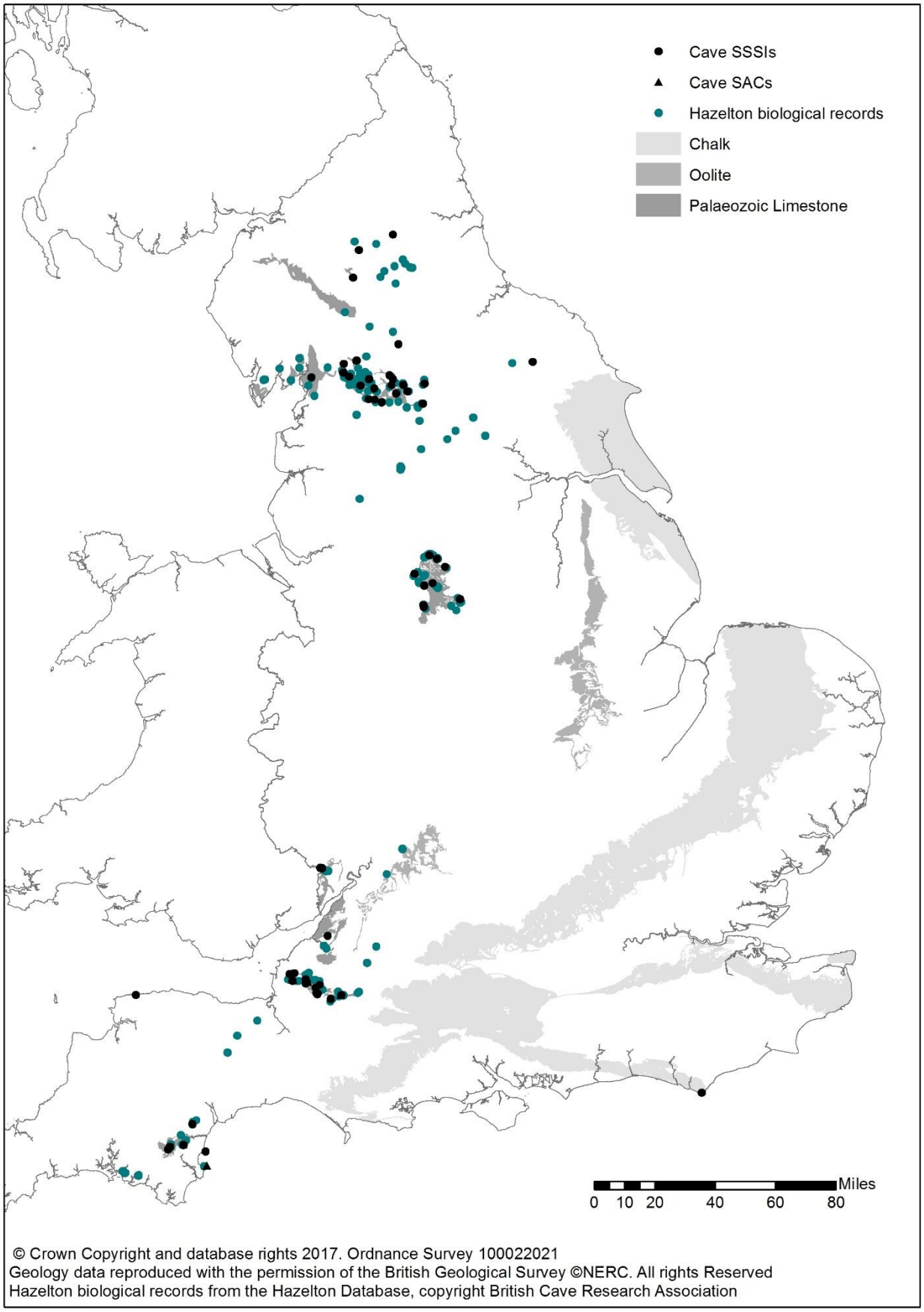
The map below shows the karst areas corresponding to the Chalk, oolite and Palaeozoic limestones (redrawn from Waltham et al, 1997). Almost all of the natural caves in England are found within the Palaeozoic limestone.

Source:

British Cave Research Association. 2015. Hazelton Database, Available from http://www.cave-registry.org.uk/svn/BiologyData/ [last checked]

Waltham, A.C., Simms, M.J., Farrant, A.R. and Goldie, H.S. (1997) Karst and Caves of Great Britain, Geological Conservation Review Series, No. 12, Chapman and Hall, London, 358 pp

Confidence: *Moderate*



4.4 Range required for future maintenance of biological diversity and variation in the habitat

New discoveries are unlikely to have a significant impact on range as significant caves are only found within limestone areas, which are reflected on the map above.

Although quarrying and public access both have the potential to damage individual cave systems, they are unlikely to have an impact on the range of the habitat at this scale.

The current range is adequate to maintain the habitat over the next 50-100 years.

***Source**: 3rd UK Habitats Directive Reporting 2013, England Submission*

***Confidence**: Poor*

4.5 Potential for restoration of the natural range

Caves can only be found where there is suitable geology, usually in limestone areas, so the natural range is unlikely to expand significantly beyond the current range even with an increase in cave exploration and discoveries.

As rates of cave formation are best expressed in geological rather than in human terms, any losses cannot be recovered.

Sources:

3rd UK Habitats Directive Reporting 2013, England Submission

***Confidence:** Moderate*

4.6 Favourable range

The current range for the habitat is the favourable range. The range is monitored using geological / biological SSSI monitoring, plus information from caving volunteers and caving databases (such as the Peak District SSSI Cave Conservation Monitoring Scheme with the Derbyshire Caving Association and Northern SSSI Cave Conservation Monitoring Scheme with the Council for Northern Caving Clubs).

4.7 Comparison with situation in 1994

The favourable range is at least that as when the Directive came into force.

Habitat area

5.1 Metric

Length in km

By their nature caves do not have a surface expression which can be measured in terms of area. The only measurement widely available for a large number of caves is the length of cave passage in kilometres. It is impossible to provide an area based measurement as individual cave passages may vary greatly in width along their length.

5.2 Historic area

There were approximately 495 km (in length) of known cave passages in 1997 (see Waltham et al, 1997). The timescales for cave formation are long and cave enlargement can take tens or hundreds of thousands of years, so extensions in area of habitat reflect new discoveries of existing caves rather than the formation of new habitat.

Quarrying has had a direct impact through the removal of caves and karst landforms. In a well-documented example, around 680 m of cave passages have been quarried away at Fairy Holes Cave in County Durham due to an extant planning permission; around 3.2 km of cave passages remain which have been protected as a SSSI (Hinde, 2014).

Sources:

Hinde, A. 2014. How Fairy Holes Cave retains its magic. Earth Heritage, 41, 15-16.

Waltham, A.C., Simms, M.J., Farrant, A.R. and Goldie, H.S. (1997) Karst and Caves of Great Britain, Geological Conservation Review Series, No. 12, Chapman and Hall, London, 358

Confidence: *Moderate*

5.3 Current area

There are approximately 524 km of known cave passages in England (this is a minimum figure and excludes figures from Devon which are not currently available). This is an increase in recorded cave passage since 1997, and is due to caving groups undertaking cave exploration and discovering previously unmapped cave passages, rather than new habitat being formed. Discoveries of completely new caves are rare.

Sources:

WALTHAM, Tony and David LOWE (eds.) (in press). Caves and Karst of the Yorkshire Dales (Volume 2). Buxton: British Cave Research Association. ISBN 978-0-900265-48-8. 360pp

Mendip Cave Registry *http://www.mcra.org.uk/registry/browse.php?cv=cave&lc=gte&lv=&dc=gte&dv=&ac=gte&av=&page=35 [last checked 13/01/2017*

Derbyshire Caving Association Cave Registry *http://thedca.org.uk/dca-cr/registry/browse.php?page=20 [last checked 13/01/2017]*

***Confidence**: Moderate*

5.4 Habitat area required for future maintenance of biological diversity and variation in the habitat

Very small areas (in the order of 10s of metres) of this habitat may be lost through extending show caves open to the general public into previously undisturbed areas of cave passage.

Losses due to quarrying are possible, due to demand for limestone, but unlikely in designated sites and protected areas.

The number and distribution of cave-dwelling species was severely impacted by glaciation during the Pleistocene when most cave areas became ice covered, cutting off the food supplies of the species which inhabited them making terrestrial troglobites are relatively scarce in Britain (Chapman, 1993). The distribution of species varies greatly, for example within the Crustacea, *Niphargus glennei* is confined to Devon and Cornwall and *N. fontanus* is only found in the southern counties of England as far north as Norfolk, whereas *N. aquiliex* has been found as far north as County Durham (Hypogean Crustacea Database, 2015).

Stebbings (1995) reports that the loss of roost sites, especially in trees, but also including caves, as an important factor in the decline of bat species. However, none of the cave-dwelling species in England are solely dependent on caves (although some are more dependent on caves, such as *Rhinolophus ferrumequinum* – Greater horseshoe bat and *Speleolepta leptogater* – fungus gnat).

As this habitat cannot be created on human timescales, it is recommended that the current area is maintained for the future maintenance of biodiversity.

Source:

Chapman, P. 1993. Caves and Cave Life. The New Naturalist, 79. Harper Collins, London.

Hypogean Crustacea Database (November 2015) http://hcrs.freshwaterlife.org/hcrs-database [last checked 16/08/2017].

STEBBINGS, R.E. "Why Bats Should Be Protected? A Challenge for Conservation." Biological journal of the Linnean Society 56Suppls1(1995): 103-118.

***Confidence**: Poor*

5.5 Potential for restoration.

The known natural area is static or expanding very slowly because the timescales for cave formation are long, cave enlargement is known to take tens or hundreds of thousands of years and completely new caves are discovered at irregular intervals (see Waltham et al, 1997).

Any further loss of habitat through, for example, quarrying, could not be restored by the natural environment within human timescales. Any increase in habitat area is due to discovery of previously unmapped cave passage, rather than creation of new habitat.

Sources:

3rd UK Habitats Directive Reporting 2013, England Submission

Waltham, A.C., Simms, M.J., Farrant, A.R. and Goldie, H.S. (1997) Karst and Caves of Great Britain, Geological Conservation Review Series, No. 12, Chapman and Hall, London, 358 pp

Confidence: *Moderate*

5.6 Favourable area

The current area for the habitat is the favourable area. The area is monitored using geological / biological SSSI monitoring, plus information from caving volunteers and caving databases.

5.7 Comparison with situation in 1994

The favourable area is at least that when the Directive came into force.

Structure and function

6.1 Structure and function attributes

At its simplest, a cave can be split into three zones (after Chapman, 1993): the entrance or parietal zone, the twilight zone and the dark zone. The entrance zone environment is closest to the environment above ground. It receives sunlight, has variable temperatures and plants usually grow there. Many species use this zone to eat, sleep or nest. Further into the cave is the twilight zone. Here there is less light and the temperature remains more constant, but may still fluctuate in conjunction with the weather above ground. Many trogloxenes, including moths, bats, spiders and millipedes inhabit the twilight zone. Even further into the cave is the dark zone, where there is no light at all. Here the temperature remains constant. Troglobites live in the dark zone and have adapted to live in this environment. The transition from one zone to another will vary from cave to cave depending upon the location and size of the cave entrance and the shape and orientation of the cave passages. Many cave fauna have very restricted ranges and limited opportunities for dispersal so are strongly affected by changes in their environment and particularly by pollution (Hamilton-Smith, 2004).

Structural attributes

- Unmodified cave structure evolving naturally
- Unmodified cave entrances
- Unmodified and undisturbed cave sediments and speleothems

Functional attributes

- Naturally occurring light levels
- Natural air-flow
- Natural hydrological regime
- Good quality water, in particular lack of metal-ion contamination and additional nutrients

Network attributes

- Condition of the cave network

***Source**: Final draft_terrestrial SAC Annex I habitats framework*

Hamilton-Smith, 2004. In Gunn, J. (ed) Encyclopedia of Caves and Karst Science. 2004. Fitzroy Dearborn, London.

***Confidence**: Moderate*

6.2 Historic situation

Although biological records have been published since the 1930s (BCRA website, 2017) it is generally recognised that biological research in the cave environment is highly specialised and has, in the main, been done as and when circumstances allow rather than systematically so there is very little or no trend data for many species.

A seven year study of the Peak-Speedwell Caverns system (Wood et al, 2008) identified two organic pollution events which had markedly different ecological responses. The study showed that the first pollution event led to the elimination of most taxa from affected areas, while the second resulted in an increase in abundance of organisms, associated with the increased availability of trophic resources.

While data from the National Bat Monitoring Programme (Bat Conservation Trust, 2016) indicates that populations of the bat species monitored are stable or recovering (across all habitats), these trends reflect relatively recent changes in bat populations (since 1999 for most species). It is generally considered that prior to this, in the period between the 1950s and at least the late 1980s, there were significant historical declines in bat populations.

Sources:

BCRA website http://bcra.org.uk/biology/uk.txt [last checked 27/01/2017]

WOOD, P.J., GUNN, J. & RUNDLE, S.D. 2008. Response of benthic cave invertebrates to organic pollution events. Aquatic Conservation: Marine and Freshwater Ecosystems 18, 909-922.

Bat Conservation Trust, 2016. The National Bat Monitoring Programme. Annual Report 2015. Bat Conservation Trust, London. Available at http://www.bats.org.uk/pages/nbmp_annual_report.html [last checked 03/03/17]

Confidence: *Moderate*

6.3 Current situation

There are 55 SSSIs which contain designated caves, but most cave SSSIs are notified for their geological features only. These assessments embrace the physical features of the cave, monitoring, for example, whether there has been any impact on them from quarrying, engineering works, hydrological changes at the surface and recreational caving, all of which would also have an impact on cave fauna.

99% of the designated resource in SSSIs is in favourable condition, although the condition data is based on geological SSSI units and in most cases the Annex 1 feature will not cover the whole unit.

One SSSI (Pridhamsleigh Caves) is notified for the Section 41 priority species *Niphargus glenniei*, as well as geological features. At this site one unit is assessed as favourable, one unit is assessed as unfavourable no change and two units are assessed as unfavourable declining due to sediment erosion.

A second SSSI (Pen Park Hole) has been notified for *Niphargus kochianus, N. fontanus* and *Microniphargus leruthi*, as well as geological features. This site is currently assessed as favourable.

The range and area for both *Rhinolophus ferrumequinum* – Greater horseshoe bat and *Rhinolophus hipposideros* – Lesser horseshoe bat are much wider than that for H8310 caves not open to the public. The cave habitat for both species has been assessed as Favourable because there is thought to be sufficient amount of both cave and wider habitat for the species to be viable,

and although habitat quality and trend are unknown, the fact that range and population are favourable suggests that habitat is not a major problem for these species (see Third Reports by the UK under Article 17 for Greater horseshoe bat and Lesser horseshoe bat).

Some of the above species are likely to be found in other non-designated caves not open to the public, but this data is currently only partially available, as these sites have not yet been assessed systematically and any data available is reported at regional level which also includes mines (and wells for aquatic species) rather than at cave level. There is no assessment of whether these sites are in favourable condition as there is currently no agreed method of assessing them.

Sources:

https://designatedsites.naturalengland.org.uk/SiteSearch.aspx [last checked 13/01/2017]
Third Report by the United Kingdom under Article 17: S1304 - Greater horseshoe bat (Rhinolophus ferrumequinum) 2012
Third Report by the United Kingdom under Article 17: S1303 - Lesser horseshoe bat (Rhinolophus hipposideros) 2012

***Confidence**: Moderate*

6.4 Structure and function attributes required for future maintenance of biological diversity and variation in the habitat

Condition: Good habitat quality will look different from place to place and condition targets should be set which are appropriate to local circumstances, taking account of guidance in the table below.

- 95% of the designated cave network should be in target condition

Guidance for structure and function at different spatial scales

England scale requirements		**Guidance for local objective setting**		
Attributes	**England scale levels**	**Landscape**	**Protected sites**	**Outside protected sites**
Structure				
Unmodified cave structure evolving naturally	At least 95% of the designated area in target condition		Quarry operations or engineering works not obscuring or damaging cave entrances, cave passage. see CSM (JNCC, 2004)	Same as protected sites
Unmodified cave entrances and passages	At least 95% of the designated area in target condition		Cave entrances and cave passages have not been blocked or damaged, directly or indirectly by human activity see CSM (JNCC, 2004)	Same as protected sites

Unmodified and undisturbed cave sediments and speleothems	At least 95% of the designated area in target condition		There is no unconsented disturbance to or removal of cave sediments or speleothems. see CSM (JNCC, 2004)	Same as protected sites
Function				
Natural hydrological regime	At least 95% of the designated area in target condition	Natural water table levels, without negative impacts from pollution or abstraction	There have been no alterations to surface hydrology, directly or indirectly by unconsented human activity, affecting underground hydrology within the cave. see CSM (JNCC, 2004)	Same as protected sites
Naturally occurring light levels	At least 95% of the designated area in target condition		This is related to the blockage of cave entrances and passages, but should be assessed separately. see CSM (JNCC, 2004)	Same as protected sites
Natural air-flow	At least 95% of the designated area in target condition		This is related to the blockage of cave entrances and passages but should be assessed separately. see CSM (JNCC, 2004)	Same as protected sites
Good quality water, in particular lack of metal-ion contamination and additional nutrients	At least 95% of the designated area in target condition		Pollution is not directly or indirectly damaging or destroying the features of interest within the cave. see CSM (JNCC, 2004)	Same as protected sites
Network attributes				
Condition	At least 95% of the designated area in target condition		Protected sites in (tailored) favourable condition	Sites in locally appropriate target condition
Species diversity	All typical species are of Least Concern		Presence of all the niches required for the	

			expected typical species in the site. Presence of typical species confirmed on site	

Quarrying has impacts upon karst processes and groundwater systems (through water abstraction). Cave ecosystems can also be significantly affected by changes to sediment loads, subsurface hydrology and both clastic (sediment) and chemical water quality (Watson et al. 1997) arising from other associated activities on the surface.

Most of the important discoveries and extensions to existing cave systems have resulted from excavations (Hardwick and Gunn 1997), and this can result in passages having their sediment fill partially or totally removed and largely deposited into active streams. Although this activity has increased the known cave resource, the impact on cave ecology is largely unknown. Guidelines have been developed to facilitate the sustainable development and conservation of cave and karst environments at national (British Caving Association, 2016) and international (Watson et al. 1997) scales.

Surface organic pollution can have a direct effect on cave fauna but also often washes in surface fauna (the species may be the same as some found in caves but the latter are often genetically distinct forms) which may out-compete and so denude the cave fauna (Wood et al, 2008). Pollution incidents within cave systems are frequently undetected due to the difficulty of identifying the pollutant source and gaining access to monitor features. Studies such as that reported in Wood et al (2002, 2008), which demonstrated the impact of contaminated agricultural runoff from the surface catchment on cave fauna in the English Peak District, are rare.

Many factors can affect air flow within caves, particularly the shape and orientation of the cave entrance and cave passages. Blockage of cave entrances or passages is undesirable where it: prevents the movement of troglophile and trogloxene species; restricts access to monitor underground features; or affects the hydrology or the air-flow of the cave system itself.

Other land management practices at the surface within the catchment of caves is an important influence on hydrology, water chemistry and nutrient load (Anna Wetherell, pers comm 2017) which will all affect habitat function.

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Confidence: *Poor-Moderate*

Potential for restoration

The potential for restoration of the structural attributes of this habitat is low.

The potential impacts of climate change are not fully understood, although weathering, increased rainfall and drought will alter dissolution rates in caves (Harrison et al, 2001). Where mean annual effective rainfall is predicted to increase (eg Yorkshire Dales) there will be an increase in dissolution rates, increasing erosion at the surface and potentially speeding up the formation of speleothems (cave "decoration" deposits). Conversely where mean annual effective rainfall is predicted to decrease (eg Mendip Hills) dissolution rates will slow down, having the opposite effect (Harrison et al, 2001). The specific rates have not been quantified, but habitat loss could not be restored by the natural environment within human timescales.

The potential for restoration of the functional attributes of this habitat is moderate, but will depend upon the circumstances of individual catchments and of the caves themselves.

Wood et al (2008) studied two organic pollution events in the Peak-Speedwell system which showed recovery of the invertebrate community following both organic pollution events occurred within 12 months, once the source of pollution had been removed. Re-colonisation of the affected sites was facilitated by annual flooding of the cave and by the presence of refugia on unaffected subterranean tributaries. Diffuse pollution sources in the wider catchment may be harder to pinpoint and therefore are more difficult to remediate.

At present there is limited direct biological monitoring of subterranean groundwater dependant ecosystems, and the consequences of pollution within them are largely unseen, so a significant knowledge gap exists regarding their impacts.

Sources:

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Confidence: *Poor – Moderate*

Favourable structure and function attributes

England's contribution to FCS is judged to be favourable for structure and function when:

England Structure & Functions attributes and levels

Attribute	England level for FCS*	Recommendations for monitoring
Unmodified cave structure evolving naturally	At least 95% of the designated area in target condition	Sample survey of condition assessments inside and outside protected sites
Unmodified cave entrances and passages	At least 95% of the designated area in target condition	Sample survey of condition assessments inside and outside protected sites
Unmodified and undisturbed cave sediments and speleothems	At least 95% of the designated area in target condition	Sample survey of condition assessments inside and outside protected sites
Natural hydrological regime	At least 95% of the designated area in target condition	Sample survey of condition assessments inside and outside protected sites
Naturally occurring light levels	At least 95% of the designated area in target condition	Sample survey of condition assessments inside and outside protected sites
Natural air-flow	At least 95% of the designated area in target condition	Sample survey of condition assessments inside and outside protected sites
Good quality water, in particular lack of metal-ion contamination and additional nutrients	At least 95% of the designated area in target condition	Sample survey of condition assessments inside and outside protected sites
Condition	At least 95% of designated area in locally appropriate target condition	Sample survey of condition assessments inside and outside protected sites
Species diversity	All typical species Least Concern	IUCN red list status

*Although data on the occurrence of individual species is available through various websites and databases (the Hypogean Crustacea Recording Scheme, the Cave Registry Data Archive and the National Biodiversity Network) the habitat outside the designated resource is not currently monitored or assessed.

Annex 1: Third Habitats Directive Reporting

UK context from the 3rd UK Habitats Directive report

Current UK conservation status:

- **Range:** Favourable
- **Area:** Favourable
- **Structure and function:** Unknown
- **Overall:** Unknown

Current UK favourable reference values:

- **Range:** 12019.06 km^2
- **Area:** None given

Proportion of UK habitat within England: Unknown

Proportion of England habitat within protected sites:

- **N2K:** No km figures – 343.01 ha

Source: Designated sites view

- **Protected areas outwith N2K:** - No km figures – 6,250.32 ha

Source: Designated sites view

European context from the 3rd Habitats Directive reports

Proportion of Atlantic biogeographic region within UK: 2.7% of distribution

Source: European Topic Centre on Biological Diversity Article 17 species assessment for Atlantic biogeographic region.

Further information

Natural England evidence can be downloaded from our **Access to Evidence Catalogue**. For more information about Natural England and our work see **Gov.UK**. For any queries contact the Natural England Enquiry Service on 0300 060 3900 or e-mail **enquiries@naturalengland.org.uk** .

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