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

Craven Limestone Complex Special Area of Conservation (SAC) Site Code: UK0014776

Date of Publication: 22 March 2019

About this document

This document provides Natural England's supplementary advice about the European Site Conservation Objectives relating to Craven Limestone Complex SAC.

This advice should therefore be read together with the SAC Conservation Objectives available here.

This advice replaces a draft version dated January 2019 following the receipt of comments from the site's stakeholders.

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	Craven Limestone Complex Special Area of Conservation (SAC)
Location	North Yorkshire
Site Map	The designated boundary of this site can be viewed here on the MAGIC website
Designation Date	01 April 2005
Qualifying Features	See section below
Designation Area	5328.25 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)	Bastow Wood SSSI Conistone Old Pasture SSSI Kilnsey Flush SSSI Malham-Arncliffe SSSI Malham-Arncliffe (Cool Pasture) SSSI
Relationship with other European or International Site designations	Malham Tarn Ramsar

Site background and geography

The Craven Limestone Complex includes the second most extensive area of calcareous grassland in the UK. It supports blue moor-grass – limestone bedstraw (*Sesleria caerulea – Galium sterneri*) grassland that exhibits exceptional structural diversity, ranging from hard-grazed open grasslands, through to tall herb-rich grasslands on ungrazed cliff ledges, woodland margins and around limestone pavements and screes. It is thus an important example of grassland-scrub transitions. The site supports a large mid-altitude limestone pavement, with a wide range of transitions to other habitats, including the calcareous grasslands, as well as alkaline fens and *Tilio-Acerion* woodlands.

There are large species-rich fen systems, principally of the dioecious sedge – common butterwort *Carex dioica – Pinguicula vulgaris* mire, quaking-grass – bird's-eye primrose *Briza media – Primula farinosa* sub-community. Frequent species include bird's-eye primrose and grass-of-Parnassus *Parnassia palustris* alongside rarities such as broad-leaved cottongrass *Eriophorum latifolium*, Alpine rush, *Juncus alpino-articulatus,* a single small colony of alpine bartsia *Bartsia alpina* and dwarf milkwort *Polygala amarella*. There are also extensive spring-fed flush fens throughout the site, typically associated with calcareous grassland and limestone scars.

The site contains extensive complexes of tufa-forming springs associated with a wide range of other habitats, including alkaline fens, calcareous grasslands, limestone pavements, cliffs and screes. Locally, calcareous springs emerge within areas of acid drift supporting heath and acid grassland. The flora of

these habitat mosaics is outstandingly species-rich and includes many rare northern species, such as alpine bartsia and bird's-eye primrose.

Craven contains what are believed to be the largest expanses of purple moor-grass – marsh hawk's-beard *Molinia caerulea – Crepis paludosa* mire in the UK, amidst alkaline fens and active raised bog communities of the Malham Tarn area. Malham Tarn Moss is an active raised bog in an area overlying limestone where wetlands are more typically base-rich fens. It displays a classic raised dome with transition from raised bog (base-poor) to base-rich conditions at the bog margin where it interfaces with land influenced by water from the limestone. It has an unusual mixture of bog-moss *Sphagnum*-rich and hair-grass *Deschampsia*-dominated vegetation.

Malham Tarn is considered the best example of an upland stonewort *Chara*-dominated lake in England and is the highest marl lake in the UK. The water drains from surrounding Carboniferous limestone and is nutrient-poor. The feeder streams and the tarn itself support populations of white-clawed crayfish *Austropotamobius pallipes*, while upland becks and streams with calcareous waters and stony beds support good numbers of bullhead *Cottus gobio*.

Craven Limestone Complex is also the single remaining native site for Lady's-slipper orchid *Cypripedium calceolus*.

Geology

Further, Craven Limestone Complex is rich in geology. Malham Tarn lies largely over Silurian slates covered with thick glacial drift and marl deposits. The tarn basin was dammed by a gravely moraine during the retreat of ice at the end of the last (Devensian) Glaciation c18,000 yrs. ago. Prior to the silting up and mire development in the west, Malham Tarn was originally twice its present size. Surrounding the Tarn is a karstic limestone landscape of predominately Carboniferous age. Malham Tarn NNR is a mountain lake surrounded by 6 farms on upland limestone. It includes rugged moorland, exposed limestone pavement (so called because it resembles artificial pavement) and hay meadows rich in wildflowers. Malham Tarn is managed by the National Trust.

Craven Limestone Complex SAC is part of the Yorkshire Dales National Character Area (NCA Profile 21).

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:

- **H3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.**

This habitat type is characterised by water with a high base content, most often calcium but very rarely magnesium, and is usually confined to areas of limestone and other base-rich substrates, from which the dissolved minerals are derived. In part the rarity of the habitat type is due to the fact that since calcareous rocks are free-draining, waterbodies occur on the surface of these rocks only very rarely. In addition, such waterbodies are characterised by very clear water and low nutrient status. They are therefore largely restricted to situations where the catchment or aquifer from which they are supplied with water remains relatively unaffected by intensive land-use or other sources of nutrients, and they are most often found in areas supporting mosaics of semi-natural vegetation.

Abundant charophytes (stoneworts) are typically the most prominent component of the vegetation; they can occur as dense beds that cover a significant part of the lake bottom over muddy marl deposits.

Hard oligo-mesotrophic waters occur in three main situations:

1. Lakes on a predominantly limestone substrate.
2. Coastal sites based on calcium-rich shell-sands, also known as machair lochs.
3. Lakes with nutrient inputs from other base-rich influences, e.g. serpentine and boulder clays.

Hard oligo-mesotrophic waters with benthic stoneworts *Chara* spp. are scarce in the UK, and the best examples of this habitat type are restricted to the north and west.

Malham Tarn in Craven Limestone Complex in northern England is considered the best example of an upland stonewort *Chara*-dominated lake in England. It is an example of a lake on limestone and is the highest marl lake in the UK. The water drains from surrounding Carboniferous limestone and is calcareous and low in plant nutrients, although the Tarn has a large catchment and some nutrient enrichment to the system has occurred in the past, slightly reducing the floristic richness.

- **H6130 Calaminarian grasslands of the *Violetalia calaminariae***

Calaminarian grasslands occur on soils that have levels of heavy metals, such as lead, zinc, chromium and copper, which are toxic to most plant species. The greatest extent of the habitat occurs on artificial sites associated with past mining activities as here. Near-natural examples are much more localised and do not occur on the Craven site. There are three main situations where this habitat type has developed:

1. Near-natural, open vegetation of serpentine rock and mineral vein outcrops with skeletal soils;
2. Stable river gravels rich in lead and zinc and that are near-natural, although the heavy metal content may be partly an artefact of past mining activity in the river catchment;
3. Artificial mine workings and spoil heaps, mainly on limestone; these are numerous (several thousand UK localities) and extensive, although few sites have a high species-richness.

Grasslands of this type are referable to the *Thlaspion-Calaminariae* alliance. The vegetation is typically species-poor but contains a number of species principally found in this habitat, most notably spring sandwort *Minuartia verna* and alpine penny-cress *Thlaspi caerulescens*. There is a genetically-adapted range of other species, such as sheep's fescue *Festuca ovina*, bladder campion *Silene vulgaris*, sea campion *Silene uniflora* and thrift *Armeria maritima*, none of which occur here Heavy metal toxicity of the soils, perhaps combined with a low nutrient status, is believed to maintain the open vegetation, retarding succession. The rarer species are favoured by lack of competition from more vigorous colonists. The

Annex I type also includes assemblages of metal-tolerant lower plants on mine waste, even if higher plant metallophytes are lacking.

In the UK some forms of this vegetation correspond to NVC type OV37 *Festuca ovina – Minuartia verna* community; other forms characterised by different metallophyte plant species or races and ecotypes are not described in the NVC.

- **H6210 Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*)**

Festuco-Brometalia grasslands are found on thin, well-drained, lime-rich soils associated with chalk and limestone. They occur predominantly at low to moderate altitudes in England and Wales, extending locally into upland areas in northern England, Scotland and Northern Ireland. Most of these calcareous grasslands are maintained by grazing. In the lowlands there are a large number of rare plants are associated with this habitat, however in the more upland settings here these are replaced by species which are more widespread in the lowlands becoming scarce and local instead such as horseshoe vetch and dropwort, *Filipendula vulgaris*, plus amongst damper turf the scarce bird's-eye primrose*, Primula farinosa*.

This Annex I category includes various forms of calcareous grassland referable in European terms to the *Mesobromion* and *Xerobromion* alliances. All forms of *Festuco-Brometalia* grassland comprise mixtures of grasses and herbs, in which there is at least a moderate representation of calcicolous species. The structural and floristic characteristics of the habitat are strongly influenced by climatic factors and management practices, in particular the intensity of grazing. The main sub-types of these grasslands in the UK correspond to the following NVC types:

CG2 *Festuca ovina – Avenula pratensis* grassland
CG9 *Sesleria albicans – Galium sterneri* grassland
CG10 Festuca ovina – Agrostis capillaris grassland

CG2 *Festuca – Avenula* grassland is widely distributed in grazed calcareous pastures throughout the lowlands of England and Wales. Typical *Mesobromion* calcicoles, such as meadow oat-grass *Avenula pratensis*, quaking-grass *Briza media*, common rock-rose *Helianthemum nummularium*, salad burnet S*anguisorba minor* ssp. *minor* and small scabious *Scabiosa columbaria*, are well-represented, but in these more upland settings species with a more Continental distribution, including dwarf thistle *Cirsium acaule* and squinancywort *Asperula cynanchica*, are notably absent and the habitat is restricted to the lower ground, south-facing slopes or in most cases form intermediate sward types with the CG9 below.

On the limestones of northern England, grasslands dominated by *Sesleria albicans* are locally abundant. In CG8 *Sesleria – Scabiosa* grassland, *Sesleria* is accompanied by a range of typical *Mesobromion* species; this community is restricted to Magnesian Limestone at low altitudes in Durham. CG9 *Sesleria – Galium* grassland is more widespread, and occurs at moderate-high altitudes on Carboniferous Limestone in the Pennines and Lake District. The sub-montane character of the vegetation is shown by the reduced frequency of *Mesobromion* species, and the presence of limestone bedstraw *Galium sterneri* and other northern/upland species; some stands are enriched with arctic-alpine rarities. Similar *Sesleria*-dominated grasslands are also found in Northern Ireland.

CG10 is the least diverse of these swards and usually represents transitions from core calcareous areas towards acid grassland swards and leached areas on high ground, (herb-rich swards in which bents and fescues are prominent tend to be CG9b with low Sesleria cover). Aside from small sedges and thyme indicator species are few and often replaced by the likes of field woodrush, *Luzula campestris*, common dog-violet, *Viola riviniana*, and yarrow, *Achillea millefolium*.

Various sub-types of *Festuco-Brometalia* grassland frequently occur in close association, their distribution being determined by slope, aspect, grazing intensity and recreational pressure. Transitions between calcareous grasslands and heath, acid grassland, scrub and woodland communities are also widespread.

This priority habitat type comprises *Festuco-Brometalia* calcareous grasslands containing important orchid assemblages and/or rare orchids. 'Important orchid sites' are defined in the *Interpretation Manual of European Union Habitats* as localities which meet one or more of the following criteria:

1. the site hosts a rich suite of orchid species;
2. the site hosts an important population of at least one orchid species considered not very common on the national territory;
3. the site hosts one or several orchid species considered to be rare, very rare or exceptional on the national territory.

Priority status is afforded only to sites which meet these criteria. It is not appropriate to identify other features that make them distinctive.

The Craven Limestone Complex SAC is the second most extensive area of calcareous grassland in the UK, and represents the NVC type CG9 *Sesleria albicans – Galium sterneri* grassland. The site exhibits an exceptional diversity of structural types, ranging from hard-grazed open grasslands, through to tall herb-rich grasslands on ungrazed cliff ledges, such as at Malham Cove, in woodland margins and around H8240 Limestone pavements and screes. It is thus an important example of grassland-scrub transitions.

- **H6410 *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)**

Molinia meadows are found mainly on moist, moderately base-rich, peats and peaty gley soils, often with fluctuating water tables. They usually occur as components of wet pastures or fens, and often form mosaics with dry grassland, heath, mire and scrub communities. This habitat type includes the most species-rich *Molinia* grasslands in the UK, in which purple moor-grass *Molinia caerulea* is accompanied by a wide range of associated species, including rushes, sedges and tall-growing herbs. The more impoverished forms of *Molinia* pasture on acidic substrates are excluded from the Annex I definition.

M26 *Molinia caerulea – Crepis paludosa* mire occurs more locally in wet grasslands and fens in uplands and upland margins of northern England and north Wales, and as small scattered stands throughout Scotland as far north as Moray. The vegetation has a distinctive sub-montane character, manifested in the presence of species with a northern distribution, such as marsh hawk's-beard *Crepis paludosa* and globe-flower *Trollius europaeus*.

Craven is one of three sites representing *Molinia* meadows in the northern England centre of distribution. This site contains what are believed to be the largest expanses of M26 *Molinia caerulea – Crepis paludosa* mire in the UK, amidst H7230 Alkaline fens and H7110 active raised bog communities of the Malham Tarn area; smaller fragments are associated with meadows, wood edges and river banks elsewhere on the site.

- **H7110 Active raised bogs**

Active raised bogs are peat-forming ecosystems that have developed during thousands of years of peat accumulation, to such an extent that the depth of peat isolates them from the influence of groundwater. Typically, lowland raised bogs form a raised dome of peat irrigated solely by rainfall. Such rainwater-fed ecosystems are very acid and poor in plant nutrients and typically support a restricted range of species, some of which are otherwise abundant only in the cooler and wetter uplands of the UK. In line with the *Interpretation manual of European habitats* (European Commission DG Environment 1999), 'active' is defined as 'supporting a significant area of vegetation that is normally peat-forming'. Such vegetation includes plants such as the bog-mosses *Sphagnum* spp., cottongrasses *Eriophorum* spp., heather *Calluna vulgaris* and other ericaceous plants, and the carnivorous sundews *Drosera* spp. Under some circumstances purple moor-grass *Molinia caerulea* is also peat-forming. Active bog vegetation is characteristic of intact (primary) bog surfaces, but peat-forming communities also occur frequently on bogs which have previously been cut for peat (secondary surfaces) but have since become revegetated.

Within the raised bog ecosystem the bog surface typically displays a distinctive microtopography, with patterns of hummocks and hollows rich in *Sphagnum* and other peat-forming species. Classical descriptions of the ecosystem show raised bogs as having a discrete lens-shaped dome of peat with flat or imperceptibly sloping topography with a halo of fen vegetation in the zone where water draining the bog meets that from adjoining mineral soils. This is known as the lagg. A characteristic of the lagg zone is that normally it has more available plant nutrients, is more alkaline and hence shows greater species diversity, with a preponderance of sedge *Carex* spp. Attention has been paid to ensure that sites with remnant lagg vegetation have been selected.

The principal NVC types found on Active raised bogs within this site is:

M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire

Malham Tarn Moss represents one of the best Active raised bogs in central northern England, in an area overlying limestone where wetlands are more typically base-rich fens. It displays a classic raised dome with transition from raised bog (base-poor) to base-rich conditions at the bog margin where it interfaces with land influenced by water from the limestone. It has an unusual mixture of bog-moss *Sphagnum*-rich and hair-grass *Deschampsia*-dominated vegetation.

- **H7220. Petrifying springs with tufa formation (Cratoneurion); Hard-water springs depositing lime**

Tufa formation is associated with hard-water springs, where groundwater rich in calcium bicarbonate comes to the surface. On contact with the air, carbon dioxide is lost from the water and a hard deposit of calcium carbonate (tufa) is formed. These conditions occur most often in areas underlain by limestone or other calcareous rocks, and particularly in the uplands of northern England and the Scottish Highlands.

Tufa-forming spring-heads are characterised by the swelling yellow-orange mats of the mosses *Cratoneuron commutatum* and *C. filicinum*. Many rare, lime-loving (calcicole) species live in the moss carpet.

Whilst written descriptions allow more latitude as to what is encompassed by this feature EUNIS and consequently NVC rather rigidly prescribe it. There are two main NVC types associated with tufa formation found on site:

M37 *Cratoneuron commutatum – Festuca rubra* spring
M38 *Cratoneuron commutatum – Carex nigra* spring

The former community is widely distributed, while the latter is found only at moderate to high altitudes and has a flora especially rich in rare arctic-alpine species where it is encountered in more montane settings than is the case in Craven.

- **H7230 Alkaline fens**

Alkaline fens consist of a complex assemblage of vegetation types characteristic of sites where there is tufa and/or peat formation with a high water table and a calcareous base-rich water supply. The core vegetation is short sedge mire (mire with low-growing sedge vegetation) of the following NVC types:

M9 *Carex rostrata – Calliergon cuspidatum/giganteum* mire
M10 *Carex dioica – Pinguicula vulgaris* mire
M13 *Schoenus nigricans – Juncus subnodulosus* mire

Most examples in the Craven Limestone Complex fit into the first two of these communities. Whilst black bog-rush, Schoenus nigricans does occur in a few places here and on the Ingleborough Complex it would appear that it has found a niche within the M10 community as the associated species are generally more characteristic of that vegetation type. At most sites there are well-marked transitions to a

range of other fen vegetation, predominantly, but not exclusively, to M14 *Schoenus nigricans – Narthecium ossifragum* mire and S24 *Phragmites australis – Peucedanum palustre* tall-herb fen in the lowlands. Alkaline fens may also occur with various types of swamp, wet grasslands (particularly various types of purple moor-grass *Molinia caerulea* grassland) and areas rich in rush *Juncus* species, as well as fen carr and, especially in the uplands, wet heath and acid bogs. This is the case both in the major wetland systems beside and near Malham Tarn and some of those that have formed within the basins within the plateau of the High Mark Polygonal Karst landscape or have formed on the slopes draining from it.

There is considerable variation between sites in the associated communities and the transitions that may occur. Such variation can be broadly classified by the geomorphological situation in which the fen occurs, namely: flood plain mire, valley mire, basin mire, hydroseral fen (i.e. as zones around open waterbodies) and spring fen. Another important source of ecological variation is altitude, with significant differences between lowland fens, which are rich in southern and continental species, and upland fens, which are rich in northern species.

Within Craven Limestone Complex SAC there are large fen systems at Great Close and Ha Mire, principally of the NVC type M10b *Carex dioica – Pinguicula vulgaris* mire, *Briza media – Primula farinosa* sub-community. They are exceptionally species-rich types with frequent bird's-eye primrose *Primula farinosa* and grass-of-Parnassus Parnassia palustris alongside rarities such as broad-leaved cottongrass *Eriophorum latifolium*, alpine rush *Juncus alpino-articulatus*, a single small colony of alpine bartsia *Bartsia alpina* and dwarf milkwort *Polygala amarella*. Where irrigation is more extensive there are transitions to M9a *Carex rostrata – Calliergon cuspidatum/ giganteum mire, Campylium stellatum – Scorpidium scorpioides* sub-community. This community is also developed extensively around the lagg of Tarn Moss, where there are transitions with M26b *Molinia caerulea – Crepis paludosa* mire, *Festuca rubra* sub-community and W3 *Salix pentandra – Carex rostrata* fen carr woodland. There are also extensive M10 *Carex dioica – Pinguicula vulgaris* spring-fed flush fens throughout the site, typically associated with calcareous grassland and limestone scars. There are several occurrences of flat sedge, *Blysmus compressus* in transitions from these flushes to rush pasture vegetation.

- **H8240. Limestone pavements**

Limestone pavements are outcrops of rock, typically horizontal or gently inclined, although a few are steeply inclined. The surface has been dissolved by water over millions of years into 'paving blocks', known as clints, with a complex reticulate pattern of crevices, known as grikes, between them. A range of calcareous rock, heath, grassland, scrub and woodland NVC types can occur on limestone pavement. The vegetation of limestone pavements is unusual because of the combinations of floristic elements, including woodland and woodland edge species, such as hart's-tongue *Phyllitis scolopendrium* and dog's mercury *Mercurialis perennis*. On the clint surfaces or the upper walls of the grikes there are plants of rocky habitats, such as wall-rue *Asplenium ruta-muraria* and maidenhair spleenwort *Asplenium trichomanes*. The grikes provide a shady, humid environment favouring woodland plants.

Grazing pressure is a key factor in determining ecological variation in limestone pavements. Where grazing pressure is low, woodland may cover the pavement and woodland vegetation may mask the limestone surface. Here only the massive areas of pavement may be exposed as clearings, e.g. the small occurrences within Bastow Wood. Where there is heavy grazing pressure, vegetation may be found only in the grikes, but, where grazing is lighter, dwarf trees, herbs and ferns may protrude from the grikes. Grikes that are about 60 cm deep provide shelter without unduly limiting light and are usually the best floristically.

Craven is one of four sites representing Limestone pavements in northern England. It is selected on the basis of its size and as an example of mid-altitude pavement. There is a wide range of transitions to other habitats, including 6210 semi-natural dry grasslands, 7230 Alkaline fens and 9180 *Tilio-Acerion* forests. Despite being accessible to grazing sheep, these pavements provide a refuge for downy currant *Ribes spicatum* and, occasionally, alpine cinquefoil *Potentilla crantzii* and baneberry *Actaea spicata*.

- **H9180. *Tilio-Acerion* forests of slopes, screes and ravines; Mixed woodland on base-rich soils associated with rocky slopes**

Tilio-Acerion ravine forests are woods of ash *Fraxinus excelsior*, wych elm *Ulmus glabra* and lime (mainly small-leaved lime *Tilia cordata* but more rarely large-leaved lime *T. platyphyllos*). Introduced sycamore *Acer pseudoplatanus* is often present and is a common part of the community in mainland Europe, where it is native. The habitat type typically occurs on nutrient-rich soils that often accumulate in the shady micro-climates towards the bases of slopes and ravines. Therefore it is found on calcareous substrates associated with coarse scree, cliffs, steep rocky slopes and ravines, where inaccessibility has reduced human impact. It often occurs as a series of scattered patches grading into other types of woodland on level valley floors and on slopes above, or as narrow strips along stream-sides. More extensive stands occur on limestone and other base-rich rocks.

This habitat type is ecologically variable, particularly with respect to the dominant tree species. To the north and west, ash and wych elm assume increasing importance in the canopy, and lime may be completely absent. Floristic differences due to variations in slope, aspect and nature of the substrate add to the diversity of the habitat. The ground flora can be very varied, but the following elements are usually present: fern banks (particularly hart's-tongue *Phyllitis scolopendrium*, soft shield-fern *Polystichum setiferum* and buckler-ferns *Dryopteris* spp.); stands of ramsons *Allium ursinum* in the moister zones; dog's mercury *Mercurialis perennis* and enchanter's-nightshade *Circaea* spp. on drier but still base-rich soils; wood avens *Geum urbanum*, and natural 'disturbance communities' comprising common nettle *Urtica dioica*, herb-Robert *Geranium robertianum* and cleavers *Galium aparine* associated with scree and cliff-bases. A wide range of other basiphilous herbs and grasses may occur within these stands of which perhaps most notable on the slopes by Malham Cove, Arnberg/Blue Scar and at Conistone Dibb are occurrences of Jacob's ladder, *Polemonium caeruleum*, the former of which is where the early naturalist John Ray first described both blue and white forms growing at the edge of the woodland feature.

The main NVC types found on site are:

W8 *Fraxinus excelsior – Acer campestre-Mercurialis perennis* woodland
W9 *Fraxinus excelsior – Sorbus aucuparia – Mercurialis perennis* woodland

Tilio-Acerion forests provide a habitat for a number of uncommon vascular plants, including, dark-red helleborine *Epipactis atrorubens*, as at Conistone Old Pasture (although at Malham-Arncliffe it currently appears to be restricted to a transition between limestone rocks and grassland as, despite the mention in the SSSI Citation about Field House Wood, nobody has actually knowingly seen or recorded it there since the early 1950s), and herb-Paris *Paris quadrifolia*. Many sites support notable bryophytes, in particular calcicoles associated with base-rich rock outcrops. Some localities have important assemblages of epiphytic lichens.
This habitat is an Annex 1 habitat and a qualifying feature for Craven Limestone Complex SAC but is not the primary reason for the site being designated.

Qualifying Species:

- **S1092 White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes***

The white-clawed crayfish *Austropotamobius pallipes* lives in a diverse variety of clean aquatic habitats but especially favours hard-water streams and rivers. A major threat to the native white-clawed crayfish is posed by the introduction of non-native species of crayfish, which have been farmed in Britain since the late 1970s. Soon after this, crayfish plague (a virulent disease caused by the fungus *Aphanomyces astaci*) broke out and spread rapidly, causing drastic losses of native crayfish in rivers in England. It is believed that this disease was introduced and is spread by the most frequently farmed species, the North American signal crayfish *Pacifastacus leniusculus*, a carrier of the disease. Crayfish plague can be introduced into a waterbody not only by entry of signal crayfish but also by water, fish or equipment that

has been in contact with signals. This greatly increases the risk to remaining white-clawed crayfish populations.

Signal and other non-native crayfish are larger and more aggressive than the native species and are able to produce more young. Consequently, the introduced species pose a threat not only because some are disease-carriers, but also through predation and competition with white-clawed crayfish. In Britain, signal crayfish are now well-established in the wild. It is only in areas free of disease that white-clawed crayfish are likely to survive in the future.

Craven Limestone Complex SAC supports populations of white-clawed crayfish *Austropotamobius pallipes* in the limestone streams feeding Malham Tarn, and in Malham Tarn itself. This site is well-isolated and is therefore an important refuge, unlikely to be invaded by non-native crayfish species.

- **S1163 Bullhead *Cottus gobio***

The bullhead *Cottus gobio* is a small bottom-living fish that inhabits a variety of rivers, streams and stony lakes. It appears to favour fast-flowing, clear shallow water with a hard substrate (gravel/cobble/pebble) and is frequently found in the headwaters of upland streams. However, it also occurs in lowland situations on softer substrates so long as the water is well-oxygenated and there is sufficient cover. It is not found in badly polluted rivers.

Craven Limestone Complex SAC represents one of the best locations for bullhead *Cottus gobio* in calcareous, upland becks and streams in the northern part of its range in England. The clean calcareous waters with their stony bottoms support good numbers of bullhead as does Malham Tarn.

- **S1902 Lady`s-slipper orchid *Cypripedium calceolus***

This orchid with large, solitary flowers with maroon-brown petals and a pouched yellow lip is found in open woodlands on calcareous soils, usually on north-facing slopes. In the UK all recorded sites appear to be scrubby woods of oak *Quercus spp*., ash *Fraxinus excelsior* and hazel *Corylus avellana* on steep rocky limestone slopes, although in mainland Europe it is found in various types of woodland to altitudes of over 2000 m. The plant is perennial, with stems rising from an underground rhizome.

Craven Limestone Complex SAC is the single remaining native site for Lady's-slipper orchid *Cypripedium calceolus*. Formerly reduced to a single plant, careful habitat management, together with hand-pollination of the few flowers that appear, and more recently re-establishment of plants from ex-situ propagation, has led to a steady increase in the size of the colony together with potential new sites on both Limestone SACs and adjacent SSSIs and former sites in Northern England.

Table 1: Supplementary Advice for Qualifying Features: H3140. Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.; Calcium-rich nutrient-poor lakes, lochs and pools

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**	Maintain the total extent of the H3140 feature within the site at approximately 58.38ha.	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. 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. 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. H3140. Hard oligo-mesotrophic waters has only been recorded within Malham-Arncliffe SSSI	Natural England (Various) Definitions of Favourable Condition for underpinning component SSSIs (Available on request from Natural England on request) This attribute will be periodically monitored as part of Natural England's site condition assessments
Structure and function (including its typical species)	**Invasive, non-native and/or introduced species**	Non-native species categorised as 'high-impact' in the UK under the Water Framework Directive should be either rare or absent but if present are causing minimal damage to the feature	Non-native species constitute a major threat to many open water systems. Impacts may be on the habitat itself (e.g. damage to banks and consequent siltation) or directly on characteristic biota (through predation, competition and disease), or a combination of these. For example, species such as signal crayfish have been responsible for much of the decline of native crayfish through competition, habitat damage and the introduction of crayfish plague. The UK Technical Advisory Group of the Water Framework Directive produces a regularly updated classification of aquatic alien species (plants and animals) according to their level of impact. In general high impact species are of greatest concern	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, King. D. 2014. Feeding ecology of an unusual still-water bullhead (*Cottus gobio* L.) population at Malham Tarn. MSc Dissertation, University College London APEM (2015) Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			but low or unknown impact species may be included in the target on a site-specific basis where there is evidence that they are causing a negative impact (for example high cover values or abundances). Those taxa considered likely to colonise lakes, are indicated by an 'L' in the UKTAG guidance. Examples of such high-impact species may include Water Fern, New Zealand pygmyweed and the zebra mussel.	Yorkshire ENSIS Ltd (2014) Interpretation of Water Framework Directive Data for CSM. Report for Natural England.
Structure and function (including its typical species)	**Macrophyte community structure**	Maintain a characteristic zonation of macrophyte vegetation; Chara beds should normally cover a minimum of 50% of the photic zone, although extent will be variable according to site and seasonal changes.	This is a strongly characteristic structural aspect of this habitat feature. In many cases Chara (stoneworts) will be the dominant feature. The site has a relatively rich aquatic flora, including two characteristic Chara species as well as a population of *P. lucens*. Abundance levels for Chara species are fluctuating.	
Structure and function (including its typical species)	**Macrophyte community structure**	Maintain maximum depth of plant colonisation. This is currently at least 3.4m at Malham Tarn. With water quality improvements it may reach maximum lake depth.	This is a strongly characteristic structural aspect of this habitat feature. It will be a response to water transparency, sediment type and disturbance. Water transparency and therefore maximum depth of colonisation is often impacted by nutrient enrichment, but can also be affected by the concentration of DOC.	
Structure and function (including its typical species)	**Macrophyte community structure**	Maintain a characteristic and well defined hydrosere associated with the water body where this is present	The hydrosere is the transition from fully aquatic to fully terrestrial habitat. This riparian habitat around the margins of the lake creates a buffer zone that can help protect the lake from a limited amount of sediment and nutrient inputs. It also increases habitat heterogeneity providing additional food sources and refugia and is of value in its own right.	
Structure and function (including its typical species)	**Physical structure - lake shoreline**	Maintain the natural shoreline of the lake.	Inclusion of hard engineering solutions to lake management may have detrimental effects on lake ecology, replacing near-natural substrates with man-made materials. Alteration of the shoreline may also result in changes in water movements within the lake, which would have effects on patterns of sediment deposition.	
Structure and function	**Physical structure -**	Maintain the natural and characteristic substrate for the	Marl production is desirable. Marl production may be reduced due to eutrophication, it can also be inhibited by high levels of	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
(including its typical species)	**lake substrate**	lake. The character and extent of types of substrate should be considered.	organic matter. The distribution of sediment particle size and organic content influences the biology of the lake and will affect the suitability of within-lake habitats for invertebrates and macrophytes, and fish spawning grounds. Increases in sediment loading from activities in the catchment area, including those on the lake shore, may result in the smothering of coarse sediments. Increased inputs of leaf litter, as a result of scrub encroachment, may also be cause for concern, as organic-rich sediments may be a poor rooting medium for macrophytes.	
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Maintain the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat; *Chara spp.* Floating Club-rush *Eleogiton fluitans;* Water-milfoil *Myriophyllum alterniflorum;* Calflora *Lythrum portula* Bulbous rush *Juncus bulbosus;;* Water dropworts *Oenanthe fistulosa;* Pondweed *Potamogeton spp;* Common water-moss *Fontanalis antipyretica,;* Stonewort *Nitella sp;* Common club-rush *Schoenoplectus lacustris ;* Common mare's tail *Hippuris vulgaris;* Bladderwort *Utricularia vulgaris;* Aquatic bladderwort *Utricularia australis;* Common water moss *Fontanalis antipyretica*	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; • **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. There may be natural fluctuations in the frequency and cover 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. 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**.**	This attribute will be periodically monitored as part of Natural England's site condition assessments

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			As the site is currently thought to be impacted there is an element of uncertainty with regard to the natural species assemblage of this site. Due to these uncertainties the list presented here is taken from a standard for the habitat. However, charophytes are undoubtedly influential species which help maintain clear water and have a role in marl production which are expected to be present in significant abundance at this site.	
Supporting processes (on which the feature relies)	**Water quality - phosphate**	Maintain stable nutrient levels appropriate for lake type. The maximum annual mean concentration of TP is 12 µg l-1 for Malham Tarn, as agreed between Natural England and the Environment Agency in 2014.	Increased loadings of P to a water body are likely to lead to higher algal biomass in the water column, which in turn can have significant impacts on the standing water ecosystem through, for example, competition with vascular plants for nutrients and light, changes in pH, oxygen depletion and production of toxins. Decreasing dissolved oxygen and increasing ammonia levels are associated with death and decay of algal blooms, as is a release of toxins from toxin-producing species. If palaeolimnological techniques or hindcast modelling have been employed to reconstruct natural background phosphorus concentrations for a particular lake, these can be used to set targets, although it may be necessary to accept a small deviation from these background conditions. Alternatively, historical water chemistry data may exist for individual lakes. Where existing, site-specific water column TP concentrations are consistently lower than the standard appropriate for the habitat type, a lower target should be applied to prevent deterioration from current status. There are diffuse water pollution issues at Malham Tarn which affect the tarn and possibly the fens. There is a concern about total phosphate levels in particular.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, Rose and Whitmore, J. 2012 Malham Tarn – Further investigations on the peat cliff stabilisation proposals. JBA Consulting. Available from Natural England. Joint Natural England / Environment Agency Designated Sites Lake Nutrient Targets 2010-17
Supporting processes (on which the feature relies)	**Water quality - nitrogen**	Maintain a stable nitrogen concentration, which will typically be between 1-2mg/l.	There is an increasing understanding that some standing waters are sensitive to nitrogen (N) enrichment and eutrophication may be driven by increases in N, but site-specific information is usually required to determine whether N	This attribute will be periodically monitored as part of Natural England's site condition assessments

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		This should be set at 1.5mg/l for Malham Tarn (agreed with EA)	or P is more important. Where P levels are significantly above their target values and there is evidence that the lake is N limited (for example by N levels falling to negligible levels in summer), N targets should be set in addition to P targets. We recommend that such targets should preferably be developed using site-specific information, but should be based around the threshold of 1-2mg/l identified by James *et al.* (2005). In this situation N targets should be used in combination with P targets to drive a management strategy for the lake that reduces all nutrient inputs.	
Supporting processes (on which the feature relies)	**Water quality - acidity**	Acidity levels should reflect unimpacted conditions - values of Acid Neutralising Capacity (ANC) should be >40µeq L^{-1} annual mean pH is typically pH 7.5-9.5 for oligo-mesotrophic hard lakes.	Changes in pH can alter the entire freshwater community present within a water body affecting all trophic levels. Potential causes of a shift in pH include air pollution and direct application of lime to the water column as an acidification amelioration strategy (this should not be carried out). Acidity levels should reflect unimpacted conditions - values of Acid Neutralising Capacity (ANC) considered to avoid significant impact on characteristic biota are laid out in the site's FCT (these are the same numerical values as used to protect high ecological status under the WFD in the UK). As a guide, pH 7.5-9.5 for oligo-mesotrophic hard lakes. Although, pH naturally fluctuates throughout the year, e.g. snow melt may lead to pulses of acid water, and increased plant biomass in summer may result in large fluctuations in pH, including daytime increases in pH values. Therefore pH is not used as a monitoring target, however its importance in affecting many in lake processes means that the pH of a water body should not be artificially altered.	
Supporting processes (on which the feature relies)	**Water quality - other pollutants**	Maintain water quality to good chemical status (i.e. compliance with relevant Environmental Quality Standards).	A wide range of pollutants may impact on habitat integrity depending on local circumstance. Good chemical status includes a list of EQSs for individual pollutants that are designed to protect aquatic biota with high levels of precaution.	
Supporting processes (on which the	**Water quality - dissolved oxygen**	Adequate dissolved oxygen levels for health of characteristic fauna. DO>7mg/l throughout the	As for species in terrestrial environments, dissolved oxygen (DO) is required for respiration by aquatic organisms. Anthropogenic activities leading to phytoplankton blooms and	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
feature relies)		year.	increased loadings of organic matter to lakes can cause decreases in the concentration of dissolved oxygen available to support the species present. Mean dissolved oxygen refers to DO being measured at 0.5m intervals throughout the entire water column where the water column is not stratified and measurements taken at 0.5 m intervals below the thermocline only where stratification occurs.	
Supporting processes (on which the feature relies)	**Water transparency**	Maintain the clarity of water at to the maximum depth of the lake	Water transparency is the major determinant of the depth of colonisation by macrophytes, therefore, it should not be reduced. This should allow plant colonisation to at least 3.5m, but if maximum depth of colonisation has previously been recorded at greater water depths this should be maintained. Increased nutrient loads leading to increased algal growth will reduce water transparency, disturbance of the sediment by water sports and bottom feeding fish such as carp and bream also increase turbidity and reduce water transparency. Increased sediment loads to a lake would also have this effect. As will increased concentrations of DOC which increase the colour of the water.	
Supporting processes (on which the feature relies)	**Water quality - algae**	Chlorophyll a concentration should comply with WFD high ecological status (annual mean 8 µg L^{-1}) and not have a negative impact on the ecosystem. Blooms of blue-green or green algae should not occur in low nutrient waters.	Chlorophyll is the pigment used for photosynthesis by plants, and the concentration of chlorophyll in the water column during the growing season therefore provides a good measure of the abundance of phytoplankton. Phytoplankton is an important driver of structure and function in lakes and high phytoplankton levels (algal blooms) are usually associated with nutrient enrichment. Characteristic and representative non-charophyte algal cover may be significant, but excessive growths of uncharacteristic, filamentous algae on lake substrate or macrophytes are indicative of nutrient enrichment. UKTAG Lake Assessment Methods: Phytoplankton. Chlorophyll a and Percentage Nuisance Cyanobacteria. Available online at: http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Biological%20Method	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			%20Statements/lake%20phytoplankton.pdf	
Supporting processes (on which the feature relies)	**Hydrology**	Maintain natural hydrological processes to provide the conditions necessary to sustain the feature within the site	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. This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. Hydrology influences lake ecosystem functioning in two ways: determining residence time (flushing) and water level fluctuations. Flushing of lakes is important for dilution and removal of nutrients and phytoplankton, and for reduction in sedimentation. The timing of different flushing rates within the year influences the biology of the lake. For example, reduced flushing in summer would encourage bloom conditions. Modifications of inflows and outlets or changes in hydrology, e.g. from flood control regimes, abstraction and gravel removal can lead to unnatural changes in lake levels. There should be no evidence of impact from lowered or artificially raised water levels. Evidence of lowered water levels include: loss of marginal or littoral vegetation or large areas of exposed lake substrate. Artificially raised water levels may result in the drowning of trees and other terrestrial vegetation above the lake shore. Recreational or industrial uses of lakes may result in areas of the shoreline and littoral being concreted or modified. Such areas should be limited to a very small proportion of the lake shore as assessed during the walk. Grazing or erosion from boat wash may reduce marginal vegetation cover.	Craven Limestone Complex cSAC and Ingleborough Complex cSAC NVC survey and condition assessment. Bullens Consultants, report to English Nature in 5 volumes, 2002. Available on request from Natural England. Malham Tarn Diffuse Water Pollution Plan. 2015. Available from Natural England
Supporting processes (on which the	**Sediment load**	Maintain the natural sediment load	Increases in the sediment load also increases nutrient loads to a site. Increases in non-calcium carbonate siltation could result from increased lake productivity, changes in catchment land-	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
feature relies)			use and drainage, lake level fluctuations, climatic fluctuations or changes in sewage treatment. Any elevated levels of dissolved organic carbon (DOC) are likely to originate from the peat. This has likely resulted in instating bank reinforcement works. However, these current barriers do not extend the full length of the peat cliff so some peat slumping is still currently likely until remedied, provided this is not induced due to land drainage.	
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 (www.apis.ac.uk).	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. 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 (NOx) 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. 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.	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).
Supporting processes (on which the feature relies)	**Functional connectivity /isolation**	Maintain the natural level of connectivity of the water body to other water bodies	The natural isolation of some standing water bodies can provide some protection from threats such as pollution and invasive species. Hydrological isolation can also lead to unique or diverse species assemblages this may be due to genetic	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			isolation or the absence of predators. These water bodies should have their isolated state maintained. In contrast other standing water bodies naturally rely on hydrological connectivity to other freshwater systems for water supply, and can support migratory species. Hydrological connectivity may also be important for geneflow, and habitat and species resilience. These water bodies should have their hydrological connectivity maintained. Connectivity between lakes and surrounding wetlands are important for resource protection and ecosystem functioning and are particularly at risk from drainage, water level stabilisation and shoreline modifications. Malham Tarn has a single inflow and outflow, but also interacts with the groundwater. Under normal conditions water sinks through the bed of Malham Water at the famous 'Water Sinks' whilst in drought the outflow might barely pass the public road south of the Tarn and after the most prolonged wet spell it can cascade over the Cove. Most of the flow re-emerges onto the surface at Aire Heads with just a small degree of cross-talk to the resurgence at the foot of Malham Cove which is mainly supplied by a large catchment extending from the stream draining Streets and sinking by an old mine chimney across Grizedales and Kirby Fell largely off the notified site.	
Structure and function (including its typical species)	**Fisheries**	Maintain a total projected estimate for biomass of total fish production at less than 200kg/ha (this should take into account the growth potential of the resident and stocked fish).	Fish communities may exert a strong influence on overall lake ecology and may cause or exacerbate eutrophication symptoms. Where fisheries are present it should be a balanced mixed fishery. There should be a presumption against stocking non-native species, carp and bream.	Fish stocking guidance Clarke. 2008. http://neintranettechnical/content/technical/topics/blog.asp?ID=8&BG=386&PG=1622&AT=5
Supporting processes (on which the feature relies)	**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	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	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			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.	
Version Control: 19th March 2019 - Natural England's Freshwater Senior Specialist - **Macrophyte community structure** attribute, description of the rich aquatic flora, including the two characteristic Chara species included; **Macrophyte community structure** attribute, site specific depth targets added and water transparency description included; **Macrophyte community structure** attribute, site specific depth targets added and water transparency description included; **Macrophyte community structure** attribute, hydrosere description re-worded; **Physical structure - lake substrate** attribute, Marl production description included; **Key structural, influential and/or distinctive species** attribute, natural species assemblage description expanded; **Water quality – acidity** attribute, site specific Acid Neutralising Capacity and pH added targets included; **Water quality - dissolved oxygen** attribute, deleted text on cyprinid waters target and dissolved organic carbon (DOC) description removed as Malham targets are high throughout the water column. The Environment Agency macrophyte surveys, measured oxygen throughout the depth of the water column. In summer show these surveys show there is the greatest risk of low oxygen levels and the data suggest the lake does not stratify and oxygen levels can be around 10 mg/l throughout the water column; **Water transparency** attribute, site specific target modified to read "Chlorophyll a concentration should comply with WFD high ecological status annual mean 8 µg L -1"; Sediment load attribute, description of DOC load included; **Functional connectivity /isolation** attribute, Hydrological connectivity description included.				
Variations from national feature-framework of integrity-guidance: 19th March 2019 - Natural England's Freshwater Senior Specialist – **Fisheries** and **Supporting off site habitat** attributes re-included due to specialist advice on relevance for this site.				

Table 2: 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**	Maintain the total extent of the feature to 5.37ha.	See the explanatory notes for this attribute above in Table 1 The extent of Calaminarian grassland is likely to shrink in area or decline in condition if there is no continuing disturbance. This Annex 1 habitat is a qualifying feature on this site but is not the primary reason for Craven Limestone Complex SAC to be designated. H6130 Calaminarian grassland is only found within Malham Arncliffe SSSI. The full extent of this feature in the SAC is unknown at this time and baseline mapping needs to be undertaken. The composition of this anthropogenic vegetation may be prone to natural change if metal concentrations decline, itself an inevitable part of natural process given all mining activity had ceased by the 1880's if not before. New sources of heavy metals are being entered into the habitat locally, apart from some inevitable rabbit disturbance there should be no unnecessarily damage the mine archaeology resource. Whilst relatively insoluble, lead and other heavy metal salts are not immune to the effects of leaching and new soil formation, especially over the timescales now involved	Natural England (Various) Definitions of Favourable Condition for underpinning component SSSIs (Available on request from Natural England on request) Craven Limestone Complex cSAC Habitats Directive Site Characterisation, Bullens, 2003. Available from Natural England Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, This attribute will be periodically monitored as part of Natural England's site condition assessments
Extent and distribution of the feature	**Spatial distribution of the feature within the site**	Maintain the distribution and configuration of the feature, including where applicable its component vegetation types, across the site	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. The distribution of H6130 Calaminarian grassland is very limited, only found locally around old mine shafts and areas of mining spoil provided this material contains low grade ore and/or smelt waste. Spoil or trial digs without low grade ore and / or smelt waste will not support this habitat.	This attribute will be periodically monitored as part of Natural England's site condition assessments

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the feature are referable to and characterised by the following National Vegetation Classification type: OV37 *Festuca ovina – Minuartia verna* community	This habitat feature will comprise a number of associated semi-natural vegetation types and their transitional zones, reflecting the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage) and vegetation management. In the UK these have been categorised by the National Vegetation Classification (NVC). Maintaining or restoring these characteristic and distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature. This will also help to conserve their typical plant species (i.e. the constant and preferential species of a community), and therefore that of the SAC feature, at appropriate levels (recognising natural fluctuations). Due to the scattered distribution of this feature, which on this site is only found on old mine spoil or the swards that have subsequently vegetated over it then it is difficult to ascertain exact community composition,	Craven Limestone Complex cSAC Habitats Directive Site Characterisation, Bullens, 2003. Available from Natural England
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Maintain the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat; Alpine pennycress *Thlaspi caerulescens;* Pyrenean Scurvygrass *Cochleria pyrenaica;* Mountain pansy *Viola lutea;* Sheep's Fescue *Festuca ovina;* Spring sandwort *Minuartia verna* Lichen assemblage	See table 1 above for full description.	This attribute will be periodically monitored as part of Natural England's site condition assessments
Structure and function (including its typical	**Vegetation: undesirable species**	Maintain the frequency/cover of the following undesirable species to within acceptable levels and prevent changes in surface	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	This attribute will be periodically monitored as part of Natural England's site condition assessments

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
species)		condition, soils, nutrient levels or hydrology which may encourage their spread.	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. Undesirable species include: Daisy *Bellis perennis*; Creeping thistle *Cirsium arvense*; Spear thistle *Cirsium vulgare*; Yorkshire fog *Holcus lanatus*; large docks (excluding *Common sorrel Rumex acetosa*); Perennial rye-grass *Lolium perenne*; Meadow buttercup *Ranunculus acris*; Creeping buttercup *Ranunculus repens*; Pearlwort *Sagina procumbens*; Common ragwort *Senecio jacobaea*; Common nettle *Urtica dioica*	
Structure and function (including its typical species)	**Vegetation community transitions**	Maintain the pattern of natural vegetation transitions	Transitions between adjacent but different vegetation communities are usually related to naturally-occurring changes in soil, aspect or slope. Such 'ecotones' retain characteristics of each bordering community and can add value in often containing species not found in the adjacent communities. Retaining such transitions can provide further diversity to the habitat feature, and support additional flora and fauna. Within the site H6130 Calaminarian grassland is often found in localised patches around old mining spoils, grading into calcareous or acidic grassland communities.	Craven Limestone Complex cSAC Habitats Directive Site Characterisation, Bullens, 2003. Available from Natural England
Structure and function (including its typical species)	**Soils, substrate and nutrient cycling**	Maintain the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, to within typical values for the habitat.	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 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.	This attribute will be periodically monitored as part of Natural England's site condition assessments
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	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.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. Some river shingle sites may be prone to flooding under extreme meteorological conditions. Depending on the frequency, timing and duration, such flooding has the potential to cause deleterious vegetation change and unfavourable condition.	
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.	Include only where applicable. 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.	
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	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. Such environmental changes may include changes in sea levels, 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. 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 and supporting habitats.	This attribute will be periodically monitored as part of Natural England's site condition assessments Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360].

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			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. 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.	
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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1'	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).
Supporting processes (on which the feature relies)	**Conservation measures**	Maintain or restore as appropriate the management measures (either within and/or outside the site boundary as appropriate) which are necessary to maintain the structure, functions and supporting processes associated with the feature	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. 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. Typical conservation measures Include grazing, cutting, scrub management, weed control. Retention of suitable land use infrastructure/patterns to enable site management e.g. pastoral livestock farming. Maintenance of local rabbit populations where applicable. Calaminarian sites have been lost over recent years through re-working for minerals, agricultural 'improvement' and scrub encroachment. The extent of calaminarian grassland is likely to shrink in area or decline in condition if there is no continuing	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			disturbance. The vegetation is generally sparse, although grazing by rabbits or sheep is often needed to prevent scrub from taking over. Restoration is an option on sites where it is constructive and practical. Soil clearance, tree and gorse removal are all positive methods of restoring the habitat. Grazing can be introduced on sites to improve condition.	
Version Control Advice last updated: N/A				
Variations from national feature-framework of integrity-guidance: The attribute relating to **Functional Connectivity to the Wider Landscape** has been removed as it is not considered relevant to this site. The ore deposits that support this feature are sparsely distributed on this site which prevents functional migration or genetic exchange within these isolated and static plant species/populations short of gardening and plant transportation. The objectives for some of the attributes listed above include both 'maintain' and 'restore' targets. This is because this SAC contains separate component sites which currently vary in their condition status. Overall, both objectives will currently be applicable to the SAC but these will differ between each component site depending on its particular circumstances. Natural England will be able to provide further advice on request.				

Table 3: Supplementary Advice for Qualifying Features: H6210. Semi-natural dry grasslands and scrubland facies: on calcareous substrates (Festuco-Brometalia); Dry grasslands and scrublands on chalk or limestone

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**	Maintain and where necessary restore the total extent of the feature to approximately 1597.83 hectares.	See the explanatory notes for this attribute above in Table 1' H6210. Semi-natural dry grasslands and scrubland facies is recorded in all 5 underpinning SSSIs. However, Kilnsey Flush SSSI supports very little of the habitat (see note at end of table). Whereas Malham-Arncliffe SSSI contains the largest extent of this habitat covering 1289 ha. The Calcareous grassland runs in an intricate mosaic within Conistone Old Pasture SSSI. Consequently the area figure may be an over-estimate of true target habitat given the mosaic nature of the site.	Natural England (Various) Definitions of Favourable Condition for underpinning component SSSIs (Available on request from Natural England on request) Natura 2000 Standard data form Available here This attribute will be periodically monitored as part of Natural England's site condition assessments
Extent and distribution of the feature	**Spatial distribution of the feature within the site**	Maintain the distribution and configuration of the feature, including where applicable its component vegetation types, across the site	A contraction in the range, or geographic spread, of the feature (and its component vegetation and typical species, plus transitional communities) across the site will reduce its overall area, the local diversity and variations in its structure and composition and may undermine its resilience to adapt to future environmental changes. This may also reduce and break up the continuity of a habitat within a site and how well its typical species are able to move around the site to occupy and use habitat. Such fragmentation can impact on their viability and the wider ecological composition of the Annex I habitat. Smaller fragments of habitat can typically support smaller and more isolated populations which are more vulnerable to extinction. These fragments also have a greater amount of open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to its interior. These conditions may not be suitable for some of the typical and more specialist species associated with the Annex I habitat feature.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the feature are referable to and characterised by the following National Vegetation Classification types: CG2 *Festuca ovina – Avenula pratensis* grassland CG9 *Sesleria albicans – Galium sterneri* grassland CG10 *Festuca ovina – Agrostis capillaris – Thymus praecox* grassland.	This habitat feature will comprise a number of associated semi-natural vegetation types and their transitional zones, reflecting the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage) and vegetation management. In the UK these have been categorised by the National Vegetation Classification (NVC). Maintaining or restoring these characteristic and distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature. This will also help to conserve their typical plant species (i.e. the constant and preferential species of a community), and therefore that of the SAC feature, at appropriate levels (recognising natural fluctuations).	Craven Limestone Complex cSAC Habitats Directive Site Characterisation, Bullens, 2003. Available from Natural England
Structure and function (including its typical species)	**Vegetation: proportion of herbs (including Carex spp)**	Maintain and restore as necessary the proportion of herbaceous species within the range 30%-90%	A high cover of characteristic herbs, including sedges (Carex species) is typical of the structure of this habitat type. A low percentage of herb cover may be a result of inappropriate grazing management, localised dominance by Moor Grass *Sesleria* sp, or the aspect of the land (such as northern facing slopes or natural mosaic habitats of neutral grassland) There is a notable drop out of all the larger or bulkier herbs with altitude with the likes of salad burnet and common rockrose being virtually unknown above 400 metres above sea level.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Maintain the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat; The constant and preferential of the CG2, CG9 and CG10 calcareous grassland NVC	See the explanatory notes for this attribute above in Table 1' Rock rose is abundant on thinner soils (key plant for northern brown argus butterfly *Aricia agestis*) and should be maintained, especially on the Littondale and Wharfedale slopes. Dropwort is very local, mainly the southern end of Conistone Old Pasture	Malham Tarn LTM Species Survey Data. 2013. Available from Natural England. This attribute will be periodically monitored as part of Natural England's site condition assessments.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		communities that contribute to the H6210 feature at this SAC.		
Structure and function (including its typical species)	**Vegetation: undesirable species**	Maintain 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; The percentage of vegetation cover made up, collectively, of *Bellis perennis* and/or *Ranunculus repens* should be less than 25%. Less than 1%, collectively, of vegetation cover should consist of undesirable species	There will be a range of undesirable or uncharacteristic species which, if allowed to colonise and spread, are likely to have an adverse effect on the feature's structure and function, including its more desirable typical species. These may include invasive non-natives such as Cotoneaster spp, or coarse and aggressive native species which may uncharacteristically dominate the composition of the feature. Weed encroachment, especially thistles, is reaching the limit of the acceptable threshold and on a local basis only, rabbits need controlling to prevent over grazing. Undesirable species include: False oat-grass *Arrhenatherum elatius*; Creeping thistle *Cirsium arvense*; Spear thistle *Cirsium vulgare*; Large docks (excluding *Rumex acetosa*) perennial ryegrass Lolium perenne; Common ragwort *Senecio jacobaea*; Common stinging nettle *Urtica dioica* Sections of the site are currently not grazed and Senecio needs intermittent controlling. Further bracken *Pteridium aquilinum* is an issue on a local basis particularly on more neutral and deeper soils in particular.	Lowland Grassland Management Handbook Chapter 10 http://webarchive.nationalarchives.gov.uk/20170302164022/http://publications.naturalengland.org.uk/publication/35034?category=42003 Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, This attribute will be periodically monitored as part of Natural England's site condition assessments
Structure and function (including its typical species)	**Vegetation community transitions**	Maintain the pattern of natural vegetation zonations/transitions	Transitions/zonations between adjacent but different vegetation communities are usually related to naturally-occurring changes in soil, aspect or slope. Such 'ecotones' retain characteristics of each bordering community and can add value in often containing species not found in the adjacent communities. Retaining such transitions can provide further diversity to the habitat feature, and support additional flora and fauna. Calcareous grassland is found extensively in mosaic throughout the site. Birch scrub and tiny pavement fragments forms a transition between Bastow Wood SSSI and within acid U4 mosaics within Conistone Old Pasture. Further CG2 community merges westwards into locally abundant areas of *Pteridium aquilinum* which, however, do not fully equate to U20	Craven Limestone Complex cSAC Habitats Directive Site Characterisation, Bullens, 2003. Available from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			since they lack species such as *Galium saxafile,* Where CG9 is transitional with neutral grassland and woodland communities *Sesleria* cover or frequency may be acceptable as low or Occasional rather than Frequent on parts of the site. Where this typical but nationally scare grass is naturally dominant the CG9 grassland may not meet attributes such as percentage of thatch, vegetation height, diverse structure at the micro-scale and species diversity, ditto any localised land that is relatively inaccessible for stock grazing.	
Structure and function (including its typical species)	**Soils, substrate and nutrient cycling**	Maintain and restore as appropriate the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, to within typical values for the habitat.	Soil is the foundation of basic ecosystem function and its properties strongly influence the colonisation, growth and distribution of those 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. On a local basis, large areas of bare ground have been recorded attributing to rabbits.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,
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 [adviser to add any details of such off-site habitat where known].	Include only where applicable. 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.	
Structure and function (including its	**Functional connectivity with wider**	Maintain the overall extent, quality and function of any supporting features within the	This recognises the potential need at this site to maintain or restore the connectivity of the site to its wider landscape in order to meet the conservation objectives. These connections	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
typical species)	**landscape**	local landscape which provide a critical functional connection with the site	may take the form of landscape features, such as habitat patches, hedges, watercourses and verges, outside of the designated site boundary which are either important for the migration, dispersal and genetic exchange of those typical species closely associated with qualifying Annex I habitat features of the site. These features may also be important to the operation of the supporting ecological processes on which the designated site and its features may rely. In most cases increasing actual and functional landscape-scale connectivity would be beneficial. Where there is a lack of detailed knowledge of the connectivity requirements of the qualifying feature, Natural England will advise as to whether these are applicable on a case by case basis.	
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	See the explanatory notes for this attribute above in Table 2	Malham Tarn LTM Species Survey Data. 2013. Available from Natural England. Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360].
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	See the explanatory notes for this attribute above in Table 1'	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).		
Supporting processes (on which the feature relies)	**Conservation measures**	Maintain the management measures (either within and/or outside the site boundary as appropriate) which are necessary to maintain the structure, functions and supporting processes associated with the feature	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. 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.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,
Version Control Advice last updated: N/A				
Variations from national feature-framework of integrity-guidance: The objectives for some of the attributes listed above include both 'maintain' and 'restore' targets. This is because this SAC contains separate component sites which currently vary in their condition status. Overall, both objectives will currently be applicable to the SAC but these will differ between each component site depending on its particular circumstances. Natural England will be able to provide further advice on request.				

Table 4: Supplementary Advice for Qualifying Features: H6410. Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*); Purple moor-grass meadows

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**	Maintain the total extent of the feature at approximately 26.63 hectares.	See the explanatory notes for this attribute above in Table 1' H6410. Molinia meadows **i**s found within the following component SSSIs: Kilnsey Flush SSSI and Malham-Arncliffe SSSI. However, due to the difficulty in separating this habitat with its scattered nature, the true extent figure may be under or overestimated.	Natural England (Various) Definitions of Favourable Condition for underpinning component SSSIs (Available on request from Natural England on request) Natura 2000 Standard data form Available here This attribute will be periodically monitored as part of Natural England's site condition assessments
Extent and distribution of the feature	**Spatial distribution of the feature within the site**	Maintain the distribution and configuration of the feature, including where applicable its component vegetation types, across the site	A contraction in the range, or geographic spread, of the feature (and its component vegetation and typical species, plus transitional communities) across the site will reduce its overall area, the local diversity and variations in its structure and composition, and may undermine its resilience to adapt to future environmental changes. This may also reduce and break up the continuity of a habitat within a site and how well its typical species are able to move around the site to occupy and use habitat. Such fragmentation can impact on their viability and the wider ecological composition of the Annex I habitat. Smaller fragments of habitat can typically support smaller and more isolated populations which are more vulnerable to extinction. These fragments also have a greater amount of open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to its interior. These conditions may not be suitable for some of the typical and more specialist species associated with the Annex I habitat feature.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the feature are referable to and characterised by the following National Vegetation Classification type: M26 *Molinia caerulea – Crepis paludosa* and any transitions with **herb-rich variations** of *M23 Juncus effusus/Acutiflorus and M25 Molinia caerulea – Potentilla erecta*	This habitat feature will comprise a number of associated semi-natural vegetation types and their transitional zones, reflecting the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage) and vegetation management. In the UK these have been categorised by the National Vegetation Classification (NVC). Maintaining or restoring these characteristic and distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature. This will also help to conserve their typical plant species (i.e. the constant and preferential species of a community), and therefore that of the SAC feature, at appropriate levels (recognising natural fluctuations).	This attribute will be periodically monitored as part of Natural England's site condition assessments
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Maintain the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat; The constant and preferential species of the M23, M25 and M26 fen meadow NVC communities that comprise the H6410 feature.	See the explanatory notes for this attribute above in Table 2	This attribute will be periodically monitored as part of Natural England's site condition assessments.
Structure and function (including its typical species)	**Vegetation: undesirable species**	Maintain 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.	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. Undesirable species include: Creeping thistle *Cirsium arvense;* Spear thistle *Cirsium vulgare;* Common sorrel *Rumex acetosa;* Creeping buttercup *Ranunculus repens;* Common nettle *Urtica Dioica*	Craven Limestone Complex cSAC Habitats Directive Site Characterisation, Bullens, 2003. Available from Natural England This attribute will be periodically monitored as part of Natural England's site condition assessments.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Vegetation community transitions**	Maintain the pattern of natural vegetation transitions	Transitions/zonations between adjacent but different vegetation communities are usually related to naturally-occurring changes in soil, aspect or slope. Such 'ecotones' retain characteristics of each bordering community and can add value in often containing species not found in the adjacent communities. Retaining such transitions can provide further diversity to the habitat feature, and support additional flora and fauna. Areas of transitions to H7230 Alkaline fens, H7110 Active raised bogs and some calcareous grassland exist within the SAC feature.	This attribute will be periodically monitored as part of Natural England's site condition assessments.
Structure and function (including its typical species)	**Soils, substrate and nutrient cycling**	Maintain the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, to within typical values for the habitat. For this feature, soil P index should typically be index 0 (< 9 mg l -1)	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 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.	
Structure and function (including its typical species)	**Water quality**	Where the feature is dependent on surface water and/or groundwater, maintain water quality and quantity to a standard which provides the necessary conditions to support the feature.	For many SAC features which are dependent on wetland habitats supported by surface and/or ground water, maintaining the quality and quantity of water supply will be critical, especially at certain times of year. Poor water quality and inadequate quantities of water can adversely affect the structure and function of this habitat type. Typically, meeting the surface water and groundwater environmental standards set out by the Water Framework Directive (WFD 2000/60/EC) will also be sufficient to support the achievement of SAC Conservation Objectives but in some cases more stringent standards may be needed. Further site-specific investigations may be required to establish appropriate water quality standards for the SAC.	
Structure and function	**Hydrology: Water table**	Maintain a hydrological regime that provides a sub-surface water	Defining and maintaining the appropriate hydrological regime is a key step in moving towards achieving the conservation	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
(including its typical species)		table during the summer (range -2 to -48 cm below ground level) and a winter water table ± at the surface. Inundation should be absent or only occasional to a minor degree in winter	objectives for this site and sustaining this feature. Changes in depth, duration, frequency, magnitude and timing of water supply can have significant implications for the assemblage of characteristic plants and animals present. This target is generic and as precise tolerances are not known, further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. Water levels in Malham Tarn were artificially raised in 1791 and may have contributed towards the development of this feature at that location. A return to more natural water levels may impact on this feature.	
Structure and function (including its typical species)	**Maintaining integrity of hydrological catchment**	Maintain the full range of hydrological/hydrogeological aspects of a site's catchment that contribute to its functioning and the maintenance of the feature	The movement, quality and distribution of water within a site's wider catchment and outside of the site's boundary will affect its ability to support this wetland habitat feature. Catchment size will vary. A site's water table and other hydrological aspects may be affected by changes in the use of the land surface, water abstraction, flood alleviation, development and mineral extraction in the wider catchment.	
Structure and function (including its typical species)	**Functional connectivity with wider landscape**	Maintain the overall extent, quality and function of any supporting features within the local landscape which provide a critical functional connection with the site	This recognises the potential need at this site to maintain or restore the connectivity of the site to its wider landscape in order to meet the conservation objectives. These connections may take the form of landscape features, such as habitat patches, hedges, watercourses and verges, outside of the designated site boundary which are either important for the migration, dispersal and genetic exchange of those typical species closely associated with qualifying Annex I habitat features of the site. These features may also be important to the operation of the supporting ecological processes on which the designated site and its features may rely. In most cases increasing actual and functional landscape-scale connectivity would be beneficial. Where there is a lack of detailed knowledge of the connectivity requirements of the qualifying feature, Natural England will advise as to whether these are applicable on a case by case	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			basis.	
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.	See the explanatory notes for this attribute above in Table 2	Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360].
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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1'	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).
Supporting processes (on which the feature relies)	**Conservation measures**	Maintain the management measures (either within and/or outside the site boundary as appropriate) which are necessary to maintain the structure, functions and supporting processes associated with the feature	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. 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. Conservation measures for this feature typically include grazing, cutting, scrub management, weed control, recreation/visitor management. Also covered is maintenance of surface drainage features such as drains, grips, gutters and foot drains. Retention of suitable land use infrastructure/patterns to enable site management e.g. pastoral livestock farming.	This attribute will be periodically monitored as part of Natural England's site condition assessments

Attributes	Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Version Control Advice last updated: N/A			
Variations from national feature-framework of integrity-guidance: N/A			

Table 5: Supplementary Advice for Qualifying Features: H7110. Active raised bogs *

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**	Maintain the total extent of the feature at between 40-53.26 hectares, whilst accepting no deterioration from current extent.	See the explanatory notes for this attribute above in Table 1 For this feature, the term 'Bog' is taken here to be the peat deposit together with typical bog vegetation, irrespective of the precise nature and condition of that vegetation. 'Lagg fen' comprises both peat deposit and vegetation, irrespective of nature and condition. H7110. Active raised bogs have only been recorded on one unit within Malham-Arncliffe SSSI.	Natural England (Various) Definitions of Favourable Condition for underpinning component SSSIs (Available on request from Natural England on request) Natura 2000 Standard data form Available here This attribute will be periodically monitored as part of Natural England's site condition assessments Craven Limestone Complex cSAC Habitats Directive Site Characterisation, Bullens, 2003. Available from Natural England
Extent and distribution of the feature	**Spatial distribution of the feature within the site**	Maintain the distribution and configuration of the feature, including where applicable its component vegetation types, across the site	A contraction in the range, or geographic spread, of the feature (and its component vegetation and typical species, plus transitional communities) across the site will reduce its overall area, the local diversity and variations in its structure and composition, and may undermine its resilience to adapt to future environmental changes. This may also reduce and break up the continuity of a habitat within a site and how well its typical species are able to move around the site to occupy and use habitat. Such fragmentation can impact on their viability and the wider ecological composition of the Annex I habitat. Smaller fragments of habitat can typically support smaller and more isolated populations which are more vulnerable to extinction. These fragments also have a greater amount of open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to	This attribute will be periodically monitored as part of Natural England's site condition assessments.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			its interior. These conditions may not be suitable for some of the typical and more specialist species associated with the Annex I habitat feature. Within Craven Limestone Complex SAC, H7110. Active raised bogs have only been recorded in Malham Tarn Moss.	
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the feature are referable to and characterised by the following National Vegetation Classification type: M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire	This Annex I feature may comprise a number of characteristic but different, naturally occurring vegetation types, which will depend on the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage), any maritime influence and grazing intensity and management. Maintaining or restoring these distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature.	This attribute will be periodically monitored as part of Natural England's site condition assessments Craven Limestone Complex cSAC Habitats Directive Site Characterisation, Bullens, 2003. Available from Natural England Malham Tarn LTM Species Survey Data. 2013. Available from Natural England.
Structure and function (including its typical species)	**Structural diversity**	Maintain the full range of typical structural features associated with the feature at this site, e.g. vegetation cover, surface patterning and hydrological zonations.	Active raised bogs in particular show varying degrees of structural variation and surface patterning reflecting hydrological gradations (which may be natural or the result of previous damage). These can occur at macro and micro scales across the habitat and include alternative aquatic and terrestrial surface features, such as pools and hummocks, and terrestrial features such as ridges and hollows. These features will support distinctive patterns of bog vegetation, and so will be sensitive to changes in topography and hydrology. These can be modified or disrupted by activities such as drainage, burning, grazing, vehicular access and peat digging. *Molinia caerulea* is very abundant and vegetation transitions occur within the periphery of the raised bog. The mire further grades partially into a drier neutral grassland zone.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan. Bullens, 2003. NVC Survey & Condition Assessment. Craven Limestone Complex cSAC - Malham-Arncliffe SSSI (Management Units 1 - 39). Available from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Invasive, non-native and/or introduced species**	Ensure invasive and introduced non-native species are either rare or absent, but if present are causing minimal damage to the feature	Invasive or introduced non-native species can be a serious potential threat to the structure and function of these habitats, because they are able to exclude, damage or suppress the growth of their associated typical species, reduce structural diversity of the habitat and prevent the natural regeneration of characteristic site-native species. Once established, the measures to control such species may also impact negatively on the features of interest (e.g. use of broad spectrum pesticides).	
Structure and function (including its typical species)	**Hydrology**	At a site, unit and/or catchment level restore natural hydrological processes to provide the conditions necessary to sustain the feature within the site	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. This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. The water table on Tarn Moss is monitored through a series of dipwells. Work took place between 2013 and 2015 to re-profile the peat cliff at the edge of Tarn Moss and install a wave-break in the Tarn to protect the peat edge. This was because the edge of Tarn Moss was being eroded by wave action from the artificially high water levels in Malham Tarn which was leading to direct loss of bog, and increased drying at the edge of the peat body. It also increased the sediment loading to the tarn. Bunds were created on Tarn Moss in summer 2014 to help to keep the peat wet.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, National Trust March 2014 Final Report into Phase 1 of Peat Cliff Project National Trust March 2015 Final Report into Phase 2 of Peat Cliff Project
Structure and function (including its typical species)	**Water chemistry**	Maintain the surface water and groundwater supporting the hydrology of the rain-fed bog at a low nutrient status.	This habitat type is predominantly rain-fed and should be naturally low in nutrients to sustain its characteristic bog communities and associated typical species. Any sources of water which contributes to supporting the bog habitat, including the margins of the bog and the lagg (the peripheral zone around the bog), should similarly be lacking in nutrients.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Soils, substrate and nutrient cycling**	Maintain the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, to within typical values for the habitat.	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 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.	
Structure and function (including its typical species)	**Adaptation and resilience**	Restore 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	See the explanatory notes for this attribute above in Table 2	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360].
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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1 The presence of more nutrient or base tolerant species of *Sphagnum* such as *S. fimbriatum* are found well away from carr / lagg zones and on ombrotrophic locations may be evidence that significant nitrogen deposition is occurring.	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).
Supporting processes (on which the feature relies)	**Functional connectivity with wider landscape**	Maintain the overall extent, quality and function of any supporting features within the local landscape which provide a critical functional connection with the site	This recognises the potential need at this site to maintain or restore the connectivity of the site to its wider landscape in order to meet the conservation objectives. These connections may take the form of landscape features, such as habitat patches, hedges, watercourses and verges, outside of the designated site boundary which are either important for the	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			migration, dispersal and genetic exchange of those typical species closely associated with qualifying Annex I habitat features of the site. These features may also be important to the operation of the supporting ecological processes on which the designated site and its features may rely. In most cases increasing actual and functional landscape-scale connectivity would be beneficial. Where there is a lack of detailed knowledge of the connectivity requirements of the qualifying feature, Natural England will advise as to whether these are applicable on a case by case basis.	
Supporting processes (on which the feature relies)	**Conservation measures**	Maintain the management measures (which are necessary to maintain the structure, functions and supporting processes associated with the feature	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. 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.	This attribute will be periodically monitored as part of Natural England's site condition assessments
Version Control Advice last updated: N/A				
Variations from national feature-framework of integrity-guidance: The attribute **Supporting Off-site Habitat** has been removed as it is not considered relevant at this site.				

Table 6: Supplementary Advice for Qualifying Features: H7220. Petrifying springs with tufa formation (Cratoneurion); Hard-water springs depositing lime *

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**	Maintain the total extent of the H7220 feature. The extent of this feature is currently unquantified due to the small scattered nature of the species contained within his feature.	See the explanatory notes for this attribute above in Table 1 Please note that this feature is very poorly mapped on SACs, SSSIs and in the wider countryside. Within Craven Limestone Complex SAC, H7220 Petrifying springs with tufa formation (Cratoneurion) is only recorded as present within Malham-Arncliffe SSSI.	Natural England (Various) Definitions of Favourable Condition for underpinning component SSSIs (Available on request from Natural England on request) Bullens, 2003. NVC Survey & Condition Assessment. Craven Limestone Complex cSAC - Malham-Arncliffe SSSI (Management Units 1 - 39). Available from Natural England
Extent and distribution of the feature	**Spatial distribution of the feature within the site**	Maintain the distribution and configuration of the feature, including where applicable its component vegetation types, across the site.	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.	
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the feature are referable to and characterised by the following National Vegetation Classification types: M37 *Cratoneuron commutatum – Festuca rubra* spring M38 *Cratoneuron commutatum – Carex nigra* spring	This habitat feature will comprise a number of associated semi-natural vegetation types and their transitional zones, reflecting the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage) and vegetation management. In the UK these have been categorised by the National Vegetation Classification (NVC). Maintaining or restoring these characteristic and distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature. Appropriate NVC types (i.e. those indicating adequate supply of low nutrient base rich water and appropriate management regime) will normally be the M37 and M38 communities, although it should be recognised the vegetation types associated with the feature have yet to be comprehensively described.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Appropriate NVC types (i.e. those indicating adequate supply of low nutrient base rich water and appropriate management regime) will normally be the M37 and M38 communities, although it should be recognised the vegetation types associated with the feature have yet to be comprehensively described. The petrifying spring habitat is highly localised in occurrence within the Craven Limestone Complex SAC, but where it does occur it is species-rich with abundant bryophytes, sedges and herbs.	
Structure and function (including its typical species)	**Invasive, non-native and/or introduced species**	Ensure invasive and introduced non-native species are either rare or absent, but if present are causing minimal damage to the feature	Invasive or introduced non-native species can be a serious potential threat to the structure and function of these habitats, because they are able to exclude, damage or suppress the growth of their associated typical species, reduce structural diversity of the habitat and prevent the natural regeneration of characteristic site-native species. Once established, the measures to control such species may also impact negatively on the features of interest (e.g. use of broad spectrum pesticides). This habitat is only found very localised and scattered, with little known little data available on condition or threats such as encroachment of undesirable species.	
Structure and function (including its typical species)	**Presence/ cover of woody species**	Maintain a low cover of woody species in flushes or springs; low Salix sp. acceptable more than 5m from edge of spring/flush feature.	Native trees and shrubs occur naturally on bog and fen surfaces but an abundance of scrub and trees on bogs and fens is sometimes regarded as detrimental because they are indicators and perpetrators of drying out and may cause damage to vegetation structure through shading effects. Birch, pine, willow and rhododendron (an invasive non-native species) are the main species of concern. The seeds of most invasive woody species are wind dispersed, so trees are able to establish on raised bog and fen surfaces. This habitat is only found very localised and scattered, with little known little data available on condition or threats such as	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			presence / cover of species.	
Structure and function (including its typical species)	**Browsing and grazing by herbivores**	Maintain appropriate levels of grazing	These characteristically small-scale habitat features are often preferentially grazed and may be vulnerable to significant overgrazing pressure associated with the management of the wider local landscape.	
Structure and function (including its typical species)	**Exposed substrate**	Maintain a low cover of exposed substrate of between 5% & 25% across feature.	For this wetland habitat type, maintaining some continuous extent of exposed, open ground surface is required to support the establishment and supply of those component species which often rely on wet and sparsely-vegetated conditions. The open nature and sometimes skeletal nature of the substrate supporting these features requires a higher, upper threshold than for some other wetlands.	
Structure and function (including its typical species)	**Integrity of tufa features**	Ensure that no more than 1% of the vegetation in which tufa is visible is showing signs of damage or disturbance	Tufa is a fragile soft porous rock composed of calcium carbonate which is deposited as lime-rich subterranean water issues out from springs and chemically interacts with the air. It is easily damaged or disturbed. The springs where tufa may be found may be the only source of surface water for grazing livestock required for the management of other features; this may lead to concentration of poaching around the spring areas. The need to minimise disturbance to tufa needs to be balanced with requirements of livestock.	
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Maintain the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat; The constant and preferential species of the M37 and M38 NVC communities that comprise the H7220 feature.	See notes for this attribute in table 1 above. For this feature appropriate (i.e. those indicating a low nutrient status environment appropriate management regime) bryophytes and vascular plant species taken from core community constants and preferentials. This Annex 1 habitat is not well-defined in the JNCC guidance and includes a wide range of 'transitional' wetland vegetation. In addition this habitat type has not been comprehensively surveyed on site so exact species composition and presence are not yet strictly defined.	Bullens, 2003. NVC Survey & Condition Assessment. Craven Limestone Complex cSAC - Malham-Arncliffe SSSI (Management Units 1 - 39). Available from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Hydrology**	At a site, unit and/or catchment level maintain natural hydrological processes to provide the conditions necessary to sustain the feature within the site	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. This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. Wheeler et al. (2009) provide range and mean for summer & winter water levels for those wetland NVC types constituting Annex 1 habitats. This provides a rough guide to appropriate levels, but it is critical that individual sites and their needs are considered as there is considerable variation within the NVC communities listed and recorded water levels.	Wheeler, BD, Shaw, SC, & Tanner, KA (2009). Wetland Framework for Impact Assessment at Statutory Sites. EA Science report. McBride et al (2011) Fen Management Handbook
Structure and function (including its typical species)	**Water chemistry**	Maintain the low nutrient status of irrigating water, ensuring it is rich in base ions, particularly calcium.	UKTAG (2012) provides threshold values for nitrate concentration in groundwaters for different wetland types. The threshold values will mainly be used in the characterisation of GWDTE status for the WFD, primarily as a risk screening tool, to assess if sites are 'at risk' or 'not at risk' from groundwater mediated nutrient pressure. Due to the complex cycling of nutrients within many GWDTE, these threshold values are less well suited for application within sites but rather just to groundwater that is directly feeding the site.	
Structure and function (including its typical species)	**Hydrology**	Maintain a High piezometric head and permanently high water table (allowing for natural seasonal fluctuations).	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. Reduction in piezometric head may reduce or prevent the precipitation of tufa, which is a key component of this habitat type. Tufa is a fragile soft porous rock composed of calcium carbonate which is deposited as lime-rich subterranean water issues out from springs and chemically interacts with the air.	

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	See the explanatory notes for this attribute above in Table 2.	This attribute will be periodically monitored as part of Natural England's site condition assessments Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360].
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.	Include only where applicable. 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.	
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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1'	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. Available here.
Supporting processes (on which the	**Conservation measures**	Maintain the management measures which are necessary to maintain the structure,	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	This attribute will be periodically monitored as part of Natural England's site condition

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
feature relies)		functions and supporting processes associated with the feature	can be provided by contacting Natural England. 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.	assessments
Version Control Advice last updated: N/A				
Variations from national feature-framework of integrity-guidance: N/A				

Table 7: Supplementary Advice for Qualifying Features: H7230. Alkaline fens; Calcium-rich springwater-fed fens

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**	Maintain the total extent of the feature at approximately 94.071 hectares.	See the explanatory notes for this attribute above in Table 1 H7230 Alkaline Fens is recorded only on Kilnsey Flush SSSI (0.15ha) and Malham-Arncliffe SSSI – M10 only (93.921ha).	Natural England (Various) Definitions of Favourable Condition for underpinning component SSSIs (Available on request from Natural England on request) This attribute will be periodically monitored as part of Natural England's site condition assessments Bullens, 2003. NVC Survey & Condition Assessment. Craven Limestone Complex cSAC - Malham-Arncliffe SSSI Available from Natural England
Extent and distribution of the feature	**Spatial distribution of the feature within the site**	Maintain the distribution and configuration of the feature, including where applicable its component vegetation types, across the site.	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.	
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the feature are referable to and characterised by the following National Vegetation Classification type: M9 *Carex rostrata – Calliergonella cuspidata / Calliergon giganteum* mire	This habitat feature will comprise a number of associated semi-natural vegetation types and their transitional zones, reflecting the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage) and vegetation management. In the UK these have been categorised by the National Vegetation Classification (NVC). Maintaining or restoring these characteristic and distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature.	Haycock and Jay Associates (2016). Alkaline fens of Craven Limestone Complex SAC. 2016. Available from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		M10 *Carex dioica – Pinguicula vulgaris* mire	Mire alkaline fen exists in a decreasing amount as part of a mosaic with M15 and other acid wet heath communities. On site, Alkaline fen features were recorded in intimate mosaics and close associations with transition mire communities including M4, M9b and S27 and open water habitats. Within Kilnsey Flush SSSI Bullens 2003 Survey did not assess and attribute communities to any of the wetland vegetation on site.	
Structure and function (including its typical species)	**Invasive, non-native and/or introduced species**	Ensure invasive and introduced non-native species are either rare or absent, but if present are causing minimal damage to the feature Ideally less than 10% of the vegetation cover should consist of, collectively, *Juncus effusus, Phragmites australis,* and *Deschampsia cespitosa*	Invasive or introduced non-native species can be a serious potential threat to the structure and function of these habitats, because they are able to exclude, damage or suppress the growth of their associated typical species, reduce structural diversity of the habitat and prevent the natural regeneration of characteristic site-native species. Once established, the measures to control such species may also impact negatively on the features of interest (e.g. use of broad spectrum pesticides).	Alkaline fens of Craven Limestone Complex SAC. 2016. Haycock and Jay Associates. Available from Natural England
Structure and function (including its typical species)	**Presence/ cover of woody species**	Maintain a low cover of woody species of not more than 10% scrub/tree cover. No woody species in flushes or springs; low Salix sp acceptable more than 5m from edge of spring/flush feature.	Native trees and shrubs occur naturally on bog and fen surfaces but an abundance of scrub and trees on bogs and fens is sometimes regarded as detrimental because they are indicators and perpetrators of drying out and may cause damage to vegetation structure through shading effects. Birch, pine, willow and rhododendron (an invasive non-native species) are the main species of concern. The seeds of most invasive woody species are wind dispersed, so trees are able to establish on raised bog and fen surfaces. In absence of grazing, succession may take place whereby alkaline fen becomes M25 which is then colonised by *Salix repens* and *S. cinerea*, in time these areas may become wet woodland.	Alkaline fens of Craven Limestone Complex SAC. 2016. Haycock and Jay Associates. Available from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Browsing and grazing by herbivores**	Maintain appropriate levels of grazing,	These habitat features are often preferentially grazed and may be vulnerable to significant overgrazing pressure associated with the management of the wider local landscape. Where grazing animals have been removed from the alkaline flush area then alkaline fen features are rapidly over whelmed and important small scale features are potentially lost. Where large herbivores have not been present for some time sedge growth becomes rank, and features tend to dry out.	Alkaline fens of Craven Limestone Complex SAC. 2016. Haycock and Jay Associates. Available from Natural England McBride A, Diack I, Droy N, Hamill B, Jones P, Schutten J, Skinner A, and Street M. 2011. *The Fen Management Handbook* Scottish Natural Heritage, Perth.
Structure and function (including its typical species)	**Exposed substrate**	Maintain the exposure of the substrate to appropriate levels, which will typically be between 5% & 25% across feature.	For this wetland habitat type, maintaining some continuous extent of exposed, open ground surface is required to support the establishment and supply of those component species which often rely on wet and sparsely-vegetated conditions. The open nature and sometimes skeletal nature of the substrate supporting these features requires a higher upper threshold than for some other wetlands. Moderate poaching of springs and alkaline fen may be highly beneficial through the creation of small pockets of bare ground and pools in hoof prints providing a locus for *Pellia endiviifolia* and small liverworts on the sides of poach marks, and areas for vegetative reproduction by *Palustriella* sp, *Scorpidium* sp and *Cratoneuron filicinum* in the pools. Poaching also creates bare ground for seeds to germinate and fragments of bryophytes and vascular plants are readily moved from flush to flush attached to hooves and in mud	Alkaline fens of Craven Limestone Complex SAC. 2016. Haycock and Jay Associates. Available from Natural England This attribute will be periodically monitored as part of Natural England's site condition assessments
Structure and function (including its typical species)	**Integrity of tufa features**	Ensure that no more than 1% of the vegetation in which tufa is visible is showing signs of damage or disturbance	Tufa is a fragile soft porous rock composed of calcium carbonate which is deposited as lime-rich subterranean water issues out from springs and chemically interacts with the air. It is easily damaged or disturbed. The springs where tufa may be found may be the only source of surface water for grazing livestock required for the management of other features; this may lead to concentration of poaching around the spring areas. The need to minimise disturbance to tufa needs to be balanced with requirements of	Alkaline fens of Craven Limestone Complex SAC. 2016. Haycock and Jay Associates. Available from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			livestock.	
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Maintain the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat. The constant and preferential species of the M9 and M10 NVC communities that comprise the H7230 feature on this site	See the explanatory notes for this attribute above in Table 1 The list of typical species given 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 or if our understanding of the term 'typical species' changes. For this feature appropriate (i.e. those indicating a low nutrient status environment appropriate management regime) bryophytes and vascular plant species taken from core community constants and preferentials. This Annex 1 habitat is not well-defined in the JNCC guidance and includes a wide range of 'transitional' wetland vegetation.	Haycock and Jay Associates. (2016) Alkaline fens of Craven Limestone Complex SAC. Available from Natural England Natural England (2006) Definition of Favourable Condition - Malham-Arncliffe SSSI (Available on request from Natural England)
Structure and function (including its typical species)	**Hydrology**	At a site, unit and/or catchment level (as necessary, maintain natural hydrological processes to provide the conditions necessary to sustain the feature within the site, including a high piezometric head and permanently high water table (allowing for natural seasonal fluctuations).	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. This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. Wheeler et al. (2009) provide range and mean for summer & winter water levels for those wetland NVC types constituting Annex 1 habitats. This provides a rough guide to appropriate levels, but it is critical that individual sites and their needs are considered as there is considerable variation within the NVC communities listed and recorded water levels.	
Structure and function (including its typical species)	**Water chemistry**	Maintain the low nutrient status of irrigating water, ensuring it is rich in base ions, particularly calcium.	UKTAG (2012) provides threshold values for nitrate concentration in groundwaters for different wetland types. The threshold values will mainly be used in the characterisation of GWDTE status for the WFD, primarily as a risk screening tool, to assess if sites are 'at risk' or 'not at risk' from groundwater	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			mediated nutrient pressure. Due to the complex cycling of nutrients within many GWDTE, these threshold values are less well suited for application within sites but rather just to groundwater that is directly feeding the site.	
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	See the explanatory notes for this attribute above in Table 2	Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360].
Structure and function (including its typical species)	**Functional connectivity with wider landscape**	Maintain the overall extent, quality and function of any supporting features within the local landscape which provide a critical functional connection with the site	This recognises the potential need at this site to maintain or restore the connectivity of the site to its wider landscape in order to meet the conservation objectives. These connections may take the form of landscape features, such as habitat patches, hedges, watercourses and verges, outside of the designated site boundary which are either important for the migration, dispersal and genetic exchange of those typical species closely associated with qualifying Annex I habitat features of the site. These features may also be important to the operation of the supporting ecological processes on which the designated site and its features may rely. In most cases increasing actual and functional landscape-scale connectivity would be beneficial. Where there is a lack of detailed knowledge of the connectivity requirements of the qualifying feature, Natural England will advise as to whether these are applicable on a case by case basis. H7320 alkaline fens occurs in intimate mosaics often with wet	This attribute will be periodically monitored as part of Natural England's site condition assessments

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			heath and open water habitats and as these habitats extend out with the SAC boundary it is likely that alkaline fens extends within the surrounding habitat as well.	
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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1	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).
Supporting processes (on which the feature relies)	**Conservation measures**	Maintain the management measures (either within and/or outside the site boundary as appropriate) which are necessary to maintain the structure, functions and supporting processes associated with the feature	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. 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. Management of this habitat can conflict, e.g. cattle grazing may benefit calcareous grassland and limestone pavement in particular, but have a negative impact on flushes and mires, depending on grazing levels and ground conditions**.** However a certain level of grazing is important to keep the alkaline fen areas open. **Th**erefore, careful consideration of best conservation practices needs to be achieved on a case and location by case basis.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, Haycock and Jay Associates. (2016) Alkaline fens of Craven Limestone Complex SAC. Available from Natural England
Version Control Advice last updated: N/A				
Variations from national feature-framework of integrity-guidance: N/A				

Table 8: Supplementary Advice for Qualifying Features: H8240. Limestone pavements *

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**	Maintain the total extent of the feature of at least 215.89 hectares. The extent of this feature can be difficult to accurately map as it often occurs win a mosaic with calcareous grassland.	See the explanatory notes for this attribute above in Table 1' H8240 Limestone Pavements are found within Bastow Woods SSSI (c.1 ha); Conistone Old Pasture SSSI (c.14.5 ha) and Malham-Arncliffe SSSI (200.39 ha). Decline in the area of the feature will be evident by damage to the pavements and removal of pavement clints. Damaged pavement is distinctively white and lichen free, shows irregular surface features, infilled grikes and rubble or broken stone.	Natural England (Various) Definitions of Favourable Condition for underpinning component SSSIs (Available on request from Natural England on request) This attribute will be periodically monitored as part of Natural England's site condition assessments Natura 2000 Standard data form Available here
Extent and distribution of the feature	**Spatial distribution of the feature within the site**	Maintain the distribution and configuration of the feature, including where applicable its component vegetation types, across the site	A contraction in the range, or geographic spread, of the feature (and its component vegetation and typical species, plus transitional communities) across the site will reduce its overall area, the local diversity and variations in its structure and composition, and may undermine its resilience to adapt to future environmental changes. This may also reduce and break up the continuity of a habitat within a site and how well its typical species are able to move around the site to occupy and use habitat. Such fragmentation can impact on their viability and the wider ecological composition of the Annex I habitat. Smaller fragments of habitat can typically support smaller and more isolated populations which are more vulnerable to extinction. These fragments also have a greater amount of open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to its interior. These conditions may not be suitable for some of the typical and more specialist species associated with the Annex I habitat feature.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Limestone pavements have additional protection measures to prevent stone removal. Fragmentation has been a serious issue in the past through stone removal, less so now, but given the limited extent of this feature even small scale illegal removal can be a problem. Increase in wooded extent can cause fragmentation of more open communities.	
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the feature are referable to and characterised by the following National Vegetation Classification type: Community mosaic present	This habitat feature will comprise a number of associated semi-natural vegetation types and their transitional zones, reflecting the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage) and vegetation management. In the UK these have been categorised by the National Vegetation Classification (NVC). Maintaining or restoring these characteristic and distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature. This will also help to conserve their typical plant species (i.e. the constant and preferential species of a community), and therefore that of the SAC feature, at appropriate levels (recognising natural fluctuations). A range of calcareous rock, heath, grassland, scrub and woodland NVC types can occur on limestone pavement. The NVC does not include limestone pavement vegetation per se but a number of NVC types may be present, usually in fragmentary form. The most distinctive to this habitat is probably OV38 *Gymnocarpium robertianum - Arrhenatherum elatius* community. Other types include OV39 *Asplenium trichomanes - A. ruta-muraria community* OV40 *Asplenium viride - Cystopteris fragilis* community CG9 *Sesleria albicans - Galium sterneri* grassland CG10 *Festuca ovina - Agrostis capillaris - Thymus praecox* grassland, W9 *Fraxinus excelsior - Sorbus aucuparia - Mercurialis perennis* woodland. Limestone pavements have two characteristic forms: wooded and open. Where a dense canopy cover results in mosses covering the clint tops the pavement is considered to be wooded. Different targets apply for wooded and open	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			pavements. In some cases a pavement feature may contain a mosaic of both types.	
Structure and function (including its typical species)	**Vegetation community transitions**	Maintain the pattern of natural vegetation zonations/transitions.	Transitions between adjacent but different vegetation communities are usually related to naturally-occurring changes in soil, aspect or slope. Such 'ecotones' retain characteristics of each bordering community and can add value in often containing species not found in the adjacent communities. Retaining such transitions can provide further diversity to the habitat feature, and support additional flora and fauna. The vegetation of limestone pavements is unusual because of the combinations of floristic elements, including woodland and woodland edge species, such as hart's-tongue *Phyllitis scolopendrium* and dog's mercury *Mercurialis perennis*. On the clint surfaces or the upper walls of the grikes there are plants of rocky habitats, such as wall-rue *Asplenium ruta-muraria* and maidenhair spleenwort *Asplenium trichomanes*. The grikes provide a shady, humid environment favouring woodland plants.	
Structure and function (including its typical species)	**Invasive, non-native and/or introduced species**	Ensure invasive and introduced non-native species are either rare or absent, but if present are causing minimal damage to the feature	Invasive or introduced non-native species can be a serious potential threat to the structure and function of these habitats, because they are able to exclude, damage or suppress the growth of their associated typical species, reduce structural diversity of the habitat and prevent the natural regeneration of characteristic site-native species. Once established, the measures to control such species may also impact negatively on the features of interest (e.g. use of broad spectrum pesticides). Non-native species may include exotic pines and beech. With the arrival and rapid spread of ash die-back, *Hymenocyphus fraxineus*, sycamore *Acer pseudoplatanus* is now considered an acceptable naturalised species, especially as it can tolerate the exposed mid-altitude nature of the majority of pavements on the SAC. In addition the high visitor number to the limestone pavements may pose some threat due to spread of invasive plant seeds on	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			footwear and clothing from external areas	
Structure and function (including its typical species)	**Vegetation composition: bracken**	Maintain and restore as appropriate the cover of dense bracken at or to less than 10% of the feature	The spread of bracken *Pteridium aquilinum* is a problem on many lowland heathlands. The unpalatable nature and density of bracken as a tall-herb fern, and its decomposing litter, can smother and shade out smaller and more characteristic heathland vegetation. Usually active management of bracken is required to reduce or contain its cover across this habitat feature. But stands of this fern has also some nature conservation value, for example on sites where fritillary butterflies occur and utilise bracken litter habitat. Bracken encroachment is affecting limestone pavements within Craven Limestone Complex SAC although on a local basis only. If the affected pavement has a good fern flora it may ecologically more desirable to accept the situation than treat it. Whilst the rarer fritillaries are absent here dark green fritillary appears to be successfully expanding its range.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, Thom.T .2009. Yorkshire Dales Limestone Country Project: LIFE2002NAT/UK/8539REV After-LIFE Conservation Action Plan for Limestone Country Available here
Structure and function (including its typical species)	**Vegetation: undesirable species**	Maintain 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;	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. Weed encroachment, especially thistles, is reaching the limit of the acceptable threshold within many sections of pavement. Further on a localised case by case basis, ragwort would benefit from control. Undesirable species may include Creeping thistle *Cirsium arvense*; Spear thistle *Cirsium vulgare*, Bramble *Rubus fruticosus*, Common stinging nettle *Urtica dioica.* Ragwort *Senecio jacobaea*	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, This attribute will be periodically monitored as part of Natural England's site condition assessments Natural England (2006) Definition of Favourable Condition - Bastow Woods SSSI FCT. (Available from Natural England on request)

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Wooded pavement: vegetation structure and distribution.**	On wooded pavements, maintain the presence of seedlings, saplings, mature trees and shrubs comprising site-native species in wooded areas, with open space typically present over 10%-30% of the pavement vegetation by area.	Structural variation will often be a result of woodland management but can also be natural as an inherent feature of the structure and the function of the pavement itself. Yew or juniper stands can be (and should be) dense and continuous. Overgrazing by sheep, deer and rabbits may have a negative impact upon tree and shrub species on these limestone pavements**.** A lack of nearby trees in some localities, may limit the potential for tree regeneration. *Hymenocyphus fraxineus* (ash die-back) has been noted on ash regeneration on some limestone pavements within the SAC; young ash trees are particularly vulnerable to this disease. The presence of scrub and woody cover needs to be balanced with the need to protect archaeological interests within the site which may be damaged by the establishment of trees or scrub	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,
Structure and function (including its typical species)	**Open pavement**	On open pavements, restore scrub and woody cover to between 5% and 25] of the pavement feature	A proportionate amount of scrub and woody cover (including Juniper which is largely absent from this site) increases the structural variety of pavement vegetation, provides more vegetation edge for plant species and results in higher invertebrate interest. The presence of scrub and woody cover needs to be balanced with the need to protect archaeological interests within the site which may be damaged by the establishment of trees or scrub	
Structure and function (including its typical species)	**Soils, substrate and nutrient cycling**	Maintain the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, to within typical values for the habitat.	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 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. .	
Structure and function	**Adaptation and resilience**	Maintain the feature's ability, and that of its supporting processes,	See the explanatory notes for this attribute above in Table 2	Natural England 2014. Craven Limestone Complex SAC Site

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
(including its typical species)		to adapt or evolve to wider environmental change, either within or external to the site	A major threat to limestone pavement has been quarrying and removal of surface limestone for use as decorative rockery stone. This threat has now been addressed through protective legislation (Limestone Pavement Orders). Climate change may also be leading to the loss of key species associated with the more upland and montane elements of calcareous rocky slopes and limestone pavement.	Improvement Plan, Thom.T .2009. Yorkshire Dales Limestone Country Project: LIFE2002NAT/UK/8539REV After-LIFE Conservation Action Plan for Limestone Country Available here Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Maintain the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat; The constant and preferential species of the NVC communities that comprise the H8420 feature present within the SAC. See explanatory notes for further information. Vascular plant assemblage including: dark-red helleborine *Epipactis atrorubens* and alpine cinquefoil *Potentilla crantzii*	See the explanatory notes for this attribute above in Table 1 Limestone pavement may support a variety of NVC communities, usually in fragmentary form. The vegetation of the limestone pavements can exist in a continuous gradation from a barren 'stony desert' with plants only surviving in the deepest grikes, to mature ash woodland with a rich and diverse ground flora. The most distinctive vegetation community associated with this habitat is OV38 *Gymnocarpium robertianum - Arrhenatherum elatius community*. Other community types present may include OV39 *Asplenium trichomanes - A. ruta-muraria* community OV40 *Asplenium viride - Cystopteris fragilis* community CG9 *Sesleria albicans - Galium sterneri* grassland CG10 *Festuca ovina - Agrostis capillaris - Thymus praecox* grassland, W9 *Fraxinus excelsior - Sorbus aucuparia - Mercurialis perennis* woodland.	This attribute will be periodically monitored as part of Natural England's site condition assessments Craven Limestone Complex cSAC and Ingleborough Complex cSAC NVC survey and condition assessment. Bullens Consultants, report to English Nature in 5 volumes, 2002. Available on request from Natural England.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1	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. Available here.
Supporting processes (on which the feature relies)	**Conservation measures**	Maintain the management measures (either within and/or outside the site boundary as appropriate) which are necessary to maintain the structure, functions and supporting processes associated with the feature	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. 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. Although rock based this is a fragile habitat and susceptible to human activity. Threats to the habitats include heavy grazing, nitrogen deposition, rock extraction and increase in non-native and undesirable species. Management measures will differ between open, scrubby and wooded pavement. Grazing is one of the main conservation measures used on the H8240 limestone pavements. Cattle grazing is often more appropriate as they rarely venture onto the rocky pavement areas leaving these in a lightly grazed state while grazing other vegetation communities within the habitat mosaics. H8240 often occurs within a mosaic of other habitats and the management of these areas need to be considered on a case by case basis depending upon the demands of the species and habitats present.	
Version Control Advice last updated: N/A				
Variations from national feature-framework of integrity-guidance: N/A				

Table 9: Supplementary Advice for Qualifying Features: H9180. Tilio-Acerion forests of slopes, screes and ravines; Mixed woodland on base-rich soils associated with rocky slopes *

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**	Maintain the total extent of the feature at approximately 50 hectares.	See the explanatory notes for this attribute above in Table 1'. For this feature tree roots (particularly of veteran trees) can extend a considerable distance beyond the boundary of the site - they can be impacted by soil compaction (such as caused by vehicles or construction works); agricultural operations or other soil disturbance (like trenches); and agro chemicals or other chemicals which get into the soil. Any loss of woodland area - whether at the edge or in the middle of a site will reduce the core woodland area where woodland conditions are found - these support significant assemblages of species dependent on woodland conditions (e.g. lichens and bryophytes - being one example). Loss of any woodland area which fragments a site into different parts will clearly disturb the movement of species between the remaining parts of the woodland. H9180. *Tilio-Acerion* forests of slopes, screes and ravines is found within Bastow Woods SSSI (31.52ha), Conistone Old Pasture SSSI (0.7ha) and Malham-Arncliffe SSSI (16.87ha). However, please note that H9180. *Tilio-Acerion* forests of slopes, screes and ravines is fairly localised throughout the site, often growing in fairly inaccessible locations resulting in limited available survey data.	Natural England (Various) Definitions of Favourable Condition for underpinning component SSSIs (Available on request from Natural England on request) This attribute will be periodically monitored as part of Natural England's site condition assessments
Extent and distribution of the feature	**Spatial distribution of the feature within the site**	Maintain the distribution and configuration of the feature, including where applicable its component vegetation types, across the site	A contraction in the range, or geographic spread, of the feature (and its component vegetation and typical species, plus transitional communities) across the site will reduce its overall area, the local diversity and variations in its structure and composition, and may undermine its resilience to adapt to future environmental changes. This may also reduce and break up the continuity of a habitat within a site and how well its typical species are able to move	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			around the site to occupy and use habitat. Such fragmentation can impact on their viability and the wider ecological composition of the Annex I habitat. Smaller fragments of habitat can typically support smaller and more isolated populations which are more vulnerable to extinction. These fragments also have a greater amount of open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to its interior. These conditions may not be suitable for some of the typical and more specialist species associated with the Annex I habitat feature. H9180. *Tilio-Acerion* forests of slopes, screes and ravines is very localised throughout the three underpinning SSSI, often being restricted to inaccessible areas	
Structure and function (including its typical species)	**Vegetation community composition**	Ensure the component vegetation communities of the feature are referable to and characterised by the following National Vegetation Classification types: A mosaic of W8 *Fraxinus excelsior - Acer campestre - Mercurialis perennis* woodland W9 *Fraxinus excelsior – Sorbus aucuparia – Mercurialis perennis* woodland	This habitat feature will comprise a number of associated semi-natural vegetation types and their transitional zones, reflecting the geographical location of the site, altitude, aspect, soil conditions (especially base-status and drainage) and vegetation management. In the UK these have been categorised by the National Vegetation Classification (NVC). Maintaining or restoring these characteristic and distinctive vegetation types, and the range of types as appropriate, will be important to sustaining the overall habitat feature.	Craven Limestone Complex cSAC and Ingleborough Complex cSAC NVC survey and condition assessment. Bullens Consultants, report to English Nature in 5 volumes, 2002.
Structure and function (including its typical species)	**Vegetation structure - canopy cover**	Maintain an appropriate tree canopy cover across the feature, which will typically be between 40-90% of the site	Canopy cover is the overall proportion of vegetative cover consisting of any woody layer ranging from established regeneration to mature and veteran stages. Woodland canopy density and structure is important because it affects ecosystem function and in particular microclimate, litterfall, soil moisture,	This attribute will be periodically monitored as part of Natural England's site condition assessments

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			nutrient turnover and shading; this in turn influences the composition of plants and animals in lower vegetation layers and soil. Open canopies with just scattered trees will have less of a woodland character and reduced diversity of woodland-dependent species (although they may be still be important as a form of woodland-pasture). Completely closed canopies across the whole woodland are not ideal either however, as they cast heavier shade and support fewer species associated with edges, glades and open grown trees, and have little space where tree regeneration could occur. In general, the woodland canopy of this feature should provide a core of woodland interior conditions with some open and edge habitat as well.	
Structure and function (including its typical species)	**Vegetation structure - open space**	Maintain areas of permanent/temporary open space within the woodland feature, typically to cover approximately 10% of area	Woodland structure includes variations in age, tree form, layering, the distribution and abundance of open space and dead wood. It plays a critical role in woodland ecosystem functioning. The targets set within this attribute should reflect the most appropriate structure for the woodland feature on a particular site, taking account of its known interest, history, past management and the landscape context. Having some open, sunlit and largely tree-less areas as part of the woodland community is often important to facilitate natural tree and shrub regeneration and also to provide supporting habitat for specialist woodland invertebrates, birds, vascular and lower plants. Such open space can be permanent or temporary and may consist of managed grazed areas, linear rides and glades, or naturally-produced gaps caused by disturbance events such as windthrow/fire/tree falling over/snow damage. In coppiced stands a lower canopy cover (of standards) can be accepted, as will also be the case in the wood pasture. A proportion of gaps at any one time may develop into permanent open space; equally some current permanent open space/glades may in time regenerate to closed canopy.	Natural England (2006) Definition of Favourable Condition - Malham-Arncliffe SSSI (Available on request from Natural England) Natural England (2006) Definition of Favourable Condition - Bastow Woods SSSI (Available on request from Natural England)

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Vegetation structure - old growth**	Maintain the extent and continuity of undisturbed, mature/old growth stands comprising at least 20% of the feature at any one time) and the assemblages of veteran and ancient trees and typically >10 trees per hectare.	Good woodland structure includes variations in age, tree form, layering, the distribution and abundance of open space and dead wood. It plays a critical role in woodland ecosystem functioning. The targets set within this attribute should reflect the most appropriate structure for the woodland feature on a particular site, taking account of its known interest, history, past management and the landscape context. For this habitat type, old or over-mature elements of the woodland are particularly characteristic and important features, and their continuity should be a priority.	Natural England (2006) Definition of Favourable Condition - Malham-Arncliffe SSSI (Available on request from Natural England)
Structure and function (including its typical species)	**Vegetation structure - dead wood**	Maintain the continuity and abundance of standing or fallen dead and decaying wood, typically relatively undisturbed mature/old growth stands or a scatter of large trees allowed to grow to over-maturity/death on site (e.g. a minimum of 10% of the woodland or 5-10 trees per ha). A minimum of 3 fallen lying trees >20 cm diameter per ha and 4 trees per ha allowed to die standing.	Woodland structure includes variations in age, tree form, layering, the distribution and abundance of open space and dead wood. It plays a critical role in woodland ecosystem functioning. The targets set within this attribute should reflect the most appropriate structure for the woodland feature on a particular site, taking account of its known interest, history, past management and the landscape context.	This attribute will be periodically monitored as part of Natural England's site condition assessments.
Structure and function (including its typical species)	**Vegetation structure - age class distribution**	Maintain at least 3 age classes (pole stage/ medium/ mature) spread across the average life expectancy of the commonest trees.	A distribution of size and age classes of the major site-native tree and shrub species that indicate the woodland will continue in perpetuity, and will provide a variety of the woodland habitats and niches expected for this type of woodland at the site in question.	This attribute will be periodically monitored as part of Natural England's site condition assessments.
Structure and function (including its typical	**Vegetation structure - shrub layer**	Maintain an understorey of shrubs cover 20 - 60% of the stand area (this will vary with light levels and site objectives on	Woodland structure includes variations in age, tree form, layering, the distribution and abundance of open space and dead wood. It plays a critical role in woodland ecosystem functioning.	English Nature (2005) Definition of Favourable Condition - Conistone Old Pasture SSSI (Available on request from

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
species)		a case by case basis)	The targets set within this attribute should reflect the most appropriate structure for the woodland feature on a particular site, taking account of its known interest, history, past management and the landscape context. Within Craven Limestone SAC, woodland frequently grades into scrub and has varying ground flora often in more open areas of CG9/MG5 species.	Natural England)
Structure and function (including its typical species)	**Vegetation structure - woodland edge**	Maintain a graduated woodland edge into adjacent semi-natural open habitats, other woodland/wood-pasture types or scrub.	Woodland edge is defined as being the transitional zone between the forest feature and adjacent but different habitat types - the best woodland edges will have a varied structure in terms of height and cover. Many typical forest species make regular use of the edge habitats for feeding due to higher herb layer productivity and larger invertebrate populations. Grasslands / arable fields managed with high doses of agro-chemicals could potentially not allow this gradation of woodland edge and could have other impacts on the integrity of the site (pollution/ nutrient enrichment etc.).	
Structure and function (including its typical species)	**Adaptation and resilience**	Maintain the resilience of the feature by ensuring a diversity of site-native trees (at least 4 site native tree species) e.g. ash/ small-leaved lime/ hazel/ alder/ sycamore/ rowan/ bird cherry/ birch) is present across the site.	See the explanatory notes for this attribute above in Table 2 Within Craven Limestone SAC, there is potential loss of the main native tree species by *Chalara* (ash die-back). .	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360 .
Structure and function	**Browsing and grazing by**	Maintain browsing at a (low) level that allows well developed	Herbivores, especially deer, are an integral part of woodland ecosystems. They are important in influencing woodland	Natural England 2014. Craven Limestone Complex SAC Site

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
(including its typical species)	**herbivores**	understorey with no obvious browse line, & lush ground vegetation with some grazing sensitive species evident (bramble, ivy etc.), and tree seedlings and sapling common in gaps.	regeneration, composition and structure and therefore in shaping woodland wildlife communities. In general, both light grazing and browsing is desirable to promote both a diverse woodland structure and continuous seedling establishment. Short periods with no grazing at all can allow fresh natural regeneration of trees, but a long-term absence of herbivores can result in excessively dense thickets of young trees which shade out ground flora and lower plant species. However, heavy grazing by deer or sheep prevents woodland regeneration, and can cause excessive trampling and/or poaching damage, canopy fragmentation, heavy browsing, barkstripping and a heavily grazed sward.	Improvement Plan, This attribute will be periodically monitored as part of Natural England's site condition assessments
Structure and function (including its typical species)	**Regeneration potential**	Maintain the potential for sufficient natural regeneration of desirable trees and shrubs; typically tree seedlings of desirable species (measured by seedlings and <1.3m saplings - above grazing and browsing height) should be visible in sufficient numbers in gaps, at the wood edge and/or as regrowth as appropriate No more than 20% of areas regenerated by planting. All planting material of locally native stock. No planting in sites where it has not occurred in the last 15 years.	The regeneration potential of the woodland feature must be maintained if the wood is to be sustained and survive, both in terms of quantity of regeneration and in terms of appropriate species. This will Include regeneration of the trees and shrubs from saplings or suckers, regrowth from coppice stools or pollards, and where appropriate planting. Browsing and grazing levels must permit regeneration at least in intervals of 5 years every 20. The density of regeneration considered sufficient is less in parkland sites than in high forest. Regeneration from pollarding of veteran trees should be included where this is happening. The density of regeneration considered sufficient is less in the wooded pasture areas of the site than in the high forest; in coppice most of the regeneration will be as stump regrowth. The establishment of *Hymenoscyphus fraxineus* ash die back, throughout the SAC and wider Dales may impact on the viability of ash regeneration as spore density is greatest within a metre or two of the ground. Loss of young saplings is often the first sign the disease is firmly established on a site.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, This attribute will be periodically monitored as part of Natural England's site condition assessments
Structure and function (including its	**Key structural, influential**	Maintain the abundance of the typical species listed below to enable each of them to be a	See the explanatory notes for this attribute above in Table 1	This attribute will be periodically monitored as part of Natural England's site condition

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
typical species)	**and/or distinctive species**	viable component of the Annex 1 habitat; The constant and preferential species of the W8 and W9 woodland NVC communities that comprise the H9180 feature within this SAC		assessments. Craven Limestone Complex cSAC and Ingleborough Complex cSAC NVC survey and condition assessment. Bullens Consultants, report to English Nature in 5 volumes, 2002.
Structure and function (including its typical species)	**Invasive, non-native and/or introduced species**	Ensure invasive and introduced non-native species are either rare or absent, but if present are causing minimal damage to the feature	Invasive or introduced non-native species are a serious potential threat to the biodiversity of native and ancient woods, because they are able to exclude, damage or suppress the growth of native tree, shrub and ground species (and their associated typical species), reduce structural diversity and prevent the natural regeneration of characteristic site-native species. Once established, the measures to control such species may also impact negatively on the features of interest (e.g. use of broad spectrum pesticides). Such species can include Rhododendrons, snowberry, Japanese knotweed, giant hogweed and Himalayan balsam, for example. Similarly, this would include pheasants, rabbits and non-native invertebrate 'pest' species.	
Structure and function (including its typical species)	**Soils, substrate and nutrient cycling**	Maintain the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, to within typical values for the habitat.	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 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.	
Supporting processes (on which the feature relies)	**Functional connectivity with wider landscape**	Maintain the overall extent, quality and function of any supporting features within the local landscape which provide a	This recognises the potential need at this site to maintain or restore the connectivity of the site to its wider landscape in order to meet the conservation objectives. These connections may take the form of landscape features, such as habitat	Natural England (2006) Definition of Favourable Condition - Bastow Woods SSSI (Available on request from Natural England)

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		critical functional connection with the site	patches, hedges, watercourses and verges, outside of the designated site boundary which are either important for the migration, dispersal and genetic exchange of those typical species closely associated with qualifying Annex I habitat features of the site. These features may also be important to the operation of the supporting ecological processes on which the designated site and its features may rely. In most cases increasing actual and functional landscape-scale connectivity would be beneficial. Where there is a lack of detailed knowledge of the connectivity requirements of the qualifying feature, Natural England will advise as to whether these are applicable on a case by case basis. A dynamic balance between wood pasture, calcareous grassland and more shaded woodland needs maintaining with the emphasis on the wood pasture element in future management agreements. Further functional connectivity of this feature depends partially upon these management practices. There is a future risk of land abandonment particularly on woodland parcels which are smaller or difficult to manage, or on rough ground, due to practicalities of management.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,
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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1'	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 (Available here)
Supporting processes (on which the feature relies)	**Hydrology**	At a site, unit and/or catchment level maintain natural hydrological processes to provide the conditions necessary to sustain the feature within the site	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.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts. This is included as disruption/ damage to hydrological processes could be caused by activities at some distance from the site boundary. E.g. through extraction of ground or surface waters; diverting or daming river channels; pollution of water source; channel alignment that disrupts natural geomorphological processes; tunnelling etc.	
Supporting processes (on which the feature relies)	**Illumination**	Ensure artificial light is maintained/to a level which is unlikely to affect natural phenological cycles and processes to the detriment of the feature and its typical species at this site.	Woodland biodiversity has naturally evolved with natural patterns of light and darkness, so disturbance or modification of those patterns can influence numerous aspects of plant and animal behaviour. For example, light pollution (from direct glare, chronically increased illumination and/or temporary, unexpected fluctuations in lighting) can affect animal navigation, competitive interactions, predator-prey relations, and animal physiology. Flowering and development of trees and plants can also be modified by un-natural illumination which can disrupt natural seasonal responses. Currently there is no available data on the effect of illumination on H9180. Tilio-Acerion forests of slopes, screes and ravines.	
Version Control Advice last updated: N/A				
Variations from national feature-framework of integrity-guidance: N/A				

Table 10: Supplementary Advice for Qualifying Features: S1092. *Austropotamobius pallipes*; White-clawed (or Atlantic stream) crayfish

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Population (of the feature)	**Population abundance**	Restore the abundance of the population to a level which equates or exceeds the baseline population-size known or estimated at or soon after the time of SAC designation whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	This will ensure there is a viable population of the feature which is being maintained at or increased to a level that contributes as appropriate to its Favourable Conservation Status across its natural range in the UK. Due to the dynamic nature of population change, the target-value given for the population size or presence of this feature is considered to be the minimum standard for conservation/restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size or presence has significantly changed as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is designated, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account in any assessment. Unless otherwise stated, the population size or presence will be that measured using standard methods, such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. Whilst we will endeavour to keep these values as up to date as possible, local Natural England staff can advise that the figures	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request. Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			stated are the best available.	
Population (of the feature)	**Population health**	Maintain an absence of non-native crayfish species from the site and the catchment surrounding the site	Once non-native crayfish species (such as signal, red-swamp and spiny-cheeked crayfish) are established in a waterbody, native populations of crayfish may be eliminated rapidly by them through direct competition for food, predation or the transfer of disease. These species can also cause physical damage to supporting habitat. The presence of non-native species within or close to the SAC poses a risk of adversely affecting the abundance and health of the feature. No non-native species were identified during the most recent surveys at Malham Tarn. Signal Crayfish have not been found at Malham Tarn or within its small catchment, nor are there any records within some 5km radius if the Tarn/ Catchment. Signal crayfish are found close to and possibly/probably within the SAC boundary but further surveys are needed to confirm numbers. Further, signal crayfish populations are also found very nearby the SAC in the River Wharfe catchment, the River Skirfare and it is highly likely that they have spread to Cowside Beck that flows within the SAC boundary. Signal crayfish are also present within the River Aire catchment at Skipton and at the SAC boundary in White Beck at Kilnsey Crag. These present a risk of both spread of non-native species and spread of crayfish plague.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014 Scientific Report 413500. Natural England, Available from Natural England on request.
Population (of the feature)	**Population health**	Maintain an absence of individuals within the site infected with crayfish plague or porcelain disease	Non-native crayfish species (such as signal crayfish) carry a fungal infection called the crayfish plague (*Aphanomyces astaci*), which is lethal to European crayfish (including our native white-clawed crayfish) and has resulted in their eradication from a number of waters in England. The presence of this disease within the native crayfish population, either within or close to the SAC, may adversely affect the abundance and health of the feature.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			The risk of the transfer of crayfish plague has reduced since 2002 when stocking of brown trout was stopped.	
Population (of the feature)	**Population health**	Ensure human activities within or around the site do not pose a significant risk of plague transfer	Non-native crayfish species (such as signal crayfish) carry a fungal infection called the crayfish plague (*Aphanomyces astaci*), which is lethal to European crayfish (including our native white-clawed crayfish) and has resulted in their eradication from a number of waters in England. Human activities, such as angling and fish farming, is able to facilitate the spread of non-native species and the spread of this disease if legislative controls and best management practice are not followed. Contamination by un-disinfected fishing equipment currently presents the only major risk of introducing crayfish plague. Off-site, the Environment Agency has worked to establish a crayfish ark site at Threshfield, which could be important in terms of conservation of populations in the wider area, and protection from invasive species and plague.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.
Supporting habitat: extent and distribution	**Distribution of supporting habitat**	Maintain the distribution and continuity of the feature and its supporting habitat, including where applicable its component vegetation types and associated transitional vegetation types, across the site	A contraction in the range, or geographic spread, of the feature (and its component vegetation) across the site will reduce its overall area, the local diversity and variations in its structure and composition, and may undermine its resilience to adapt to future environmental changes. Contraction may also reduce and break up the continuity of a habitat within a site and how well the species feature is able to occupy and use habitat within the site. Such fragmentation may have a greater amount of open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to its interior. These conditions may not be suitable for this feature and this may affect its viability. Malham Tarn has only one significant inflow, which enters from the north west; the only other surface flow being restricted to a number of small seeps. The limestone geology also contributes	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014 Scientific Report 413500. Natural England, Available from Natural England on request. Bradley, P. 2001. White-clawed crayfish (*Austropotamobius pallipes*) at Craven Limestone Complex SAC, North Yorkshire. Proceeding of Past, present, future. Monitoring and Managing Change at Malham Tarn. Available from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			significant amounts of ground water to the site. The outflow was dammed in the late 18th Century and a weir installed, raising the original lake level by approximately 1.2 m.	
Supporting habitat: extent and distribution	**Extent of supporting habitat**	Maintain the total extent of the habitats which support the feature	In order to contribute towards the objective of achieving an overall favourable conservation status of the feature at a UK level, it is important to maintain or if appropriate restore the extent of supporting habitats and their range within this SAC. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending on the nature, age and accuracy of data collection, and may be subject to periodic review in light of improvements in data. Malham-Arncliffe SSSI is the only underpinning SSSI within Craven Limestone Complex SAC that supports populations of white-clawed crayfish *Austropotamobius pallipes*. White-clawed crayfish are found in the limestone streams feeding Malham Tarn, and in Malham Tarn itself.	Species Accounts - S1092. *Austropotamobius pallipes*; White-clawed (or Atlantic stream) crayfish. JNCC. Available here
Supporting habitat: structure/ function	**Biological connectivity**	The movement of white-clawed crayfish within the site should not be artificially constrained.	Vertical drops are sufficient to prevent upstream movement of adult white-clawed crayfish. Even low weirs will therefore prevent recolonization of upper reaches affected by lethal pollution episodes or drought, and more generally will also lead to constraints on life cycle movements and genetic interactions throughout the river that may have adverse consequences.	
Supporting habitat: structure/ function	**Calcium levels**	Maintain calcium levels at or to above 5mg/l	Because of their thick exoskeletons and regular moult cycles, freshwater crustaceans such as crayfish have high calcium needs. When calcium levels drop, their exoskeletons become weaker reducing the abundance, size, and weight of these crustaceans. A reduction in size can slow the onset of sexual maturity, making them more vulnerable to predators. This, in turn, may further affect the overall size of their population. Finally, affected crustaceans may become less tolerant of other factors such as temperature, toxic metals, and Ultra Violet radiation.	Malham Tarn Diffuse Water Pollution Plan. 2005. Joint - Natural England, Environment Agency, National Trust. Available on request from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting habitat: structure/ function	**Oxygen levels**	Maintain supporting rivers and waterbodies in/to a well-oxygenated state, typically with a dissolved oxygen standard of >70%	Good water quality, reflected in high oxygen levels, is important to ensure availability of food which includes worms, insect larvae, snails, small fish, macrophytes and algae. Rose and Whitmore (2012) showed that there seemed to be a source of Dissolved Organic Carbon emanating from within the Tarn.	Malham Tarn Diffuse Water Pollution Plan. 2005. Joint - Natural England, Environment Agency, National Trust. Available on request from Natural England Rose and Whitmore. 2012. Malham Tarn – Further investigations on the peat cliff stabilisation proposals. JBA Consulting. Available from Natural England.
Supporting habitat: structure/ function	**Pollution**	Ensure supporting habitat is not at risk of effluent discharges from agricultural or fish farms from within the site's wider catchment	Native crayfish are particularly susceptible to pollution incidents, and the transfer of diseases from other sources	Malham Tarn Diffuse Water Pollution Plan. 2005. Joint - Natural England, Environment Agency, National Trust. Available on request from Natural England
Supporting habitat: structure/ function	**River banks**	Maintain the full extent of bankside tree cover including their root systems	Habitat conditions for white-clawed crayfish vary naturally in rivers. Some river sections may provide optimal habitat whilst others may be largely unsuitable. Optimal conditions typically occur in relatively shallow, fast flowing reaches with coarse substrates. A characteristically diverse biotope mosaic allows the white-clawed crayfish and other species to move within the channel to locate optimal habitat conditions in the face of a fluctuating flow regime. Pools, exposed tree root systems and marginal shallows are important high-flow refugia for the species. Impounding structures in particular can have a dramatic effect on white-clawed crayfish habitat, generating heavy siltation and loss of the coarse substrates on which white-clawed crayfish depend.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.
Supporting habitat: structure/	**River bed**	Maintain an abundance of naturally-occurring cobbles, rubble and boulders on the river	Habitat conditions for white-clawed crayfish vary naturally in rivers. Some river sections may provide optimal habitat whilst others may be largely unsuitable. Optimal conditions typically	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
function		bed	occur in relatively shallow, fast flowing reaches with coarse substrates. A characteristically diverse biotope mosaic allows the white-clawed crayfish and other species to move within the channel to locate optimal habitat conditions in the face of a fluctuating flow regime. Pools, exposed tree root systems and marginal shallows are important high-flow refugia for the species. Impounding structures in particular can have a dramatic effect on white-clawed crayfish habitat, generating heavy siltation and loss of coarse substrates on which white-clawed crayfish depend. White-clawed crayfish are not usually found inhabiting substrates covered in mud or silt, although they may cross such areas while foraging. Land-use change, the draining of lakes or ponds, and lowering or widening a stream or river bed can increase siltation and reduce water flow, resulting in a change in the channel flora and creating unsuitable conditions for crayfish. While they are known to occur in sections of river where the banks are poached by cattle, such activity can have an adverse effect on a population by increasing turbidity and decreasing dissolved oxygen concentrations as a result of sediment and excrement entering the water Refuges are present throughout the entire perimeter of the lake and in both the inlet and outlet streams and white-clawed crayfish would be expected to be present throughout Malham Tarn.	Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request. Holditch, 2003. Ecology of the White-clawed Crayfish. Conserving Natura 2000 Rivers, Ecology Series No. 1. An English Nature Report. Available here
Supporting habitat: structure/ function	**River flow**	Ensure more than 90% of the naturalised daily mean flow remains in the river all year round	The natural flow regime both shapes and sustains characteristic biotope mosaics, affecting factors such as current velocities and bed hydraulics, water levels and depths, wetted area, temperature regime and dissolved oxygen regime, All parts of the natural flow regime are important, including flushing flows, seasonal baseflows and natural low flows.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Natural seasonal flow recession is critical in supporting the full expression of supporting habitats (marginal and riparian vegetation, exposed riverine sediments, ephemeral headwaters). Any significant impacts on the natural flow regime should be rectified sustainably by reducing flow modifications, not by artificial augmentation, or by altering channel form to fit reduced levels of flow. There are particular difficulties around such generic targets in a Karst landscape where many of the surface streams are periodically captured along parts of their length to flow underground such that surface flow rates 'naturally fluctuate' over far greater extremes than other English/UK land surfaces with impermeable rock types/ solid geology.	
Supporting habitat: structure/ function	**River morphology**	Maintain the physical structure of the river channel and its banks in a natural state	To be considered in conjunction with supplementary advice for associated Annex I habitat features. Habitat conditions for white-clawed crayfish vary naturally in rivers. Some river sections may provide optimal habitat whilst others may be largely unsuitable. Optimal conditions typically occur in relatively shallow, fast flowing reaches with coarse substrates. A characteristically diverse biotope mosaic allows the white-clawed crayfish and other species to move within the channel to locate optimal habitat conditions in the face of a fluctuating flow regime. Pools, exposed tree root systems and marginal shallows are important high-flow refugia for the species. Impounding structures in particular can have a dramatic effect on white-clawed crayfish habitat, generating heavy siltation and loss of coarse substrates on which white-clawed crayfish depend. A Natural channel morphology provides a diversity of refuge and feeding opportunities for white-clawed crayfish. The proximity of different refuges facilitates foraging and the movement of individuals to different habitats with age.	Holditch, 2003. Ecology of the White-clawed Crayfish. Conserving Natura 2000 Rivers, Ecology Series No. 1. An English Nature Report. Available here

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Operations that widen, deepen and/or straighten the channel reduce variations in habitat. Land-use change, the draining of lakes or ponds, and lowering or widening a stream or river bed can increase siltation and reduce water flow, resulting in a change in the channel flora and creating unsuitable conditions for crayfish. While they are known to occur in sections of river where the banks are poached by cattle, such activity can have an adverse effect on a population by increasing turbidity and decreasing dissolved oxygen concentrations as a result of sediment and excrement entering the water.	
Supporting habitat: structure/ function	**River/ waterbody vegetation**	Maintain the extent of submerged and marginal vegetation within the river channel / standing water body (as appropriate)	To be considered in conjunction with supplementary advice for associated Annex I habitat features. Habitat conditions for white-clawed crayfish vary naturally in rivers. Some river sections may provide optimal habitat whilst others may be largely unsuitable. Optimal conditions typically occur in relatively shallow, fast flowing reaches with coarse substrates. A characteristically diverse biotope mosaic allows the white-clawed crayfish and other species to move within the channel to locate optimal habitat conditions in the face of a fluctuating flow regime. Pools, exposed tree root systems and marginal shallows are important high-flow refugia for the species. Impounding structures in particular can have a dramatic effect on white-clawed crayfish habitat, generating heavy siltation and loss of coarse substrates on which white-clawed crayfish depend.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.
Supporting habitat: structure/ function	**Shoreline refugia**	Maintain the extent and diversity of shoreline refuges associated with the water body, such as submerged tree roots, bank crevices and marginal vegetation	White-clawed crayfish of all ages need refuges, or places to shelter or hide. Juvenile crayfish are especially vulnerable to predation by fish, ducks and other water birds, otter and mink, carnivorous dragonfly larvae and other predatory invertebrates, including adult crayfish. Crayfish are also vulnerable to high flows in watercourses,	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			when they can be washed away from favourable habitats and stranded, crushed or eaten. Pools, exposed tree root systems and marginal shallows are important high-flow refugia for the species. Within the Shoreline there are many man-made bank-side structures and overhanging trees with root systems and emergent macrophytes that offer potential marginal refuge for crayfish. Cobble-boulder dominated substrate is present along the northern and eastern shores. The southern shore is characterised by cobble-pebble substrate. The refuges created by the larger stones at Malham Tarn offer some of the most suitable and the most valuable white-clawed crayfish habitat. Further the wide range of clast sizes within these zones results in a range of refuge sizes providing opportunities for all age classes of white-clawed crayfish.	
Supporting habitat: structure/ function	**Soils, substrate and nutrient cycling**	Maintain the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, within typical values for the supporting habitat	Soil supports basic ecosystem function and is a vital part of the natural environment. Its properties strongly influence the colonisation, growth and distribution of those 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 the supporting habitat of this Annex II feature. The soils around Malham Tarn are mostly thin and identified as MALHAM 1 (silty over limestone) and some WETTON 2 (shallow peat over limestone). The only real exception to this is the wetland that surrounds the tarn and has a deeper layer of peat.	Malham Tarn Diffuse Water Pollution Plan. 2005. Joint - Natural England, Environment Agency, National Trust. Available on request from Natural England
Supporting habitat: structure/ function	**Supporting off-site habitat**	Maintain the quality of any supporting habitat present beyond the site boundary upon which the white-clawed crayfish population of the site depend	White-clawed crayfish populations within the designated boundary of the SAC may be dependent on the continued or restored integrity of sections of river channel and riparian areas that lie outside of the site boundary. For example, headwater areas and tributaries may not fall within the site boundary, yet white-clawed crayfish may use these areas for spawning and	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			juvenile development and be critical for sustaining populations in the SAC further downstream.	
Supporting habitat: structure/ function	**Total Nitrogen**	Maintain levels typically at or below 0.2 mg.l-1 NO2 suggested as reflecting the EPA limit for salmonid waters. This should be set at 1.5mg/l for Malham Tarn (agreed with EA).	These need to be made bespoke the individual site, as they will vary both between fluvial and static water bodies, and within those class types. High levels of nitrogen are likely to be toxic to crayfish. There seems to be a tolerance of nitrates in this species, with food consumption being impacted before other physiological impacts are noted, though mortality climbs with increasing concentration.	Malham Tarn Diffuse Water Pollution Plan. 2005. Joint - Natural England, Environment Agency, National Trust. Available on request from Natural England
Supporting habitat: structure/ function	**Turbidity: rivers**	Maintain an annual mean level of typically less than 25 mg/l of suspended solids throughout the site	The supporting riverine habitat of the feature should be characterised by clean gravels; excess siltation can obstruct crayfish gills and this may cause physico-pathological changes in the long term. Construction operations often cause marked and extensive turbidity in water, coupled with an increase in iron content	Holditch, 2003. Ecology of the White-clawed Crayfish. Conserving Natura 2000 Rivers, Ecology Series No. 1. An English Nature Report. Available here
Supporting habitat: structure/ function	**Un-ionised Ammonia**	Maintain ammonia levels at or to less than 0.6mg NH3 l-1 throughout the site	High level of ammonia in watercourses, derived from organic pollution, is likely to be toxic to white-clawed crayfish.	Malham Tarn Diffuse Water Pollution Plan. 2005. Joint - Natural England, Environment Agency, National Trust. Available on request from Natural England
Supporting habitat: structure/ function	**Water pH**	Maintain pH levels at or to within the range 6.5 - 9	Higher pH levels as part of supporting water habitat chemistry maximise the survival and growth of animals. Water pH appears to be stable and in line with what is expected on such a site.	Malham Tarn Diffuse Water Pollution Plan. 2005. Joint - Natural England, Environment Agency, National Trust. Available on request from Natural England
Supporting habitat: structure/ function	**Water quality: biological**	Maintain supporting habitat to Good biological status (i.e. compliance with relevant Environmental Quality Standards) throughout the site.	Good water quality is important to this feature to ensure sufficient availability of prey which includes worms, insect larvae, snails, small fish, macrophytes and algae. For many SAC features which are dependent on wetland habitats supported by surface and/or ground water, maintaining the quality and quantity of water supply will be critical, especially at certain times of year. Poor water quality and inadequate quantities of water can	Malham Tarn Diffuse Water Pollution Plan. 2005. Joint - Natural England, Environment Agency, National Trust. Available on request from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			adversely affect the structure and function of this supporting habitat type. Typically, meeting the surface water and groundwater environmental standards set out by the Water Framework Directive (WFD 2000/60/EC) will also be sufficient to support the achievement of SAC Conservation Objectives but in some cases more stringent standards may be needed. Further site-specific investigations may be required to establish appropriate water quality standards for the SAC (see targets for the H3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. feature).	
Supporting habitat: structure/ function	**Water quality: chemical**	Maintain supporting habitat to Good chemical status (i.e. compliance with relevant Environmental Quality Standards) throughout the site.	Good water quality is important to ensure availability of prey which includes worms, insect larvae, snails, small fish, macrophytes and algae. For many SAC features which are dependent on wetland habitats supported by surface and/or ground water, maintaining the quality and quantity of water supply will be critical, especially at certain times of year. Poor water quality and inadequate quantities of water can adversely affect the structure and function of this habitat type. Typically, meeting the surface water and groundwater environmental standards set out by the Water Framework Directive (WFD 2000/60/EC) will also be sufficient to support the achievement of SAC Conservation Objectives but in some cases more stringent standards may be needed. Further site-specific investigations may be required to establish appropriate water quality standards for the SAC.	
Supporting habitat: structure/ function	**Water temperature**	Maintain water temperature at naturally-occurring levels	Good water quality is important to ensure availability of food which includes worms, insect larvae, snails, small fish, macrophytes and algae.	
Supporting habitat: structure/ function	**Woody debris**	Maintain an abundance of large woody debris within the channel or water body	Woody debris is an important component of river habitat for white-clawed crayfish as well as the wider biological community. White-clawed crayfish are particularly associated with woody debris in lowland reaches, where it is likely that it provides an alternative source of cover from predators and	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			floods. It may also be used as an alternative spawning substrate.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Adaptation and resilience**	Maintain the feature's ability, and that of its supporting habitat, to adapt or evolve to wider environmental change, either within or external to the site	See the explanatory notes for this attribute above in Table 2	Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360].
Supporting processes (on which the feature and/or its supporting habitat relies)	**Air quality**	Maintain or, where necessary, restore 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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1'	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)
Supporting processes (on which the feature and/or its supporting habitat relies)	**Conservation measures**	Maintain the management measures which are necessary to maintain the structure, functions and supporting processes associated with the feature and/or its supporting habitats.	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. 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.	Natural England, 2006. Definition of Favourable Condition - Malham-Arncliffe SSSI (Available from Natural England on request) Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,
Supporting processes (on which the feature and/or its supporting habitat relies)	**Fish density**	Maintain fish populations at or to densities low enough to avoid significant predation of juvenile crayfish	Predatory fish species may include chub, eel, perch, pike and trout Bullhead (*Cottus gobio*), brown trout (*Salmo trutta*), three-spined stickleback (*Gasterosteus aculeatus*) and stone loach (*Barbatula barbatula*) have all been recorded within Malham Tarn. These species are all native to the UK and are not	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			stocked. The National Trust stopped stocking brown trout at Malham Tarn in 2002 and it is assumed this includes Malham Water.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Water quantity/ quality**	Where the feature or its supporting habitat is dependent on surface water and/or groundwater maintain water quality and quantity to a standard which provides the necessary conditions to support the feature	For many SAC features which are dependent on wetland habitats supported by surface and/or ground water, maintaining the quality and quantity of water supply will be critical, especially at certain times of year. Poor water quality and inadequate quantities of water can adversely affect the structure and function of this habitat type. Typically, meeting the surface water and groundwater environmental standards set out by the Water Framework Directive (WFD 2000/60/EC) will also be sufficient to support the achievement of SAC Conservation Objectives but in some cases more stringent standards may be needed to reflect the ecological needs of the species feature. Further site-specific investigations may be required to establish appropriate water quality standards for the SAC. Within Malham Tarn, given the low gradient of the littoral zone a significant reduction in water level over time would leave much of the marginal sites exposed in future condition assessments. A reduction in wetted area would reduce the amount of available habitat for white-clawed crayfish and thus needs to be monitored. However, the current water level fluctuations are small and under natural influence: the hydrology is therefore considered to be acceptable. There no known abstraction from Malham Tarn or upstream. Thus, drawdown is likely to be driven by natural seasonal climatic variation. The control structure at the outlet controls current water level in the tarn and this structure should not be altered / removed without prior consideration of the effects on marginal habitat.	Malham Tarn: Annex 1 2007-2012 CMS Assessment. Natural England. Available on request from Natural England. APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.
Version Control Advice last updated: **11th March 2019** – Stakeholder comments - **Population health** attributes, list of locations nearby to the SAC where signal crayfish have been recorded and potential issues with both spread of non-native species and spread of crayfish plague. Further, mention of the crayfish ark site at Threshfield, which could be				

Attributes	Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
important in terms of conservation of populations in the wider area, and protection from invasive species and plague.			
Variations from national feature-framework of integrity-guidance: N/A			

Table 11: Supplementary Advice for Qualifying Features: S1163. *Cottus gobio*; Bullhead

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Population (of the feature)	**Juvenile densities**	Restore juvenile densities at those expected under unimpacted conditions throughout the site, taking into account natural habitat conditions and allowing for natural fluctuations	Impacts on physical, chemical or hydrological integrity, or from non-native species, may suppress juvenile densities. Within Malham-Arncliffe SSSI, in the survey of Malham Tarn in 2014 young-of-year bullhead density ranged from zero to two individuals per m2 with an average of 0.67 across all sites. Further at least three age classes (0+, 1+, and older) of bullhead were discernible. Adults represented 58% of the demographic structure whilst young-of-year bullhead contributed 42%, thus failing against the target of at least equal densities of adult and young-of-year fish. However due to natural population fluctuations this is deemed within a borderline acceptable range but should be reviewed within a suitable period of time to ensure no further decrease. This marginally older population may be due to lack of younger fish being caught as they can hide deeper in the streambed cobbles and therefore are not available to be stunned/captured/counted as readily.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request. JBA Consulting (S. Roses) (2013) Malham Streams SSSI Condition Assessment Final Report May 2013
Population (of the feature)	**Population abundance**	Maintain the abundance of the population at a density which is close to that expected under unimpacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	This will ensure there is a viable population of the feature which is being maintained at or increased to a level that contributes as appropriate to its Favourable Conservation Status across its natural range in the UK. Due to the dynamic nature of population change, the target-value given for the population size or presence of this feature is considered to be the minimum standard for conservation/restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size or presence has significantly changed as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request. JBA Consulting (S. Roses) (2013) Malham Streams SSSI Condition Assessment Final Report May 2013

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is designated, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account in any assessment. Unless otherwise stated, the population size or presence will be that measured using standard methods, such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. Whilst we will endeavour to keep these values as up to date as possible, local Natural England staff can advise that the figures stated are the best available. Within the most recent (2015) surveys adult bullhead population density ranged from zero to five individuals per m2 with a mean of 0.93 across all the sites which exceeds the target derived for upland rivers of 0.2 individuals per m2. The mean total bullhead density ranged from zero to five individuals per m2 with a mean of 1.60 across all sites. Adults represented 58% of the demographic structure whilst young-of-year bullhead contributed 42%, thus failing against the target of at least equal densities of adult and young-of-year fish. However due to natural population fluctuations this is deemed within an acceptable range but should be reviewed within a suitable period of time to ensure no further decrease.	
Supporting habitat:	**Distribution of supporting**	Maintain the distribution and continuity of the feature and its	A contraction in the range, or geographic spread, of the feature (and its component vegetation) across the site will reduce its	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
extent and distribution	**habitat**	supporting habitat, including where applicable its component vegetation types and associated transitional vegetation types, across the site	overall area, the local diversity and variations in its structure and composition, and may undermine its resilience to adapt to future environmental changes. Contraction may also reduce and break up the continuity of a habitat within a site and how well the species feature is able to occupy and use habitat within the site. Such fragmentation may have a greater amount of open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to its interior. These conditions may not be suitable for this feature and this may affect its viability.	
Supporting habitat: extent and distribution	**Extent of supporting habitat**	Maintain the total extent of the habitat(s) which support the feature (	In order to contribute towards the objective of achieving an overall favourable conservation status of the feature at a UK level, it is important to maintain or if appropriate restore the extent of supporting habitats and their range within this SAC. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending on the nature, age and accuracy of data collection, and may be subject to periodic review in light of improvements in data. Recent surveys (2015) found that Bullhead were present at 80% of marginal sites. These sites were located on the northern, eastern and southern shore. It should also be noted that whilst specific bullhead surveys were not conducted in the stream network entering Malham Tarn from the north west, two adult bullhead were caught as bye-catch during the white-claw crayfish trapping surveys. Bullhead were further present in the outlet stream Malham Water.	Species Accounts - S1163. *Cottus gobio*; Bullhead. JNCC. Available here APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.
Supporting habitat: structure/ function	**Biological connectivity**	The movement of characteristic biota should not be artificially constrained.	Many species, including fish and invertebrates, require natural freedom of movement to complete their life cycle in rivers and maximise their population size and genetic diversity. Longitudinal connectivity within the river channel and lateral	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			connectivity between the channel and the floodplain are both critical to a healthy river ecosystem. Constraints to longitudinal movement such as waterfalls and debris dams are a natural feature of rivers and add to the complexity and diversity of the habitat. Natural waterfalls in headwater areas can create unique (often fishless) communities of conservation importance. New artificial constraints to movement should be avoided and existing artificial constraints should be addressed through strategic river restoration as outlined above. Barriers should be removed where ever possible to restore all aspects of habitat integrity - fish passes constitute a partial mitigation measure for longitudinal biological movement and should only be considered where it is not possible to remove the barrier. Where established, they should allow for the passage of as many characteristic species as possible, including Annexe II fish species such as allis and twaite shad and lamprey species. Vertical drops of >18-20 cm are sufficient to prevent upstream movement of adult bullheads. They will therefore prevent recolonisation of upper reaches affected by lethal pollution episodes or drought, and more generally will also lead to constraints on genetic interactions that may have adverse consequences.	
Supporting habitat: structure/ function	**Biotope mosaic**	Maintain the extent and pattern of in-channel and riparian biotopes (habitats) to that characteristic of natural fluvial processes.	Watercourses with a high degree of naturalness are governed by dynamic processes which result in a mosaic of characteristic physical habitats or biotopes, including a range of substrate types, variations in flow, channel width and depth, in-channel and side-channel sedimentation features (including transiently exposed sediments), bank profiles (including shallow and steep slopes), erosion features (such as cliffs) and both in-channel and bankside (woody and herbaceous) vegetation cover. All of these biotopes, and their characteristic patterns within the river corridor, are important to the full expression of the biological community. A range of physical habitat modifications cause simplification of biotope mosaics, resulting in declines of characteristic biota	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			dependent upon biotopes that have been lost or reduced in extent. Rivers that have sections that are already significantly physically modified should be subject to a process for planning and implementing physical restoration measures. This should be based on restoring natural geomorphological processes (including restoration of hydrological continuity between river and floodplain) as far as possible to allow restoration of characteristic and sustainable biotope mosaics, working within the practical constraints of essential flood protection for people and the built environment. Excessive levels of livestock grazing denudes the riparian zone, causes artificially high bank instability, and degradation of the fauna and flora of exposed riverine sediments. Low levels of grazing by suitable livestock are important in generating the full expression of riparian biotopes. Habitat conditions for bullhead vary naturally in rivers. Some river sections may provide optimal habitat whilst others may be largely unsuitable. Optimal conditions typically occur in relatively shallow, fast flowing reaches with coarse substrates (used for egg-laying and juvenile/adult cover). A characteristically diverse biotope mosaic allows the bullhead and other species to move within the channel to locate optimal habitat conditions in the face of a fluctuating flow regime. Pools, exposed tree root systems and marginal shallows are important high-flow refugia for the species. The advice for H3260 is based on natural river function, which provides a characteristic biotope mosaic that caters for bullhead to a degree characteristic of the river.	
Supporting habitat: structure/ function	**Control of livestock grazing activity**	Maintain grazing activity in the riparian zone and in the river channel at or to suitably low levels.	Ideally, grazing levels should be managed at low levels across whole riparian fields. Where this is not feasible, set-back fencing may be established with access provision for limited grazing within the riparian zone Particularly sensitive areas (e.g. exposed riverine sediments likely to support good invertebrate communities) may need to be fenced off to avoid	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			any concentration of livestock activity, even if only present in low numbers. Close bankside fencing that excludes the development of a functional river corridor is not appropriate. Over-grazing of riparian areas can have a dramatic effect on bullhead habitat, eliminating marginal habitat and generating excessive loads of fine sediment. There is no current evidence of any major poaching. The majority of livestock in the area are controlled by stock proof fencing. However, on some localised areas, where livestock exclusions are not in place there is still some evidence of overgrazing of stream sides. e.g. SERCON score1 for bankside vegetation of all 3 streams.	on request. Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,
Supporting habitat: structure/ function	**Fisheries - introduction of fish species**	Ensure fish stocking/ introductions do not interfere with the ability of the river to support self-sustaining populations of the feature	The presence of artificially high densities of fish can creates unacceptably high levels of predatory pressure on bullhead. The management aim is to provide conditions in the river that support a healthy, natural and self-sustaining salmon population, achieved through habitat protection/restoration and the control of exploitation as necessary. Stocking represents a loss of naturalness and, if successful, obscures the underlying causes of poor performance (potentially allowing these risks to perpetuate). It carries various ecological risks, including the loss of natural spawning from broodstock, competition between stocked and naturally produced individuals, disease introduction and genetic alterations to the population Brown trout *Salmo trutta*, three-spined stickleback *Gasterosteus aculeatus* and stone loach *Barbatula barbatula* have all been recorded within Malham Tarn. These species are all native to the UK and are not stocked. The National Trust stopped stocking brown trout at Malham Tarn in 2002 and it is assumed this includes Malham Water.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting habitat: structure/ function	**Flow regime**	Maintain the natural flow regime of the river, with daily flows as close to what would be expected in the absence of abstractions and discharges (the naturalised flow).	The natural flow regime both shapes and sustains characteristic biotope mosaics, affecting factors such as current velocities and bed hydraulics, water levels and depths, wetted area, temperature regime and dissolved oxygen regime, All parts of the natural flow regime are important, including flushing flows, seasonal baseflows and natural low flows. Natural seasonal flow recession is critical in supporting the full expression of ephemeral habitats (marginal and riparian vegetation, exposed riverine sediments, ephemeral headwaters). Any significant impacts on the natural flow regime should be rectified sustainably by reducing flow modifications, not by artificial augmentation, or by altering channel form to fit reduced levels of flow. There should be no increase in the existing level of impact on the natural flow regime, and any significant impacts should be controlled to acceptable levels. Flow targets for WFD high ecological status should be used to avoid deterioration and for restoration where this is technically feasible. These are: <5% deviation at <Qn95 and <10% at >Qn95 - based on 'natural' water (i.e. water that has not been abstracted and returned). As a minimum, the flow regime should be restored to the values given in the site's FCT. Where multiple natural channels exist, flow targets should apply across all of these channels - any artificial channels should not create non-compliances in natural channels. The natural flow regime is critical to all aspects of the bullhead life cycle, maintaining the high current velocities and substrate conditions that are optimal for the species.	
Supporting habitat: structure/ function	**Integrity of off-site habitats**	Habitats beyond the site boundary upon which characteristic biological communities of the site depend should be maintained in a state that does not impair the full expression of the characteristic	The characteristic biological communities of the site are dependent on the integrity of sections of river channel, riparian areas, and transitional waters that lie outside of the site boundary. Headwater areas and tributaries may not fall within the site boundary, yet a range of species characteristic of the site may	Environment Agency. Bullhead surveys. Available on request from the Environment Agency

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		biota within the site.	use these areas for spawning and juvenile development and be critical for sustaining populations within the site. Fully developed riparian zones are essential to site integrity, yet part of this zone may lie outside of the site boundary, particularly if the river channel is operating under natural processes and moves laterally over time within the floodplain. Bullhead populations within the SAC may be dependent on the integrity of sections of river channel and riparian areas that lie outside of the site boundary. Headwater areas and tributaries may not fall within the site boundary, yet bullhead may use these areas for spawning and juvenile development and be critical for sustaining populations within the site. Bullhead has been identified during recent surveys and is present in Malham Beck, Goredale Beck, Goredale Bridge, Cowside Beck and the River Skirfare.	
Supporting habitat: structure/ function	**Riparian zone**	Maintain a patchy mosaic of natural woody and herbaceous (tall and short swards) riparian vegetation (except in upland areas above the natural tree line). The riparian zone should be sufficiently wide to act as a healthy and functional habitat zone within the river corridor.	A mosaic of natural and semi-natural riparian vegetation types provides conditions for all characteristic in-channel and riparian biota to thrive, creating patches of tall and short riparian swards, a mixture of light and shade on the river channel, and tree root systems and a supply of large woody debris that add channel complexity. Patchy tree cover provides shade protection against rising water temperatures caused by climate change. Between 30 and 50% riparian tree cover is generally considered optimal for in-channel and riparian habitats. Intensive cutting across significant proportions of the riparian zone is not appropriate. Also see above comments on livestock grazing. Active marginal vegetation including riparian trees provides important cover for bullhead. A mosaic of vegetation types and sward heights provides suitable conditions for the whole characteristic biological community including bullhead.	
Supporting habitat: structure/ function	**Screening of intakes and discharges**	All intakes and discharges likely to trap a significant number of individuals of characteristic species are being adequately	Intakes and discharges can be responsible for significant mortalities of fish. Long-distance migratory species such as Atlantic salmon sea trout and European eel can be particularly susceptible.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		screened.	Archimedes screw turbines are a recent development in small-scale hydropower and should also be screened until such times that there is robust evidence that they cause no damage to characteristic fish populations. Bullhead can be entrained in intakes and discharges along with other fish species.	
Supporting habitat: structure/ function	**Sediment regime**	Maintain the natural supply of coarse and fine sediment to the river	Coarse sediment supply is essential for the stability of the river channel and for creating and sustaining key biotopes including riffles and exposed shingle banks. Coarse sediment supply can be interrupted by weirs and other impounding structures, and by dredging or extraction, and can result in channel incision and heavy bankside erosion that have consequences for both biodiversity and river management (e.g. flood risk). Excessive fine sediment supply can lead to the smothering of coarse substrates and the loss of flora and fauna dependent on them (note that impoundment of the river can have the same effects). In upland streams, damage to blanket peat creates enhanced levels of organic particulates that cause considerable change to macroinvertebrate communities. Where fine sediment delivery is a problem, control measures need to be planned in the catchment. In upland areas, the restoration of intact peat bodies is critical in controlling organic sediment load. Natural levels of coarse sediment supply are critical to the maintenance of high quality bullhead habitat, maintaining bed substrates in optimal condition for egg-laying and juvenile and adult cover. Excessive delivery of fine sediment, from the catchment or artificially enhanced bank erosion, can cause siltation of egg-laying sites and juvenile and adult refugia. During the recent (2015) survey fine sediment levels in Malham Tarn were visually assessed as part of the shoreline walkover	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			survey. They were not deemed to be higher than would be expected for a relatively unimpacted scenario and there was no evidence of elevated levels of sediment entering the tarn.	
Supporting habitat: structure/ function	**Soils, substrate and nutrient cycling**	Maintain the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, within typical values for the supporting habitat	Soil supports basic ecosystem function and is a vital part of the natural environment. Its properties strongly influence the colonisation, growth and distribution of those 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 the supporting habitat of this Annex II feature. Silt levels within Malham Tarn are not deemed to be higher than would be expected for a relatively unimpacted scenario and there is currently no evidence of elevated levels of sediment entering the tarn from the tributaries that drain uncultivated and lightly grazed land.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.
Supporting habitat: structure/ function	**Vegetation composition: invasive non-native species**	Ensure non-native species categorised as 'high-impact' in the UK under the Water Framework Directive are either rare or absent but if present are causing minimal damage to the feature	Non-native species constitute a major threat to many river systems. Impacts may be on the river habitat itself (e.g. damage to banks and consequent siltation) or directly on characteristic biota (through predation, competition and disease), or a combination of these. For example, species such as signal crayfish have been responsible for much of the decline of native crayfish through competition, habitat damage and the introduction of crayfish plague. The UK Technical Advisory Group of the Water Framework Directive produces a regularly updated classification of aquatic alien species (plants and animals) according to their level of impact. In general high impact species are of greatest concern but low or unknown impact species may be included in the target on a site-specific basis where there is evidence that they are causing a negative impact (for example high cover values or abundances). Those taxa considered likely to colonise lakes, are indicated by an 'L' in the UKTAG guidance. Examples of	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request. Environment Agency. Bullhead surveys. Available on request from the Environment Agency

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			such high-impact species may include Water Fern, New Zealand pygmyweed and the zebra mussel. Species such as signal crayfish can have a serious effect on bullhead habitat (by destabilising banks and enhancing fine sediment input), and can predate heavily on bullhead if present at high densities. Chinese mitten crab has the potential to migrate long distances up rivers and can cause similar damage to bullhead habitat. Signal crayfish are present in the Bullhead habitat on the River Skirfare (just outside SAC boundary), and highly likely to be present in Cowside Beck (within SAC boundary).	
Supporting habitat: structure/ function	**Vegetation structure: cover of submerged macrophytes**	Maintain a sufficient proportion of all aquatic macrophytes to allow them to reproduce in suitable habitat and unaffected by river management practices.	Removal of submerged aquatic vegetation (often called 'weed-cutting') might be undertaken for flood risk management or fishery purposes. Except in situations of extreme flood risk, best practice is for cutting to leave a mosaic of submerged and marginal vegetation, and should promote a characteristic diversity of plant species. It is recommended that where appropriate a weed management plan is developed for the site, allowing for higher levels of cutting at flood risk pinch-points, balanced by lower levels of cutting in other stretches. Any weed-cutting operations should be undertaken to leave a sufficient proportion of in-channel and marginal vegetation in the river to support characteristic biota (in terms of cover, food supply and spawning substrate). Weed-cutting should not interfere with the ability of the river channel to downsize through encroachment of marginal vegetation during the summer flow recession. In rivers where it naturally occurs, submerged and marginal vegetation can provide important cover for bullhead, particularly if coarse (cobble) substrates are in short supply for cover. Within areas supporting bullhead, the substrate was in places covered by both diatomaceous and algal growth.	APEM 2015. Monitoring of bullhead and white-clawed crayfish at Malham Tarn, North Yorkshire 2014. Scientific Report 413500. Natural England, Available from Natural England on request.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting habitat: structure/ function	**Water quality - acidification**	Maintain levels of acidity to those which reflect unimpacted conditions	Acid deposition can cause major changes to flora, fauna and ecosystem functioning and affects organisms as diverse as diatoms, invertebrates and fish. Upland streams are particularly susceptible owing to the higher rainfall in these areas. Acid impacts are typically sporadic and tend to be greatest during the winter months. In humic (peat-stained) waters, pH is naturally lower due to the presence of weak acids, and the pH standard is correspondingly lower for these waters. However, humic compounds also provide buffering capacity that helps to reduce fluctuations in pH. Acidification lowers dissolved organic carbon in these waters, reducing the buffering capacity and altering ecosystem functioning. The values given should be applied throughout the site, not just at routine sampling points. Note that, in respect of ANC, some allowance may need to be made for anthropogenically elevated levels of humic substances in rivers and streams draining degraded peat bodies - this artificially raises the buffering capacity of the water and may under-estimate the anthropogenic acid load The bullhead is susceptible to acidification stress in low alkalinity waters. Maps of critical loads provide an indication of acidification hotspots.	
Supporting habitat: structure/ function	**Water quality - nutrients**	Maintain the natural nutrient regime of the river s, with any anthropogenic enrichment above natural/background concentrations limited to levels at which adverse effects on the feature are unlikely.	Nutrient enrichment can lead to loss of substrate condition for bullhead due to benthic algal growth and associated enhanced siltation. The bullhead is susceptible to both episodic and chronic organic pollution. Episodic pollution causes direct mortalities whilst chronic pollution affects substrate condition through the build-up of excessive microbial populations.	
Supporting habitat: structure/ function	**Woody debris**	Maintain the presence of coarse woody debris within the structure of the channel (except in upland areas above the natural tree line). In smaller watercourses, temporary debris dams should be a feature of channel dynamics.	Dead woody material that falls into streams ('woody debris') plays an important role in increasing habitat diversity, providing shelter for fish, supplying a food source for aquatic invertebrates, and for slowing the passage of nutrients downstream. Woody debris is therefore a key feature of healthy rivers.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			Woody debris should be left in situ, unless there are overriding reasons of public safety (for example to prevent flooding or bridge collapse).	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Adaptation and resilience**	Maintain the feature's ability, and that of its supporting habitat, to adapt or evolve to wider environmental change, either within or external to the site	See the explanatory notes for this attribute above in Table 2	Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/4954594591375360].
Supporting processes (on which the feature and/or its supporting habitat relies)	**Air quality**	Maintain or, where necessary, restore 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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1'	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).
Supporting processes (on which the feature and/or its supporting habitat relies)	**Conservation measures**	Maintain the management measures (either within and/or outside the site boundary as appropriate) which are necessary to maintain the structure, functions and supporting processes associated with the feature and/or its supporting habitats.	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. 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. Malham-Arncliffe SSSI is the only underpinning SSSI within Craven Limestone Complex SAC that supports populations of Bullhead *Cottus gobio*. Bullhead are found in the limestone outflow and inflow streams feeding Malham Tarn, and in Malham Tarn itself.	Natural England (2006) Definition of Favourable Condition - Malham-Arncliffe SSSI (Available on request from Natural England) Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan,

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting processes (on which the feature and/or its supporting habitat relies)	**Water quantity/ quality**	Where the feature or its supporting habitat is dependent on surface water and/or groundwater, maintain water quality and quantity to a standard which provides the necessary conditions to support the feature.	For many SAC features which are dependent on wetland habitats supported by surface and/or ground water, maintaining the quality and quantity of water supply will be critical, especially at certain times of year. Poor water quality and inadequate quantities of water can adversely affect the structure and function of this habitat type. Typically, meeting the surface water and groundwater environmental standards set out by the Water Framework Directive (WFD 2000/60/EC) will also be sufficient to support the achievement of SAC Conservation Objectives but in some cases more stringent standards may be needed to reflect the ecological needs of the species feature. Further site-specific investigations may be required to establish appropriate water quality standards for the SAC.	Joint - Natural England, Environment Agency, National Trust. (2005 Malham Tarn Diffuse Water Pollution Plan. Available on request from Natural England
Version Control Advice last updated: **11th March 2019** – Stakeholder comments - **Integrity of off-site habitats** attribute, list of locations from recent Environment Surveys where Bullhead have been identified nearby to the SAC. **Vegetation composition: invasive non-native species** attribute, list of where signal crayfish have been identified within bullhead habitat.				
Variations from national feature-framework of integrity guidance: N/A				

Table 12: Supplementary Advice for Qualifying Features: S1902. *Cypripedium calceolus*; Lady`s-slipper orchid

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Population (of the feature)	**Flowering/ fruiting performance**	Ensure at least some plants should be flowering/fruiting each year. At each site the minimum requirement should be >20 flowering stems present at least once during each 5-year period.	Even just one flowering/fruiting plant will often be found to have 10-15 flowering stems producing potentially prodigious quantities of seed (5,000-20,000 seeds on a large multi-stemmed plant). Weather conditions (winter storms, cold spring, and summer drought) can limit seed production in any one year, but poor fruiting in two or three in every five is unlikely to be a problem.	
Population (of the feature)	**Metapopulation size and structure**	Maintain or restore as appropriate both the geographical extent/limits of each metapopulation and the number of colonies/sites contained within it.	Each colony in relation to its nearest neighbours and other colonies will form groups or clusters which function as a larger metapopulation. Some (usually outlying and very small) populations may 'come and go'. Natural losses are acceptable, but the aim should be to ensure that, over the medium to long term, local losses are more or less offset by re/colonisation at other sites.	
Population (of the feature)	**Population abundance**	Maintain OR Restore the abundance of the population at/to a level which is at or above 100 plants, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.	This will ensure there is a viable population of the feature which is being maintained at or increased to a level that contributes as appropriate to its Favourable Conservation Status across its natural range in the UK. The currently low population level is insufficient to ensure more than occasional pollination since there is evidence that *Andrena* bees acquire a prey image for flowers which are frequent in the landscape. The effectiveness of pollination is likely to increase with increasing flower number and, whilst it is impossible at present to say with certainty what population level is required, the number is certainly bigger than at present and a target of >100 would seem more realistic. Due to the dynamic nature of population change, the target-value given for the population size or presence of this feature is considered to be the minimum standard for conservation/ restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size or presence has significantly changed as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is designated, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account in any assessment. Unless otherwise stated, the population size or presence will be that measured using standard methods, such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. Whilst we will endeavour to keep these values as up to date as possible, local Natural England staff can advise that the figures stated are the best available.	
Population (of the feature)	**Population structure**	Maintain or restore as appropriate] a 'healthy' population defined as including plants of different ages, with flowering/fruiting plants, vegetative plants, 'youngsters' and seedlings all present.	When censusing for this species, separate counts should be kept of flowering/fruiting and vegetative mature plants and seedlings/youngsters.	
Supporting habitat: extent and distribution	**Distribution of supporting habitat**	Maintain or restore as appropriate the distribution and continuity of the feature and its supporting habitat, including where applicable its component vegetation types and associated transitional vegetation types, across the site	A contraction in the range, or geographic spread, of the feature (and its component vegetation) across the site will reduce its overall area, the local diversity and variations in its structure and composition, and may undermine its resilience to adapt to future environmental changes. Contraction may also reduce and break up the continuity of a habitat within a site and how well the species feature is able to occupy and use habitat within the site. Such fragmentation may have a greater amount of	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to its interior. These conditions may not be suitable for this feature and this may affect its viability.	
Supporting habitat: extent and distribution	**Extent of supporting habitat**	Maintain or restore as appropriate the total extent of the habitat(s) which support the feature	In order to contribute towards the objective of achieving an overall favourable conservation status of the feature at a UK level, it is important to maintain or if appropriate restore the extent of supporting habitats and their range within this SAC. The information available on the extent and distribution of supporting habitat used by the feature may be approximate depending on the nature, age and accuracy of data collection, and may be subject to periodic review in light of improvements in data. The decline in Lady`s-slipper orchid across the site and the UK has often been a result of uprooting by gardeners and the shrink in suitable habitat due to removal of woodland and overgrazing by high sheep stocking rates.	
Supporting habitat: structure/ function	**Habitat structure: regeneration/colonisation niches**	Maintain or restore as appropriate the availability of regeneration niches to aid seedling establishment	Cypripedium requires an open vegetation in the absence of agricultural management, primarily achieved through the relatively severe topography and limited depth and low nutrient status of soils coupled with some natural instability of the underlying rock and pedalogical processes such as soil creep and terracetting and natural levels of animal activity. All but essential human access should be avoided.	
Supporting habitat: structure/ function	**Mycological interaction**	Maintain or restore as appropriate low nutrient conditions by ensuring no deliberate application of artificial fertilisers or pesticides and by protecting the site from drift of such substances from nearby land (e.g. by ensuring surrounding land has sufficient buffering capabilities.	Cypripedium is dependent on its parasitism of specific soil fungi (identity currently unknown) for germination of its seeds and subsequent early growth and development. Most soil fungi are very sensitive to nutrient enrichment and even low levels of nitrogen fertiliser can have devastating effects, as of course can fungicides/	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting habitat: structure/ function	**Pollination**	Maintain or restore as appropriate conditions which are favourable to solitary bees of the genus *Andrena,* providing both nesting opportunities (some warm bare ground) and a healthy food supply (diverse and abundant flowering).	Cypripedium is pollinated by solitary bees - primarily of the genus *Andrena*. These bees require bare ground to nest and an adequate supply of nectar and pollen throughout their flight period. It is essential that surrounding land can support an adequate population of such bees if successful pollination is to be achieved. It may be necessary to maintain zero input pastures with low levels of grazing through the spring, summer and autumn months on adjacent agricultural land to achieve this.	
Supporting habitat: structure/ function	**Soils, substrate and nutrient cycling**	Maintain or restore as appropriate the properties of the underlying soil types, including structure, bulk density, total carbon, pH, soil nutrient status and fungal: bacterial ratio, within typical values for the supporting habitat	Soil supports basic ecosystem function and is a vital part of the natural environment. Its properties strongly influence the colonisation, growth and distribution of those 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 the supporting habitat of this Annex II feature. Lady`s-slipper orchid *Cypripedium calceolus* typically requires very lightly grazed wood-pasture* (in the Northern England/ Scottish context, not Parkland) or woodland which has edaphically or topographically maintained clearings or is found growing in the decomposed humus of semi-shaded woodland cover on limestone. It can also utilise semi-shaded limestone pavement grikes and clitter (loose rock). Micro-habitat conditions, principally soil structure and fungal associations may be limiting current establishment of re-introduced plants.	JNCC and Plant Conservation Working Group.2006. Conservation status assessment for: S1902: *Cypripedium calceolus* - Lady's-slipper Orchid. 2006. Second Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2001 to December 2006. Available here
Supporting habitat: structure/ function	**Substrate**	Maintain or restore as appropriate sandy/ gravelly/ shingly substrates and thin, skeletal soils with minimal amounts of organic material and clear evidence of lateral water movement at surface or within rooting depth of plants.	Substrate varies with site; sand dune and some beach-head sites are on sand, while cliff sites are on rock outcrops/platforms or amongst boulders, often on slumping soft-rock cliffs or at junction between soft-rock and underlying bedrock platform (coinciding with point where water oozing through 'head' seeps out across underlying rock platform and across beach-head).	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting habitat: structure/ function	**Vegetation structure and composition**	Maintain or restore as appropriate a relatively open mosaic of bare limestone and turf (principally Sesleria) with no more than light shading from ash, hazel and hawthorn.	Need to recognise that definition/delimitation of 'suitable habitat' may be problematic given the highly restricted nature of the sole remaining natural population. At the scale of the individual plants and based primarily on an analysis of successes and failures within the re-introduction programme, sites which provide a relatively open mosaic of bare limestone and turf with no more than light shading from ash, hazel and hawthorn seem most suitable. At the site scale Cypripedium is associated with transitional vegetation between calcareous grassland and ash woodland: NVC - CG9 and W8g (with some characteristics of MG2).	
Supporting habitat: structure/ function	**Vegetation succession and maintenance of early-succession communities**	Maintain or restore as appropriate supporting habitat in an open, sparsely vegetated early-successional condition.	This feature tends to occur in ecotonal situations subject to succession if ground too stable. Without combination of erosion and accretion (and exposure), habitat patches could gradually become unsuitable, tending towards scrub/bramble, dense Phragmites or rank grassland. Maritime exposure and edaphic/hydrological factors alone are sometimes insufficient to maintain habitat patches in favourable condition. A range of 'natural' and 'anthropogenic' factors may help in maintaining habitat patches at an early-successional stage. Many factors that may be advantageous 'in moderation' could be detrimental in larger doses, but determining 'safe' and 'unsafe' levels may be difficult and are probably site-specific (dependent on topography, exposure, substrate, etc). Aim should be to maintain open vegetation, so any shift towards more closed/tall/rank communities should be avoided as far as possible.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Adaptation and resilience**	Maintain or restore as appropriate the feature's ability, and that of its supporting habitat, to adapt or evolve to wider environmental change, either within or external to the site	See the explanatory notes for this attribute above in Table 2	Natural England, 2015. Climate Change Theme Plan and supporting National Biodiversity Climate Change Vulnerability assessments ('NBCCVAs') for SACs and SPAs in England [Available at http://publications.naturalengland.org.uk/publication/495459459137

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
				5360].
Supporting processes (on which the feature and/or its supporting habitat relies)	**Air quality**	Maintain or, where necessary, restore 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 (www.apis.ac.uk).	See the explanatory notes for this attribute above in Table 1'	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).
Supporting processes (on which the feature and/or its supporting habitat relies)	**Conservation measures**	Maintain or restore] as appropriate the management measures (either within and/or outside the site boundary as appropriate) which are necessary to maintain or restore as appropriate the structure, functions and supporting processes associated with the feature and/or its supporting habitats.	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. 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. There is a possible risk of theft of Lady's slipper orchid as Craven Limestone Complex is the only documented wild site remaining in Britain where the species is found.	Natural England 2014. Craven Limestone Complex SAC Site Improvement Plan, JNCC and Plant Conservation Working Group.2006. Conservation status assessment for: S1902: *Cypripedium calceolus* - Lady's-slipper Orchid. 2006. Second Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2001 to December 2006. Available here
Supporting processes (on which the feature and/or its supporting habitat relies)	**Grazing pressure**	Maintain or restore as appropriate a grazing regime to maintain or restore lightly shaded conditions but avoiding the growing season.	Low levels of grazing outside the growing season are acceptable, but this should not be viewed as a primary way of keeping habitat patches open - edaphic and topographic conditions coupled with natural grazing should be sufficient to achieve the desired community structure. Even moderate levels of livestock grazing or any livestock grazing/trampling during the growing period would be damaging.	
Version Control; Advice last updated: N/A				
Variations from national feature-framework of integrity-guidance: Due to the rarity and high protection status of Lady's-slipper Orchid *Cypripedium calceolus* this table has been left non-site specific with targets set to both maintain or restore as appropriate.				