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

Oxford Meadows Special Area of Conservation (SAC)
Site Code: UK0012845

Pixey and Yarnton Meads. Photo © Peter Wakely

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About this document

This document provides Natural England's supplementary advice about the European Site Conservation Objectives relating to Oxford Meadows SAC. This advice should therefore be read together with the SAC Conservation Objectives available here.

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

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

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

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

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

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

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

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

About this site

European Site information

Name of European Site	Oxford Meadows Special Area of Conservation (SAC)
Location	Oxfordshire
Site Map	The designated boundary of this site can be viewed here on the MAGIC website
Designation Date	1 April 2005
Qualifying Features	See section below
Designation Area	265.89 hectares
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)	Pixey and Yarnton Meads SSSI, Port Meadow with Wolvercote Common and Green SSSI, Cassington Meadows SSSI, Wolvercote Meadows SSSI
Relationship with other European or International Site designations	n/a

Site background and geography

The Oxford Meadows Special Area for Conservation is situated on the broad floodplain of the River Thames to the west and north-west of Oxford. The site is in the Upper Thames Clay Vales National Character Area (NCA Profile 108) and is set in a landscape which is typical of the middle reach of the River Thames. The landscape is characterised by a mixture of large and small grass fields bounded by tall hedges with frequent tall willows. There are broad vistas across the landscape to the 'dreaming spires' of Oxford and the wooded, higher ground dominated by Wytham Woods to the west. There are relatively low levels of intrusion on the surrounding landscape by built development, despite the presence of major roads, railways, gravel workings and settlements. The natural course of the River Thames has been altered as it passes through the complex by creating an additional channel known as the Wolvercote Mill Stream but the Thames is otherwise largely unmodified in this section and regularly floods the adjacent grasslands.

The site is made up of an extensive complex of meadows and pastures which support species-rich grassland vegetation which would once have been widespread on floodplains in lowland England but which is now very rare. The grasslands are located on alluvial, river terrace deposits with silty, mostly free-draining, relatively nutrient-rich soils with varying amounts of flint gravel. The soils are typically neutral in terms of soil chemistry but there are localised indications of moderately alkaline conditions, probably related to the seepage of water through underlying limestones. The grasslands include Pixey and Yarnton Meads and Port Meadow and Wolvercote Common which have a very long history of management by traditional hay making with aftermath grazing and extensive pasture management respectively. This continuity and stability of management contributes to the special character and composition of the grasslands.

The grasslands are situated on predominantly flat ground but small-scale variation in topography created by ancient river channels and deposition features gives rise to features such as seasonally-wet hollows, marshy areas and drier, raised hummocks. This creates subtle variation in the vegetation with transitions from dry grassland, through damp grassland to tall fen and inundation communities. Some areas support marginal beds of common reed *Phragmites australis* indicating that in the absence of regular cutting and grazing parts of the area would be occupied by reed bed and tall fen habitats. The close proximity of the grasslands to Oxford contributes significantly to the special character of the city's landscape setting and Port Meadow in particular is a very popular and fiercely protected amenity for local people. Port Meadow and Wolvercote Common are registered common land and have open public access.

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:

Oxford Meadows SAC has one qualifying habitat:

- **H6510 Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*)**

Together with North Meadow and Clattinger Farm, also in southern England, Oxford Meadows represents **lowland hay meadows** in the Thames Valley centre of distribution. The site includes vegetation communities that are perhaps unique in the world in reflecting the influence of long-term grazing and hay-cutting on **lowland hay meadows**. The site has benefited from the survival of traditional management, which has been undertaken for several centuries, and so exhibits good conservation of structure and function.

The vegetation at Oxford Meadows SAC includes extensive stands of a grassland type which is strongly associated with floodplain meadows. This is characterised by the frequent occurrence of greater burnet *Sanguisorba officinalis*, meadow foxtail *Alopecurus pratensis*, meadowsweet *Filipendula ulmaria*, pepper saxifrage *Silaum silaus* and knapweed *Centaurea nigra*. This grassland type is described as a distinct plant community in the National Vegetation Classification (Rodwell ed. 1992) as type MG4 *Alopecurus pratensis - Sanguisorba officinalis* grassland. This is a nationally rare grassland type with less than 1500 hectares estimated to remain in England (Jefferson 1997). Similar grassland types on mainland Europe have distinct differences in composition (Rodwell *et al* 2007) and so the UK has a particular responsibility to protect the global resource.

The MG4 grassland type occupies extensive areas of Pixey and Yarnton Meads SSSI, Wolvercote Meadows SSSI and Cassington Meadows SSSI. It is otherwise rare in Oxfordshire and is generally present as small, isolated examples. The grassland type is confined to lowland situations and is mostly associated with relatively fertile alluvial soils in floodplain situations which are subject to seasonal (ie winter) flooding. These grasslands are almost exclusively managed as traditional hay meadows with cutting taking place in early summer, followed by grazing of the re-growth or 'aftermath' in autumn or early winter. They are vulnerable to degradation through excessive nutrient input, changes in the cutting or grazing regime, and changes in hydrology.

Qualifying Species:

There is a single qualifying species for which Oxford Meadows is classified as SAC:

- **S1614 *Apium repens* creeping marshwort**

Apium repens is a very rare plant of seasonally-flooded habitats which are unshaded and have very low levels of competition with surrounding vegetation. It is a perennial plant capable of surviving summer flooding and, on mainland Europe, some populations are in locations which are subject to inundation by brackish water. Across its range in Europe colonies are associated with a variety of habitats from short-grazed rush pasture, dune slacks and coastal grassland, riverside gravel banks and even mown grassland in a public park. So the plant appears to be tolerant of a wide range of environmental conditions if there is an absence of shading, ground conditions are wet or at least damp all year round and there are low levels of competition. The species is tolerant of heavy grazing, growing very close to the ground and flowering below the grazing level of cattle and horses. *Apium repens* flowers in most years and produces an abundance of fruit which are capable of survival for several years buried in the soil.

Up until 1995 when DNA analysis was carried out on samples of this plant from Port Meadow there was confusion between *Apium repens* with the very similar prostrate growth form of *Apium nodiflorum* which

occurs in similar habitats, which meant that it was poorly recorded and studied. A great deal of work has been carried out to improve understanding of the ecological requirements and biology of *Apium repens* as part of a Species Recovery Programme, summarised in McDonald & Lambrick (2006).

At the time of SAC classification Port Meadow, a component part of the Oxford Meadows complex, was the only known locality for this plant in the UK. It was formerly recorded at widely scattered localities from Fife and Kintyre in Scotland, to East Anglia, London and Oxfordshire. However, by the 1960s only two populations were known to survive in the UK. The second site additional to Port Meadow, Langel Common in Witney, appears to have been lost as a result of agricultural intensification. Two apparently 'native' populations have subsequently been re-discovered at Binsey Green which is on the opposite bank of the Thames from Port Meadow and in a ditchside location in Walthamstow, Greater London.

Two 'new' colonies have been successfully established through translocation. The Port Meadow population remains the largest and most consistently recorded of the colonies. On Port Meadow *Apium repens* is confined to a narrow ecological zone, associated with seasonally-inundated hollows in the middle and southern parts of the site. The number of plants present varies considerably from year to year suggesting that individual plants have a short life span but re-establishment from seed is consistently good when conditions for germination are suitable.

Apium repens is specially protected through inclusion in Schedule 8 of the Wildlife and Countryside Act 1981 which makes it an offence to pick or uproot any part of the plant for the purpose of offering for sale.

References

Jefferson RG 1997. Distribution, Status and Conservation of *Alopecurus pratensis – Sanguisorba officinalis* Flood-plain Meadows in England. English Nature Research Report 249. Natural England. Peterborough.

Jensen K, Schwerdtfeger J & Burmeier S 2007. EU-LIFE Project Baltcoast: Conservation Guidelines for *Apium repens*.

McDonald AW & Lambrick CR 2006. *Apium repens* creeping marshwort. Species Recovery Programme 1995-2005. English Nature Research report 706. English Nature. Peterborough.

Rodwell, JS. (ed.) 1992. British Plant Communities. Volume 3. Grassland and montane communities. Cambridge University Press.

Rodwell JS, Morgan V, Jefferson RG & Moss D 2007. The European Context of British Lowland Grasslands. JNCC. Peterborough.

Table 1: Supplementary Advice for Qualifying Features: H6510. Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*)

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 at or above the baseline level of 106.96 hectares.	There should be no measurable reduction (excluding any trivial loss) in the extent and area of this feature. The baseline-value of extent was calculated using grassland survey data collated close to the date of SAC classification. The area measurement given will be approximate and the extent of the feature can be expected to vary naturally over time within acceptable limits as a result of natural processes. Note that the extent of an Annex I habitat feature covers the sum extent of all of the component vegetation communities present and will include transitions and mosaics with other closely-associated habitat features. 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. For this feature, there will be year to year fluctuations in composition and perhaps also extent as a consequence of variation in the flood regime and groundwater levels. This may mean that there will need to be some allowance for reversible shifts in vegetation types between NVC type MG4 (H6510) and wetter vegetation types such as inundation grasslands (e.g. types MG13, MG7c) and related vegetation depending on the flood cycle	Porley, R.D. (1998a) National Vegetation Classification survey of Pixey and Yarnton Meads. Unpublished Phase 2 grassland survey held on Natural England file. Porley, R.D. (1998b) National Vegetation Classification survey of Cassington Meadows. Unpublished Phase 2 grassland survey held on Natural England file.
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 conditions may not be suitable for some of the	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			typical and more specialist species associated with the Annex I habitat feature.	
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: MG4 *Alopecurus pratensis - Sanguisorba officinalis* grassland]	This habitat feature is comprised of 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).	
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Maintain or restore as necessary the abundance of the typical species listed below to enable each of them to be a viable component of the Annex 1 habitat: • Constant and preferential plant species of the MG4 *Alopecurus pratensis – Sanguisorba officinalis* grassland type.at this site.	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	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			England will provide bespoke advice on this as necessary.	
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 include indicators of nutrient input and soil disturbance, as well as common constituents of wetland habitats which will increase in abundance in the absence of regular management. Undesirable species include: Creeping thistle *Cirsium arvense*; Spear thistle *Cirsium vulgare*; Docks *Rumex* spp; Nettle *Urtica dioica*; Hogweed *Heracleum sphondylium*; Cow parsley *Anthriscus sylvestris*; Bulky sedges such as *Carex acutiformis*, Common reed *Phragmites australis*; Willows *Salix* spp.	This attribute will be periodically monitored as part of Natural England's SSSI 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. In this case natural variation in topography related to riverine deposition and erosion features and the related differences in soil type and groundwater level give rise to a complex pattern of vegetation types. This variation adds to the special and distinctive character of the site and it important that it is maintained.	
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 between index 0 and 1 (< 15 mgl $^{-1}$).	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.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
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 Oxford Meadows SAC groundwater supply should be assessed as 'good' in relation to Water Framework Directive targets. River water quality in the River Thames upstream of the SAC should be assessed as at least meeting the 'good ecological status' target.	For this SAC feature which is critically dependent on surface and ground water supply, maintaining the quality and quantity of water supply is very important, 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. The hydrological requirements of MG4 type grassland have been investigated in detail and the available information collated in Gowing *et al* (2002).	Anon (2009). Water for Life and Livelihoods – River Basin Management Plan, Thames River Basin District. Environment Agency. Bristol. Gowing DJG, Tallowin JRB, Dise NB, Goodyear J, Dodd ME and Lodge RJ (2002). A Review of the Ecology, Hydrology and Nutrient Dynamics of Floodplain Meadows in England. English Nature research report 446. English Nature. Peterborough.
Structure and function (including its typical species)	**Hydrology: Water table**	Maintain a hydrological regime which provides a consistently near-surface water table which typically averages depths of 35 cm (winter), 45cm (spring), 70cm (summer) and 60cm (autumn) below ground level	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 investigations may be required to fully inform conservation measures and/or the likelihood of impacts. A wealth of information on groundwater levels is available for the Pixey and Yarnton Meads part of the SAC as a result of monitoring of levels in connection with the sand and gravel extraction to the north of the site. This provides year-round data over a number of years. There is limited data available for other parts of the site.	Institute of Hydrology (1984) Worton Rectory Farm – Environmental Monitoring at Yarnton and Pixey Meads SSSIs. Unpublished IoH report. Dixon A 2005. The Hydrology of Oxford Meadows SAC. Report for the Environment Agency.
Structure and function (including its typical species)	**Hydrology: Flooding regime**	Maintain a hydrological regime which provides a cumulative duration of annual surface flooding which is typically less than 10 days between December-February and less than 3 days between September-	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. For this feature, the timing, frequency, extent and duration of surface	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		November, with no inundations during March – August, subject to natural change.	flooding should be commensurate with maintenance of the feature at this site. A non-optimal flooding regime can result in a shift from H6510 to other vegetation types (such as inundation grassland, fen vegetation and reed bed). Too little flooding may compromise the necessary management due to reduced nutrient inputs which will reduce hay yields making hay management less viable and sustainable, whilst summer flooding may prevent hay cutting and grazing. Prolonged summer flooding can also have damaging effects on soils and can affect vegetation composition by encouraging the spread of weedy species and by washing away the seeds of plants.	
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	The structure and function of the qualifying habitat, including its typical species, 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. In this case the close proximity of other grasslands to support grazing stock and handling facilities for stock management are critical aspects to support sustainable management of the H6510 feature. It is important that the SAC is part of a viable, local agricultural economy to support grazing with appropriate livestock and hay-making by traditional methods.	
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	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			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	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. 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. The overall vulnerability of this SAC to climate change has been assessed by Natural England (2015) as being 'medium', taking into account the sensitivity, fragmentation, topography and management of its habitats. This means that this site is considered to be vulnerable and that further assessment and action may be required. In this case vulnerability to damage is related in particular to changes in water supply to the site, both through reduced groundwater levels and changes in the flooding regime.	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]. NERC 2016 Climate Change Impact Report Cards
Supporting processes (on which the feature relies)	**Air quality**	Maintain 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	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)
			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.	
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 will include grazing, hay cutting, control of scrub encroachment and management of hedgerows, weed control and management of watercourses. The retention of suitable land use infrastructure/patterns in the vicinity of the site to enable site management, in particular the availability of land for livestock grazing and livestock handling facilities are critically important.	Views About Management document for Pixey and Yarnton Meads SSSI.
Version Control Advice last updated: N/A				
Variations from national feature-framework of integrity-guidance: N/A				

Table 2: Supplementary Advice for Qualifying Feature: S1614. *Apium repens* Creeping marshwort

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Population (of the feature)	**Area of occupancy**	Maintain the known actual area occupied by the feature, typically varies between 100 and 600 m^2 depending on conditions (notably seasonal fluctuations in water table)	The size, location and extent of the *Apium repens* population at this site is monitored annually and there is a good understanding of how the population varies over time, mostly in relation to flooding regime and groundwater levels. A trend of decreasing numbers of plants, number of separate 'patches' of plants or reduced extent of area occupied would all be considered to indicate a negative change which would require investigation and remedial action.	The population of *Apium repens* is currently monitored annually by the Oxfordshire Flora Group of the Ashmolean Natural History Society.
Population (of the feature)	**Population abundance**	Maintain the abundance of the population at a level which is above the baseline population-size, whilst avoiding deterioration from its current level as indicated by the latest count or estimation. Baseline population size = 100 plants.	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	McDonald AW & Lambrick CR 2006. *Apium repens* creeping marshwort. Species Recovery Programme 1995-2005. English Nature Research report 706. English Nature. Peterborough

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			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. 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. The setting of a baseline population target for the *Apium repens* population at this site is problematic as detailed monitoring has demonstrated that it varies widely from year to year, from less than 50 plants to many hundreds. Although nominally a perennial plant *Apium repens* appears to be short-lived and maintenance of the population is highly dependent upon the production of seed and establishment of new generations of plants each spring as floodwater recedes. Monitoring over the course of a year has shown that the number of plants can vary as a result of young plants dying off or being killed by trampling. It is also important to note that estimation of population size is complicated by the occurrence of the very similar plant *Apium nodiflorum* and the presence of the hybrid between *Apium repens* and *Apium nodiflorum*, which all have very similar characteristics. It can also be difficult to determine what constitutes a single individual plant given the growth form of *Apium repens*, which produces long prostrate shoots which root at each 'node'. In some years only a rough estimation of plant numbers has been possible. However, errors in population size estimation have been reduced through the co-ordination of this work by a core group of volunteer workers. For these reasons the baseline target should be interpreted as indicative only.	
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	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	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
		vegetation types and associated transitional vegetation types, across the site	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. In this case, the maintenance of the open, unenclosed nature of the grassland and the small-scale variation in surface topography are critically important factors. Any reduction in the continuity of the supporting habitat by splitting the area into smaller grazing compartments could be damaging, by affecting aspects such as grazing patterns, trampling pressure and nutrient levels. Small-scale, natural variation in ground levels provides a range of 'niches' with a variety of levels of ground wetness and different vegetation composition types, which will maximise the opportunities for *Apium repens*.	
Supporting habitat: extent and distribution	**Extent of supporting habitat**	Maintain the total extent of the habitat(s) which support the feature at a baseline level of 164.97 hectares, meaning that there should be no reduction in the extent of that part of Port Meadow and Wolvercote Common within the SAC.	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 baseline figure is precautionary. The number of plants of *Apium repens* and the location of centres of population varies considerably from year-to-year in relation to factors such as the depth and duration of flooding. It is important that the whole of both Port Meadow and Wolvercote Common within the designated site boundary are available as potential supporting habitat to allow for this variation.	McDonald AW & Lambrick CR 2006. *Apium repens* creeping marshwort. Species Recovery Programme 1995-2005. English Nature Research report 706. English Nature. Peterborough.
Supporting habitat: structure/ function	**Hydrological regime**	Maintain a regime of winter flooding (at least 2 weeks inundation at least one year in three in areas potentially holding the plant) and gradual drying out in late summer/autumn.	*Apium repens* has a relatively broad tolerance for variation in flooding regime and groundwater supply but individual plants appear to be short-lived. Therefore it is important that suitable conditions for seedling establishment and survival are available at least every one in three years to replenish and maintain the population. Winter flooding is important in creating suitable bare areas in low-lying parts of the site where seedlings can	Dixon A 2005. The Hydrology of Oxford Meadows SAC. Report for the Environment Agency. Gowing D & Youngs E 2005. The Requirements of *Apium repens* – an Ecohydrological Assessment.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			establish when the water recedes in late spring. Established plants are able to tolerate summer flooding but this can kill plants if conditions become anoxic. This may also result in significant changes in the composition of the surrounding grassland, with implications for the viability of the grazing management of the site. *Apium repens* is critically dependent upon groundwater supply to maintain damp ground conditions throughout the growing season. Groundwater supply to the site has been investigated and found to be mainly fed by percolation from the north through the underlying gravels and there is little connection with river levels. This means that the protection of groundwater supply (and quality) in the upstream catchment will be of critical importance. Significant new barriers to groundwater flow or new off-site developments which intercept or divert groundwater supply to the site have the potential to have very damaging influences. Small changes in the pattern of drainage on the site itself may also be damaging, by either increasing flooding in parts of the site or reducing ground wetness.	Cranfield University report for the Environment Agency.
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.	
Supporting habitat: structure/ function	**Vegetation composition: invasive non-native species**	Ensure that invasive non-native plants are not present or that their effects are maintained at a level which does not significantly affect the feature.	*Apium repens* is a weak competitor and so is at risk of adverse impacts through the growth of more robust surrounding vegetation. The invasive New Zealand stonecrop *Crassula helmsii* is present on part of the site but it is not currently in the areas occupied by *Apium repens*. An on-going programme of control is in place to contain the spread of this plant on site.	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
Supporting habitat: structure/ function	**Vegetation structure**	Maintain vegetation supporting *Apium repens* with typically 5-10% cover of patchy bare ground in late summer and a sward typically 1-10cm tall with 75% <5cm.	The availability of bare ground present as small gaps in the turf created by grazing animals and as more extensive areas created by flooding is important for the survival of *Apium repens*. These areas provide opportunities for seeding establishment early in the year before other competing plants have fully developed. However, *Apium repens* often inhabits a narrow zone around hollows at the site as larger bare areas may be utilised as 'dust bath' type features by grazing stock, so it is important that a range of bare ground features are available in suitable areas across the site.	
Supporting habitat: structure/ function	**Water level fluctuation**	Maintain the zones where winter flooding recedes to leave a drying muddy margin with reduced competition.	The maintenance of natural variation in surface topography is of critical importance in maintaining habitat suitability for *Apium repens*. Activities which might reduce this variation such as levelling, re-grading, shallow ploughing, deposition of dredgings and in-filling of ditches would all reduce the extent of available habitat for *Apium repens*.	
Supporting habitat: structure/ function	**Water quality/ quantity**	Maintain water quality and quantity to a standard which provides the necessary conditions to support the feature. For Oxford Meadows SAC groundwater supply should be assessed as 'good' in relation to Water Framework Directive targets. River water quality in the River Thames upstream of the SAC should be assessed as at least meeting the 'good ecological status' target.	For this SAC feature which is critically dependent on surface and ground water supply, maintaining the quality and quantity of water supply is very important, 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.	Anon 2009. Water for Life and Livelihoods – River Basin Management Plan, Thames River Basin District. Environment Agency. Bristol.
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 explanatory notes for this attribute in Table 1. In this case vulnerability to damage is related in particular to changes in water supply to the site, both through reduced groundwater levels and changes in the flooding regime. *Apium repens* is sensitive to damage through prolonged summer drought and drying out of the soil. It is tolerant of summer	

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			flooding as long as conditions do not become anoxic, in which case all vegetation including *Apium repens* tends to die off due to lack of oxygen. Reduced levels of winter flooding may also be damaging as flooding reduces the quantity of competing vegetation. Without this effect conditions can become unsuitable for establishment by *Apium repens*.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Air quality**	Maintain 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. Exceedance of critical loads of plant nutrients supplied via aerial deposition at this site is likely to be masked by the effects of grazing animals in maintaining very short sward conditions. However, this exceedance will be additional to the supply of nutrients in groundwater and surface flooding. The prevalence of artificially raised nutrient levels may have undesirable consequences for *Apium repens*, such as by promoting the growth of competing plants, promoting the spread of weedy species and reducing the availability of bare ground for seedling establishment.	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. In this case the critical aspects are the maintenance of traditional grazing activity, maintenance of water levels, weed control and management of non-native invasive species. *Apium repens* has very low ability to compete with taller-growing plants and is adapted to survive in habitats which are closely-grazed all-year-round. It is highly sensitive to loss through shading cast by surrounding scrub or trees and so its supporting habitat must be kept free of tree and shrub growth. The maintenance of infrastructure affecting water supply and	Oxford Meadows Site Improvement Plan McDonald AW & Lambrick CR 2006. *Apium repens* creeping marshwort. Species Recovery Programme 1995-2005. English Nature Research report 706. English Nature. Peterborough. Jensen K, Schwerdtfeger J & Burmeier S 2007. EU-LIFE Project Baltcoast: Conservation Guidelines for *Apium repens*.

Attributes		Targets	Supporting and Explanatory Notes	Sources of site-based evidence (where available)
			water level, such as ditches, drains and culverts, including where these are off-site, may be very important.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Grazing pressure**	Maintain a stable grazing regime to produce suitable habitat conditions for *Apium repens*, ie maintenance of short sward conditions (at least 75% should be less than 5cm tall) and with frequent bare patches in damp areas of the site, whilst avoiding excessive 'poaching'.	The maintenance of a stable grazing regime is of critical importance. *Apium repens* is a very weak competitor and does not survive well where surrounding vegetation is allowed to grow much above ground level. Cattle and horses or a combination of the two create suitable conditions for *Apium repens* where they are managed extensively. *Apium repens* is grazed by animals but a significant proportion of flowers are produced below grazing level and can produce viable seed in a very short sward. Cattle and horses have the additional benefit of producing small gaps in the turf in damp parts of the site, creating opportunities for seeding establishment. Sheep do not create suitable conditions for *Apium repens* as their grazing tends to create a tight, closed sward with few gaps.	Jensen K, Schwerdtfeger J & Burmeier S 2007. EU-LIFE Project Baltcoast: Conservation Guidelines for *Apium repens*.
Supporting processes (on which the feature and/or its supporting habitat relies)	**Water quantity/ quality**	Maintain water quality and quantity to a standard which provides the necessary conditions to support the feature.	For this feature which is 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. Extensive work has been carried out at this site to investigate the hydrological regime and to place this in the context of the ecological requirements of *Apium repens*. For example see Dixon 2005 and Gowing and Youngs 2005.	Dixon A 2005. The Hydrology of Oxford Meadows SAC. Report for the Environment Agency. Gowing D & Youngs E 2005. The Requirements of *Apium repens* – an Ecohydrological Assessment. Cranfield University report for the Environment Agency.
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