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

West Midland Mosses Special Area of Conservation (SAC)
Site code: UK0013595

Abbots Moss Photo credit: Paul Thomas

Date of Publication: 7 March 2018

About this document

This document provides Natural England's supplementary advice about the European Site Conservation Objectives relating to West Midland Mosses SAC. This advice should therefore be read together with the SAC Conservation Objectives which are available here.

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

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.

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.

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	West Midland Mosses Special Area of Conservation (SAC)
Location	Cheshire, Shropshire, Staffordshire
Site maps	The designated boundary of this site can be viewed here on the MAGIC website
Designation Date	1 April 2005
Qualifying Features	See SAC Conservation Objectives section
Designation Area	184.18ha
Designation Changes	N/A
Feature Condition Status	Condition assessment information relating to this site can be found using Natural England's Designated Sites search tool.
Names of component Sites of Special Scientific Interest (SSSIs)	Abbots Moss SSSI, Chartley Moss SSSI, Clarepool Moss SSSI, Wybunbury Moss SSSI
Relationship with other European or International Site designations	The boundary of West Midland Mosses SAC overlaps with Midland Meres and Mosses (phase 1) Ramsar (Chartley Moss, Clarepool Moss, Wybunbury Moss) and Midland Meres and Mosses (Phase 2) Ramsar (Abbots Moss).
Other information	Natura 2000 Standard Data Form for West Midland Mosses SAC

Site background and geography

Lying in the lowlands of the Shropshire, Cheshire and Staffordshire Plain National Character Area, the West Midlands Mosses SAC comprises four individual sites: Clarepool Moss, Abbots Moss, Chartley Moss and Wybunbury Moss. These support large basin mires which have developed as quaking bogs, known as 'schwingmoors', together with associated hollows and pools showing various types and stages of mire development, including raised bog on solid peat at two sites. This complexity of habitats gives rise to a diverse assemblage of associated plants and invertebrates of international significance.

The underlying bedrock geology of the area is almost entirely formed of red and brown Triassic sandstones, silts and muds. Glacial activity has affected the whole plain by rounding off hard outcrops of sandstone, creating meltwater channels and lake beds and depositing a variety of materials from boulder clay to marls, sands and gravels. These deposits have in places caused the formation of a number of shallow meres and peat-filled mosses which are present today.

The component sites have been all modified by human activity to a greater or lesser extent, including drainage, peat cutting and nutrient enrichment, generally to the detriment of the natural features.
The restoration of the sites to achieve the best outcomes for the SAC features requires re-naturalisation of the hydrological processes that created them, in terms of both water quality/chemistry and the water supply mechanisms, including groundwater and surface water regimes.

The SAC also includes the Chartley Moss National Nature Reserve and Wybunbury Moss National Nature Reserve.

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:

- **H3160. Natural dystrophic lakes and ponds (Acid peat-stained lakes and ponds)**

  Dystrophic water bodies are very acidic and poor in plant nutrients. Their water has a high humic acid content and is usually stained dark brown through exposure to peat. This habitat is rare in England, and is represented in only two SACs. Most examples of this habitat type are small (less than 5 ha in extent), shallow, and contain a limited range of flora and fauna.

  Some dystrophic lakes have developed a 'schwingmoor' (a floating or quaking area of bog) along their edges, where bog-mosses *Sphagnum* are found in association with cotton-grass *Eriophorum angustifolium* and white water-lily *Nymphaea alba*. Pools are naturally species-poor and a littoral zone is often absent. In the UK, several notable scarce dragonfly species are associated with dystrophic lakes and ponds.

  West Midlands Mosses contains three notable pools, one at Clarepool Moss and two at Abbots Moss, that are examples of dystrophic lakes and ponds in the lowlands of England and Wales, where this habitat type is rare. The pool at Clarepool Moss is unusual as a dystrophic type on account of its relatively base-rich character, which is reflected in the presence of a diverse fauna and flora. The two at Abbots Moss are more typical, base-poor examples.

  The dystrophic lakes and ponds at this site are associated with schwingmoor development, a characteristic of this habitat type in the West Midlands. Schwingmoor is an advancing floating raft of bog-moss *Sphagnum*, which grows from the edge of the pool and can completely cover over the pool; the site has also been selected for this Annex I feature (7140 Transition mires and quaking bogs). Similar pools are also present at Chartley Moss.

- **H7140. Transition mires and quaking bogs (Very wet mires often identified by an unstable `quaking` surface)**

  The term 'transition mire' relates to vegetation that in terms of its floristic composition and general ecological characteristics is transitional between acid bog and alkaline fens, in which the surface conditions range from markedly acidic to slightly base-rich. As a result, the mire vegetation normally has intimate mixtures of species considered to be tolerant of acid conditions and others which flourish in more base-rich conditions.

  In some cases the mire occupies a physically transitional location between bog and fen vegetation, as for example on the marginal 'lagg' of raised bog or associated with certain valley and basin mires. In other cases these intermediate properties may reflect the actual process of succession, as peat accumulates in groundwater-fed fen or open water to produce rainwater-fed bog isolated from groundwater influence. Many of these systems are very unstable underfoot and can therefore also be described as 'quaking bogs'.

  West Midlands Mosses represents schwingmoor vegetation. Floating rafts of *Sphagnum*-dominated vegetation have developed over semi-liquid substrates within basins. In the UK this type of *Sphagnum*-dominated vegetation with a scatter of sedges *Carex* species and cranberry *Vaccinium oxycoccos* is confined to this part of England and mid-Wales.

The West Midland Mosses SAC sites also display excellent examples of spatial transitions from very acidic communities to base-rich vegetation and from open water to terrestrial habitats, as well as temporal transitions from base-rich vegetation to rain-fed bog vegetation.

Table 1: Supplementary Advice for Qualifying Features: H3160 Natural dystrophic lakes and ponds

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 H3160 feature at 2.9ha.	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.	Abbots Moss aerial photographs 2000 & 2010 (available from Natural England). Chartley Moss aerial photographs 2003 (available from Natural England). Clarepool Moss aerial photographs 1999 & 2009 (available from Natural England). LOCKTON, A. AND WHILD, S., 2001. LOCKTON, A. AND WHILD, S., 2003. 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	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 H3160 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. 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	WATER FRAMEWORK DIRECTIVE UK TECHNICAL GROUP. 2016.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			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 *Azolla filiculoides*, New Zealand pigmyweed *Crassula helmsii* and the zebra mussel *Dreissena polymorpha.*	
	Macrophyte community structure	Maintain a characteristic zonation of fringing vegetation. Zonation, depth distribution and structure will be site specific. Colonisation at depth may be limited by poor light penetration or unsuitable sediment type.	This is a strongly characteristic structural aspect of this habitat feature. It will be a response to water transparency, sediment type and disturbance. The dystrophic deep water influences the zonation and structure of aquatic vegetation, meaning the most likely macrophytes are floating communities. Lily Pool at Abbots Moss displays two distinct zones of macrophytes, with acidophilic plants such lesser bladderwort *Utricularia minor* around the edge of the pool, and white water-lily *Nymphaea alba* in the centre.	LOCKTON, A. AND WHILD, S., 2001. LOCKTON, A. AND WHILD, S., 2003. MARTIN, J. 1989. COLESHAW, T. AND WALKER, C., 1998
Structure and function (including its typical species)	Macrophyte community structure	Maintain a characteristic zonation of fringing vegetation around the open water body.	This is a strongly characteristic structural aspect of this habitat feature. It will be a response to water transparency, sediment type and disturbance. Characteristic fringing vegetation of this habitat type includes floating *Sphagnum* lawns and typically low cover of vascular plants such as common cotton-grass, *Eriophorum angustifolium* and round-leaved sundew *Drosera rotundifolia* and may include sedges such as bottle sedge *Carex rostrata.*	LOCKTON, A. AND WHILD, S., 2001. A LOCKTON, A. AND WHILD, S., 2003. MARTIN, J. 1989. COLESHAW, T. AND WALKER, C., 1998
	Macrophyte community structure	Maintain a characteristic and well defined hydrosere associated with the water body where this is present	This represents the natural transition from a fully aquatic open water community (downslope) to a terrestrial community (upslope) and is critically dependent on natural water levels and shorelines. The extent of this hydrosere will depend on the morphology of the lake or pond and the topography of the surrounding area, as well as the substratum and underlying geology. The natural environmental diversity encompassed by a natural hydrosere includes a range of water depths, light climates, wave exposure and sediment types. This structure 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.	LOCKTON, A. AND WHILD, S., 2001. LOCKTON, A. AND WHILD, S., 2003. MARTIN, J. 1989. COLESHAW, T. AND WALKER, C., 1998

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
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.	
	Physical structure - lake substrate	Maintain the natural and characteristic substrate for the lake as predominantly peaty.	Changes in plant community may result from enriched sediments entering the open water body and changing the lake bed. 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.	
	Key structural, influential and/or distinctive species	Restore the abundance of the species listed below to enable each of them to be a viable component of the H3160 Annex 1 habitat; Characteristic species: bladderworts *Utricularia* spp, bog-mosses *Sphagnum* spp, marsh cinquefoil *Comarum palustre* , bulbous rush *Juncus bulbosus ,* white water-lily *Nymphaea alba,* bogbean *Menyanthes trifoliata* and bog pondweed *Potamogeton polygonifolius* with associates of floating bur-reed *Sparganium angustifolium,* floating club-rush *Eleogiton fluitans* and	Some plant or animal species (or related groups of such species) make a particularly important contribution to the 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 habitat's structure or help to define an Annex I habitat on a site (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 site. 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.	JUKES, A., 2015. LOCKTON, A. & AND WHILD, S., 2001. LOCKTON, A AND WHILD, S., 2003.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		Drepanocladus spp. Assemblage of dragonflies and damselflies (including white-faced darter *Leucorrhinia dubia*, downy emerald *Cordulia aenea* and black darter *Sympetrum danae)*.	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. For this feature characteristic and associated species of natural dystrophic lakes and ponds typically include bladderworts *Utricularia* spp., floating bur-reed *Sparganium angustifolium*, bog-mosses *Sphagnum* spp., floating club-rush *Eleogiton fluitans*, blubous rush *Juncus bulbosus*, *Drepanocladus* spp., white water-lily *Nymphaea alba,* bogbean *Menyanthes trifoliate* and bog pondweed *Potamogeton polygonifolius*. The assemblage of dragonflies and damselflies includes fourteen species recorded at Abbots Moss (eleven of which have been known to breed on the site) including the nationally rare, white-faced darter *Leucorrhinia dubia* (no longer present, historic record at Clarepool Moss also) and rare in Cheshire: downy emerald *Cordulia aenea* and black darter *Sympetrum danae.* (Note all of the above have been almost totally lost from Abbots Moss as a consequence of eutrophication). The white-faced dragonfly is still extant at Chartley Moss.	
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 (*Cyprinus* spp) and bream (*Abramis* spp). Fishing stocking is inappropriate for this site.	
Supporting processes (on which the feature relies)	Water quality - phosphate	Restore stable nutrient levels appropriate for lake type. Water is normally acidic and poor in available nutrients. Restore mean annual total phosphorous to less than 10 µg L^{-1}.	Increased loadings of phosphorus (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.	ENVIRONMENT AGENCY 2006, 2014.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
	Water quality - nitrogen	Restore nitrogen concentrations to less than 1.5 mg L^{-1}.	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 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.	
	Water quality - acidity	Restore acidity to levels which reflect un-impacted conditions: Acid Neutralising Capacity (ANC) are >40µeq L-1 annual mean. Typically pH <5.0 for dystrophic lakes and ponds.	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 un-impacted conditions - values of Acid Neutralising Capacity (ANC) considered to avoid significant impact on characteristic biota are the same numerical values as used to protect high ecological status under the WFD in the UK. As a guide, pH <5.0 for dystrophic lakes and ponds. 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.	
	Water quality - other pollutants	Restore 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	Water quality - dissolved	Restore dissolved oxygen levels to >7mg/l throughout the year.	As for species in terrestrial environments, dissolved oxygen (DO) is required for respiration by aquatic organisms. Anthropogenic activities	ENVIRONMENT AGENCY 2006, 2014.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
(on which the feature relies)	oxygen		leading to phytoplankton blooms and 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.	
	Water transparency	Restore the clarity of water to an appropriate level	Water transparency is the major determinant of the depth of colonisation by macrophytes, therefore, it should not be reduced. 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. Water in dystrophic lakes and ponds should be stained by dissolved humic material, and will usually be visibly brown.	
	Water quality - algae	Restore chlorophyll concentrations to a level which complies with 'high' ecological status	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 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%20Statements/lake%20phytoplankton.pdf	ENVIRONMENT AGENCY 2006, 2014.
Supporting processes (on which the feature relies)	Hydrology	At a site, unit and/or catchment level restore natural hydrological processes to provide the conditions necessary to sustain the H3160 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. This is because 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.	BGS borehole logs available from: http://mapapps.bgs.ac.uk/boreholescans_mobile/MobileBoreholeScans.html#/boreholescans_mobile/MobileBoreholeScans.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			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. The dystrophic pools at this site are set within the transition mire and quaking bog feature, which is subject to artificial drainage for peat extraction and agriculture. Hydrological restoration is required, through blocking / infilling of drainage ditches and reduction of woodland cover.	html&ui-state=dialog ENVIRONMENTAL CONSULTANCY UNIVERSITY OF SHEFFIELD (ECUS), 2001a. ENVIRONMENTAL CONSULTANCY UNIVERSITY OF SHEFFIELD (ECUS), 2001b. GRAY, E., 1987 Ground water monitoring boreholes within/ around Abbots Moss (data available from Environment Agency). LOW, R., 2015. RIELEY, J.O. AND PAGE, S.E., 1992. WHEELER, B.D., AND SHAW S.C., 2009. This attribute will be periodically monitored as part of Natural England's site condition assessments.
Supporting processes (on which the feature relies)	Sediment load	Maintain the natural sediment load.	Increases in siltation could result from e.g. increased lake productivity, changes in catchment land-use, (particularly over-grazing and peat harvesting), lake level fluctuations, climatic fluctuations.	
	Supporting off-site habitat	Restore the extent, quality and spatial configuration of land or	The structure and function of the qualifying habitat, including its typical species, may rely upon the continued presence of areas which surround	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		habitat surrounding or adjacent to the site which is known to support the H3160 feature	and are outside of the designated site boundary. The integrity of the dystrophic pools is reliant on the integrity of the transition mire and quaking bog. Changes in surrounding land-use may adversely (directly/indirectly) affect the functioning of the feature and its component species. Of particular importance is the effect of land within the catchment on the hydrology and water quality of the site.	
	Air quality	Restore 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 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 levels for atmospheric nitrogen and acidity are currently being exceeded. 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 at www.apis.ac.uk .
Supporting processes (on which the feature relies)	Functional connectivity /isolation	Maintain the natural connectivity of the water body to other water bodies. This feature is groundwater dependent. Connectivity with surface water may provide pollution source to the feature.	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 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 gene-flow, and habitat and species resilience.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			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.	
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 or restore the structure, functions and supporting processes associated with the H3160 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. ENGLISH NATURE, 2005.
Version Control Advice last updated: 8th February 2018				
Variations from national feature-framework of integrity-guidance: Variations from the national feature-framework of integrity guidance have been actioned on the below sections, all following consultation with Natural England Lakes Senior Specialist: 1) Macrophyte community structure supporting and explanatory notes amended. 2) Water quality – phosphate, nitrogen and acidity targets amended.				

Table 2: Supplementary Advice for Qualifying Features: H7140. Transition mires and quaking bogs

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Extent and distribution of the feature Extent and distribution of the feature	Extent of the feature within the site	Restore the total extent of the H7140 feature to 110 hectares, based on the mapped extent of peat and basin dimensions.	There should be no measurable reduction (excluding any trivial loss) in the extent and area of this feature, and in all cases, the full extent of the feature should 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, and areas capable of restoration to this habitat. 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. This feature includes a range of wetland habitats including bog pools, *Sphagnum* lawns, base-rich fen, wet woodland and rush pasture, and transitions between these habitat types. The extent of peat and basin dimensions have been used to determine the likely extent of the feature prior to drainage.	ENVIRONMENTAL CONSULTANCY UNIVERSITY OF SHEFFIELD (ECUS), 2001B. LOCKTON, A. AND WHILD, S., 2001. LOCKTON, A. AND WHILD, S., 2003. LOW, R., 2015. MARTIN, J. 1989. RIELEY, J.O. AND PAGE, S.E., 1992. COLESHAW, T. AND WALKER, C., 1998 TRATT, R., EADES, P., WHEELER, B., SHAW, S., 2015 This attribute will be periodically monitored as part of Natural England's site condition assessments.
	Spatial distribution of the feature within the site	Restore the distribution and configuration of the H7140. 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.	Abbots Moss aerial photographs 2000 & 2010 (available from Natural England). Environmental Consultancy

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			The extent of peat and basin dimensions have been used to determine the likely extent of the feature prior to drainage. This has mainly occurred since the 19th Century, and has resulted in a reduction in the extent and quality of the designated habitat, increased the susceptibility of the site to scrub invasion, and historic drainage channels provide a pathway for nutrients into the site. The current extent of the feature at all component sites is less than the previous/ potential extent, as a result of ongoing effects of drainage and land uses in the site catchments.	University OF SHEFFIELD (ECUS), 2001b. LOCKTON, A. AND WHILD, S., 2001. LOCKTON, A. AND WHILD, S., 2003. LOW, R., 2015. MARTIN, J. 1989. RIELEY, J.O. AND PAGE, S.E., 1992. COLESHAW, T. AND WALKER, C., 1998 TRATT, R., EADES, P., WHEELER, B., SHAW, S., 2015. This attribute will be periodically monitored as part of Natural England's site condition assessments.
Structure and function (including its typical species)	Vegetation community composition	Ensure the component vegetation communities of the H7140 feature are referable to and characterised by the following National Vegetation Classification types (including transitions between them ; M1, M2, M3, M4, M5, M9, M18, M22, S2, S3, S24, S27, W2, W4, W5	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. The understanding of the scope of this feature in England has recently been much improved by the publication of Tratt *et al*. (2013), which provides a much clearer and less ambiguous definition of the Annex 1 habitat. This clarifies the various types of vegetation encompassed by the term 'transition	LOCKTON, A. AND WHILD, S., 2001. LOCKTON, A. AND WHILD, S., 2003. MARTIN, J. 1989. COLESHAW, T. AND WALKER, C., 1998 TRATT, R., EADES, P., WHEELER, B., SHAW, S., 2015.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			mire' and includes some excluded by the JNCC (e.g. some examples of M21) and others currently often included in other Annex 1 types, e.g. M14.	TRATT, R., PARNELL, M., EADES, P. AND SHAW, S.C. (2013) 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	Restore the abundance of the species listed below to enable each of them to be a viable component of the H7140 habitat. Assemblage of vascular plants: lesser tussock-sedge *Carex diandra,* slender sedge *Carex lasiocarpa,* bog sedge *Carex limosa,* bottle sedge *Carex rostrata,* white beak-sedge *Rhychospora alba*, bogbean *Menyanthes trifoliate,* marsh lousewort *(Pedicularis palustris*) Bryophytes: giant spearmoss *Calliergon giganteum,* yellow starry feather-moss *Campylium stellatum,* rusty hook-moss *Scorpidium (Drepanocladus) revolvens,* hooked scorpion-moss *Scorpidium scorpioides* Assemblage of *Sphagnum*	See the explanatory notes for this attribute given in Table 1 above. The listed species occur or once occurred in the West Midlands Mosses SAC. The damage to the four component sites of the SAC which took place pre-notification resulted in the loss of many characteristic Transition mire & quaking bog species, including some of those listed. The full restoration of the habitat and key species at these sites is likely to require re-introduction of these species when appropriate environmental conditions have been restored. This may include non-listed highly typical species of high conservation status once present on these sites including crested buckler-fern *Dryopteris cristata* and the Annex 2 species slender green feather-moss *Hamatocaulis vernicosus.* In addition, a number of species are listed in the Interpretation Manual that have never occurred or are now extinct in England, the latter group including Rannoch rush *Scheuchzeria palustris*, which previously occurred at Wybunbury Moss and Clarepool Moss.	LOCKTON, A. AND WHILD, S., 2001. LOCKTON, A. AND WHILD, S., 2003. MARTIN, J. 1989. COLESHAW, T. AND WALKER, C., 1998 TRATT, R., EADES, P., WHEELER, B., AND SHAW, S., 2015. 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)
		mosses including *Sphagnum papillosum, S. angustifolium S. fimbriatum, S. riparium S. cuspidatum* *Aneura pinguis* ten-spotted pot beetle *(Cryptocephalus decemacaulatus),* window winged sedge (*Hagenella clathrata*), white-faced darter *(Leucorrhinia dubia*		
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 H7140 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)	Presence / cover of woody species	Restore a low cover (<10% of the area) of scrub or trees within stands of H7140	Native trees and shrubs occur naturally on bog and fen surfaces but an abundance of scrub and trees on bogs and fens can be an indicator of drainage impacts and/or nutrient enrichment birch *Betula* spp, pine *Pinus* spp, willow *Salix* spp and rhododendron (an invasive non-native species) are the main species of concern.	LOCKTON, A. AND WHILD, S., 2001. LOCKTON, A. AND WHILD, S., 2003. MARTIN, J. 1989. COLESHAW, T. AND WALKER, C., 1998 TRATT, R., EADES, P., WHEELER, B., SHAW, S., 2015. This attribute will be periodically monitored as part of Natural England's

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
				site condition assessments.
Structure and function (including its typical species)	Hydrology	At a site and catchment level, restore natural hydrological processes to provide the conditions necessary to sustain and restore the H7140 feature and associated species.	Identifying and restoring the natural hydrological regime (for both groundwater and surface water) is a key step in moving towards achieving the conservation objectives for this site and sustaining this feature. These sites developed their unique features under a regime of natural water flows (surface water and groundwater) with associated water chemistry and nutrient status. Modifications to these through drainage and land-use intensification have resulted in loss of habitat extent, loss of species and general habitat deterioration. This target is generic and further site-specific investigations may be required to fully inform conservation measures and/or the likelihood of impacts.	BGS borehole logs available from: http://mapapps.bgs.ac.uk/boreholescans_mobile/MobileBoreholeScans.html#/boreholescans_mobile/MobileBoreholeScans.html&ui-state=dialog ENVIRONMENT AGENCY, 2010. ENVIRONMENTAL CONSULTANCY UNIVERSITY OF SHEFFIELD (ECUS), 2001b. ENVIRONMENTAL CONSULTANCY UNIVERSITY OF SHEFFIELD (ECUS), 2001c. GRAY, E., 1987 Ground water monitoring boreholes within / around Abbots Moss & Wybunbury Moss (data available from Environment Agency). LOW, R., 2015. NATURAL ENGLAND, 2015.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
				MAINSTONE, C., HALL., R. & DIACK, I. 2016. RIELEY, J.O. AND PAGE, S.E., 1992. TRATT, R., EADES, P., WHEELER, B. AND SHAW, S., 2015. WHEELER, B.D., AND SHAW S.C., 2009.
Structure and function (including its typical species)	Water chemistry	Restore the surface water and groundwater supplies supporting the hydrology of the component sites of the SAC to a natural, low-nutrient status.	As described above. West Midland Mosses is currently subject to nutrient pressures, principally from agriculture, forestry and development.	BELLAMY, B., 2015. DOBSON, M., WEBB, H., SCOTT, D., 2016. ENVIRONMENT AGENCY, 2006, 2014. ENVIRONMENT AGENCY, 2010. Ground water monitoring boreholes within / around Abbots Moss & Wybunbury Moss (data available from Environment Agency). LOW, R., 2015. RIELEY, J.O. AND PAGE, S.E., 1992. WASTE MANAGEMENT CONSULTANTS,

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
				2003.
Structure and function (including its typical species)	Adaptation and resilience	Restore the H7140 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 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 as being **high**, taking into account the sensitivity, fragmentation, topography and management of its habitats. This means that these sites are considered to be the most vulnerable sites overall and are likely to require the most adaptation action, most urgently. This means that action to address specific issues is likely, such as reducing habitat fragmentation, creating more habitat to buffer the site or expand the habitat into more varied landscapes and addressing particular management and condition issues. Individual species may be more or less vulnerable than their habitat itself. In many cases, change will be inevitable so appropriate monitoring would be required. 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.	NATURAL ENGLAND, 2015a.
Structure and function (including its typical species)	Supporting off-site habitat	Restore the extent, quality and spatial configuration of land or habitat surrounding or adjacent to the site which is known to support (directly or indirectly) the H7140 feature	The structure and function of the qualifying habitat, including its typical species, relies upon the continued presence of areas which surround and are outside of the designated site boundary. Activity on surrounding land may adversely (directly/indirectly) affect the functioning of the feature and its component species. This supporting habitat is critical to the typical species of the feature to support their feeding, breeding, roosting, population dynamics ('metapopulations'), pollination or to	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			prevent/reduce/absorb damaging impacts from adjacent land uses e.g. pesticide drift, nutrient enrichment. Sympathetic management of the catchments of the component sites is critical to achieving good condition. All four component sites have activities in their catchments which are known or suspected to be damaging.	
Supporting processes (on which the feature relies)	Air quality	Restore 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 explanatory notes for this attribute in Table 1 above. Site critical loads are currently exceeded, and evidence exists of impacts on bryophytes as a result of this.	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). CALLAGHAN, D., 2015.
Supporting processes (on which the feature relies)	Conservation measures	Maintain or establish the management measures (either within and/or outside the site boundary as appropriate) which are necessary to restore the structure, functions and supporting processes associated with the H7140 feature	Active and ongoing conservation management is currently needed to protect, maintain or restore this feature at the component sites. Further details about the necessary conservation measures for this site can be provided by contacting Natural England. However, removal of pressures, particularly nutrient enrichment and drainage, from the sites will reduce the need for ongoing management intervention. 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. In some cases, the base-rich areas may require ongoing cutting or grazing to maintain its open character.	NATURAL ENGLAND, 2014. NATURAL ENGLAND, 2015b. NATURAL ENGLAND, 2016. NATURAL ENGLAND, 2015c.
Version Control Advice last updated: 8th February 2018				

Attributes	Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Variations from national feature-framework of integrity-guidance*:* Variations from the national feature-framework of integrity guidance have been actioned on the below sections, all following consultation with Iain Diack, Natural England Wetlands Senior Specialist: 1) Extent of feature supporting and explanatory notes amended. 2) Vegetation community target amended. 3) Typical species target & supporting and explanatory notes amended. 4) Presence / cover of woody species supporting and explanatory notes amended. 5) Exposed substrate attribute removed. 6) Hydrology supporting and explanatory notes amended. 7) Water chemistry target amended. 8) Hydrology (high piezometric head) removed. 9) Conservation measures target amended.			

References

BELLAMY, B., 2015. Analysis of surface water quality samples from Wybunbury Moss NNR. Report to Natural England (available from Natural England).

CALLAGHAN, D., 2015. Bryophyte Survey of Wybunbury Moss, Cheshire. Report to Natural England (available from Natural England).

COLESHAW, T. AND WALKER, C.1998 quadrat vegetation survey of Chartley Moss (available from Natural England).

DOBSON, M., WEBB, H., SCOTT, D., 2016. Water quality monitoring of Cheshire meres and mosses. Report to Natural England (available from Natural England).

ENGLISH NATURE, 2005. Views about Management for Abbots Moss SSSI, Chartley Moss SSSI, Clarepool Moss SSSI, Wybunbury Moss SSSI. Available from NE Designated Sites System

ENVIRONMENT AGENCY, 2010. Refining River Basin Planning through targeted investigations on GWDTE. Environment Agency.

ENVIRONMENT AGENCY 2006, 2014. Still Waters Monitoring Programme – Continuous Monitoring of Gull Pool (available from Environment Agency).

ENVIRONMENTAL CONSULTANCY UNIVERSITY OF SHEFFIELD (ECUS), 2001a. Meres and Mosses Conservation Plans: Abbots Moss and Forest Camp. Report to English Nature (available from Natural England).

ENVIRONMENTAL CONSULTANCY UNIVERSITY OF SHEFFIELD (ECUS), 2001b. Meres and Mosses Conservation Plans: Chartley Moss. Report to English Nature (available from Natural England).

ENVIRONMENTAL CONSULTANCY UNIVERSITY OF SHEFFIELD (ECUS), 2001c. Meres and Mosses Conservation Plans: Wybunbury Moss. Report to English Nature (available from Natural England).

GRAY, E., 1987. Abbots Moss Peat depth survey (available from Natural England).

JUKES, A., 2015. Chartley Moss CSM – Invertebrates. Report to Natural England (available from Natural England).

LOCKTON, A. AND WHILD, S., 2001. A botanical survey of Abbots Moss. Report to English Nature (available from Natural England).

LOCKTON, A. AND WHILD, S., 2003. A botanical survey of Clarepool Moss. Report to English Nature (available from Natural England).

LOW, R., 2015. Review of the eco-hydrological status of Chartley Moss, Staffs. Report to Natural England (available from Natural England).

MAINSTONE, C., HALL., R. & DIACK, I. 2016. A narrative for conserving freshwater and wetland habitats in England. Natural England Research Reports, Number 064.

MARTIN, J. 1989. Chartley Moss Habitat Map. Report to English Nature (available from Natural England).

NATURAL ENGLAND, 2014.Site Improvement Plan: West Midland Mosses (SIP261). Available at http://publications.naturalengland.org.uk/publication/5422476326600704

NATURAL ENGLAND. 2015. Hydrological functioning theme plan. (IPENSTP018) - restoring the hydrology of Natura 2000 terrestrial wetlands. Available at http://publications.naturalengland.org.uk/publication/6400975361277952

NATURAL ENGLAND, 2015a. Climate Change Theme Plan and supporting NBCCV Assessments for SACs and SPAs [both available at http://publications.naturalengland.org.uk/publication/4954594591375360].

NATURAL ENGLAND, 2015b. Chartley Moss NNR Management Plan 2015-2020 (available from Natural England).

NATURAL ENGLAND, 2015c. Wybunbury Moss NNR Management Plan 2015-2020 (available from Natural England).

NATURAL ENGLAND. 2016. A Narrative for Conserving Freshwater and Wetland Habitats in England. Available at http://publications.naturalengland.org.uk/publication/6524433387749376

RIELEY, J.O. AND PAGE, S.E., 1992. Hydrology and hydrochemistry of Charley Moss National Nature Reserve (November 1991 – September 1992). University of Nottingham.

TRATT, R., PARNELL, M., EADES, P. AND SHAW, S.C. 2013. Development of Inventories for Annex 1 habitats 'Alkaline Fens' and 'Transition Mires & Quaking Bogs' in England. Report to Natural England; Telford.

TRATT, R., EADES, P., WHEELER, B. AND SHAW, S., 2015. Wybunbury Moss: wetland vegetation survey and eco-hydrological assessment 2015. Report to Natural England (available from Natural England).

WASTE MANAGEMENT CONSULTANTS, 2003. A Hydrological Assessment of the Delamere Sandsheet and Environs. Report to Environment Agency

WATER FRAMEWORK DIRECTIVE UK TECHNICAL GROUP, 2016. Classification of alien species according to their level of impact - revised list.
Accessed at http://www.wfduk.org/resources/classification-alien-species-according-their-level-impact-revised-list

WHEELER, B.D., AND SHAW S.C., 2009. Ecohydrological site accounts for West Midlands: A Wetland Framework for Impact Assessment at Statutory sites in England and Wales. Environment Agency.

WHEELER, B.D., AND SHAW S.C., 2009. Ecohydrological site accounts for West Midlands: A Wetland Framework for Impact Assessment at Statutory sites in England and Wales. Environment Agency.