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

River Avon Special Area of Conservation (SAC)
Site code: UK0013016

Date of Publication: 11 March 2019

About this document

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

Where this site overlaps with other European Sites, you should also refer to the separate European Site Conservation Objectives and Supplementary Advice (where available) provided for those sites.

This advice replaces a draft version dated 5 November 2018 following the receipt of comments from the site's stakeholders.

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

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

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

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

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

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

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

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

About this site

European Site information

Name of European Site	River Avon SAC
Location	Dorset, Hampshire, Wiltshire
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	498.24ha
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)	Avon Valley (Bickton to Christchurch) SSSI, Jones's Mill SSSI, Lower Woodford Water Meadows SSSI, Porton Meadows SSSI, River Till SSSI
Relationship with other European or International Site designations	Much of the floodplain within which the River Avon SAC sits forms the Avon Valley SPA. Additionally, one of the tributaries of the river flows through The New Forest SAC and New Forest SPA. The European Site Conservation Objectives for these nearby sites can be found at: • Avon Valley SPA • The New Forest SAC • New Forest SPA

Site Background and Geography

The River Avon and its tributaries (the Nadder, Wylye, and the Bourne) are generally single thread 'chalk rivers' flowing through narrow chalk valleys to converge at Salisbury. Below Salisbury the large calcareous river flows over a wide floodplain, becoming more strongly anastomosed (or branching and inter-connected) south of Ringwood as it flows over tertiary deposits through Hampshire to reach the estuary at Christchurch in Dorset. Some of the River Avon SAC lies within the Cranborne Chase and West Wiltshire Downs Area of Outstanding Natural Beauty (AONB) protected landscape. It is a diverse landscape offering areas of rolling chalk grassland, ancient woodlands, chalk escarpments, downland hillsides and chalk river valleys each with a distinct and recognisable character. The AONB provides a significant wider landscape network which is a key contributor to sustaining wildlife and habitats.

The Avon and its tributaries are each of interest in their own right, and with contrasting geologies, are included in the SAC primarily on account of their importance for the internationally rare or threatened habitat and species: the chalk stream habitat with water crowfoot and starwort vegetation, Atlantic salmon, sea lamprey, brook lamprey, bullhead and Desmoulin's whorl snail.

The headwaters of the Avon and Wylye rise on a complex geology of Upper Greensands and Chalk before developing into chalk rivers. The Nadder is influenced by the Greensand but is again primarily calcareous in character and the River Bourne is a pure chalk stream, as is the River Till, which is also a winterbourne. The site also includes the Dockens Water, an energetic, largely unmodified, steeper and highly sinuous acid stream that drains New Forest heathlands.

The river supports over 180 species of plants including the water crowfoot and starworts that grow in clumps on the river bed. This diverse aquatic plant community supports an extremely rich invertebrate life including mayfly and snails that in turn support an abundant fish fauna and bird life. Adjacent and associated wetland on the floodplain comprises wet swamp and fen providing habitat for the Desmoulin's whorl snail.

The land along the Avon and its tributaries is pasture and arable with improved pasture predominantly within the river corridor. Broadleaved woodland occurs along the Dockens Water and River Nadder, and to a lesser extent along the Wylye, although there has been a significant loss of riparian woody vegetation in recent times. The River Bourne and the main Avon are highly managed within the urban areas.

The Lower Avon floodplain is dominated by pasture (although parts have been subject to gravel extraction) and below Bickton the channel floodplain is designated as an SSSI for its unimproved floodplain grazing marshes that support important wintering bird populations (part of the Avon Valley SSSI, SPA and Ramsar site). The entire river is highly valued for its recreational fisheries; the lower river is widely known for its reputation both for salmon and coarse fishing whilst the upper river, including its many tributaries, is fished for trout and grayling.

The upper greensand, limestone and chalk geology provides major aquifers that result in a high and stable river flow regime dominated by 79-90% groundwater fed flows with numerous spring lines and surface water flows on the floodplain. These aquifers also provide an important public water supply source. Below Salisbury some large non-consumptive surface water abstractions occur on the river. The upper greensand geology also contributes to naturally higher level of phosphates in the upper reaches of the SAC.

Past management for water meadow development, mills, navigation, and in more recent times, flood alleviation for agriculture and urban development has shaped the river over the centuries. Today the River Avon is typically constrained within fixed channels which maintain flows to existing and historic uses, the channels are often modified (i.e. realigned, straightened, over deepened, widened, 120 weirs and structures). These modifications to the river's hydro morphology have led to the considerable loss of river channel habitats and a loss of connectivity between the river and its floodplain. They also influence flow rates on a system that has generally low channel gradients resulting in increased siltation.

Whilst substantial improvements in river water quality have been achieved over recent years, and in particular through improvements made to sewage treatment works, the river is still being adversely affected by nutrient enrichment from both point and more diffuse sources within the river's wider catchment and high levels of siltation.

About the qualifying features of the SAC

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

Qualifying Habitats:

- **H3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation ('Rivers with floating vegetation often dominated by water-crowfoot')**

This habitat type is characterised by the abundance of water-crowfoots *Ranunculus* spp. Floating mats of these white-flowered species are characteristic of river channels in early to mid-summer. They may modify water flow, promote fine sediment deposition, and provide shelter and food for fish and invertebrate animals. There are several variants of this habitat in the UK, depending on geology and river type, and at each site, *Ranunculus* species will be associated with a different assemblage of other aquatic plants.

The Avon in southern England is a large, lowland river system that includes sections running through chalk and clay, with transitions between the two. Five aquatic Ranunculus species occur in the river system, but stream water-crowfoot *Ranunculus penicillatus ssp. pseudofluitans* and river water-crowfoot *R. fluitans* are the main dominants. Some winterbourne reaches, where *R. peltatus* is the dominant water-crowfoot species, are included in the SAC.

Over time the Avon SAC and its tributaries have been managed and modified to suit man's needs. These practices have resulted in more than 50% of the river channel length being modified producing uniform channel habitats, detrimentally modified water velocities and water depths and loss of key features such as gravel substrates, in-channel woody material and tree cover. Surveys have also found the riparian and floodplain vegetation to be severely degraded over much of the system. In addition to the physical impacts; elevated levels of nutrients and sediment loads from diffuse and point sources also continue to impact on the habitat.

The effect of these practices on the habitat features typical species and communities, including the Annex 2 species, is both direct and in-direct and the restoration of a naturally functioning river and floodplain that is sustainably managed is key to the health of the whole river system.

Qualifying Species:

- **S1016 Desmoulin`s whorl snail *Vertigo moulinsiana***

Desmoulin's whorl snail *Vertigo moulinsiana* is the largest *Vertigo* species, with a shell height up to about 2.6 mm. This snail is restricted to calcareous wetlands, usually bordering lakes or rivers, or in fens where high levels of humidity appear to be important in determining local distribution within sites. It normally lives on reed-grasses and sedges, such as reed sweet-grass *Glyceria maxima* and tussocks of greater pond-sedge *Carex riparia* and lesser pond-sedge *C. acutiformis*, where it feeds on the micro-flora, and in autumn it may climb taller reeds and scrub. It is highly dependent on the maintenance of existing local hydrological conditions.

At the time of notification there was an extensive population of Desmoulin's whorl snail along about 20 km of the margins and associated wetlands of the Rivers Avon, Bourne and Wylye. This is one of two sites representing the species in the south-western part of its range, in chalk stream habitat. It occurs here in a separate catchment from the Kennet and Lambourn, within an environment more heavily dominated by intensive agriculture and management for fisheries.

Since then there has been an estimated 86% decline in the population along the length of the river and tributaries (Willing, 2015[9]), the two best remaining populations at Jones's Mill and Porton Meadows located on habitats sustained by spring-lines and backwater hydrology; and not directly dependent on river water. Desmoulin's whorl snail is therefore close to being functionally extinct on this river.

The restoration of a naturally functioning river and floodplain with a network of back-water swamp and fen habitats is critical to the survival of this species in the catchment.

- **S1095 Sea lamprey *Petromyzon marinus***

The sea lamprey *Petromyzon marinus* is a primitive, jawless fish resembling an eel. It occurs in estuaries and easily accessible rivers, and is an anadromous species (i.e. spawning in freshwater but completing its life cycle in the sea). Sea lamprey are the largest of the three species, reaching a size of approximately one metre in length.

After spending 18-24 months feeding at sea, adult sea lampreys migrate into rivers during the spring and early summer. Like other species of lamprey, sea lampreys need clean gravel for spawning, and marginal silt or sand for the burrowing larvae following egg-hatching. They spawn between the months of May-July in areas of pebble and cobble substrate

The River Avon SAC represents sea lamprey in a high-quality river in the southern part of its range. There are excellent examples of the features that the species needs for survival, including extensive areas of sand and gravel in the middle to lower reaches of the river where sea lampreys are known to spawn.

- **S1096 Brook lamprey *Lampetra planeri***

The brook lamprey *Lampetra planeri* is a primitive, jawless fish resembling an eel, and is the smallest of the lampreys found in the UK. It is a non-migratory freshwater species, occurring in streams and occasionally in lakes in north-west Europe. Like other lamprey species, the brook lamprey requires clean gravel beds for spawning and soft marginal silt or sand for the larvae. It spawns mostly in parts of the river where the current is not too strong.

The Avon is a high-quality river that represents the southern part of the range of brook lamprey. A healthy, stable population occurs in the main river and in a number of tributaries. The main river, and in particular its tributaries, provides clean beds of gravel for spawning and extensive areas of fine silt for juveniles to burrow into.

- **S1106 Atlantic salmon *Salmo salar***

The Atlantic salmon is an anadromous species. Spawning takes place in shallow excavations called 'redds', found in shallow gravelly areas in clean rivers and streams where the water flows swiftly. The young that emerge spread out into other parts of the river. After a period of 1-6 years the young salmon migrate downstream to the sea as 'smolts'. Salmon have a homing instinct that draws them back to spawn in the river of their birth after 1-3 years in the sea. This behaviour has resulted in genetically distinct stock between rivers and even within individual rivers, with some evidence of further genetic distinctiveness in the tributaries of large rivers.

The Avon in southern England represents a south coast chalk river supporting Atlantic salmon The salmon populations here are typical of a high-quality chalk stream, unaffected by the introduction of genetic stock of non-native origin.

Salmon numbers within the Hampshire Avon Catchment declined severely at the end of the 1980s and

have remained at much reduced levels since this time. They continue to fail to meet the levels desired for them and do not meet their minimum safe level (the conservation limit). The decline is now thought to be due to a step change in climate effecting rainfall patterns and temperature. The impact of summer low flows and high temperatures are now considered to be the principal limiting factors on the recovery of the population. However, there also continue to be a number of in-river factors that also impact on the salmon population. These include past channel modifications affecting channel habitat such as gravels, water velocities and water depth, and diffuse pollution from a variety of land uses in the wider catchment.

- **S1163 Bullhead *Cottus gobio***

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

The Avon represents bullhead *Cottus gobio* in a calcareous, relatively unmodified river in the southern part of its range in England. The River Avon has a mosaic of aquatic habitats that support a diverse fish community. The bullhead is an important component of this community, particularly in the tributaries.

Table 1: Supplementary Advice for Qualifying Features: H3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
Extent and distribution of the feature.	**Extent of the feature within the site**	Restore the total extent of the H3260 feature (subject to natural changes). A set target length/area extent is not appropriate; however, there should be no reduction in the extent and area of this feature present at notification (498.24 hectares).	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. It should be noted that the adjacent semi-natural wet riparian habitat forms an integral part of the river community. In particular, the River Till is a reliable winterbourne and the riparian vegetation mosaics that show hydroseral zonation of fen, swamp, wet woodland, unimproved chalk and neutral grasslands are integral to the winterbourne type. 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. The Strategic Framework for the Restoration of the River Avon (Halcrow and GeoData 2000) identifies where restoration/assisted natural recovery of river length and channel size and floodplain wetlands will restore a straightened or tightly constrained river. The headwaters and the tributaries such as the Ebble, Nine Mile River, East and West Arm of the Upper Avon, the New Forest streams, that have not been included within the boundary of the SAC (or underpinning SSSI) are integral to the natural functioning of the whole river system and also support the habitats and species for which the site was notified. These headwaters and tributaries therefore have a strong relationship with the integrity of the river SAC as a whole.	[1] HALCROW AND GEODATA. 2009 [2] ENVIRONMENT AGENCY 2010 updated 2012 [3]BLACK AND VEATCH. 2018. [4]IARC – CENTRE FOR AQUATIC PLANT SURVEY. 2000. [5]ENGLISH NATURE. 1994.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
Structure and function (including its typical species)	**Riparian habitat mosaic**	Restore the extent and pattern of in-channel and riparian habitats to that characteristic of natural fluvial processes.	Watercourses with a high degree of naturalness are governed by dynamic processes which result in a mosaic of characteristic physical habitats or biotopes, including a range of substrate types, variations in flow, channel width and depth, in-channel and side-channel sedimentation features (including transiently exposed sediments), bank profiles (including shallow and steep slopes), erosion features (such as cliffs) and both in-channel and bankside (woody and herbaceous) vegetation cover. All of these biotopes, and their characteristic patterns within the river corridor, are important to the full expression of the river's biological community. Winterbournes (River Till), in particular, are shaped by the catchment and natural hydrological characteristics and should exhibit the full range of habitat mosaics from intermittent in the upper reaches through winterbourne and transitional communities to perennial and the associated riparian vegetation mosaics that show hydroseral zonation of fen, swamp, unimproved chalk and neutral grasslands biotopes. A range of physical habitat modifications cause simplification of biotope mosaics, resulting in declines of characteristic biota dependent upon biotopes that have been lost or reduced in extent. This is demonstrated by the 86% decline in the population of Desmoulin's whorl snail along the length of the river and tributaries since 2000 caused in part by the lack of extent, and intensive management, of the riparian edge and floodplain habitats. Rivers that have sections that are already significantly physically modified should be subject to a process for planning and implementing physical restoration measures. This should be based on restoring natural geomorphological processes (including restoration of hydrological continuity between river and floodplain) as far as possible to allow restoration of characteristic and sustainable biotope mosaics, working within the practical constraints of essential flood protection for people and the built environment. Excessive levels of livestock grazing denudes the riparian zone, causes artificially high bank instability, and degradation of the fauna and flora of exposed riverine sediments. Similarly, 'traditional' bank repair, in the form of chalking alters the riverbank and top groundwater and soil conditions; and together with frequent cutting management of the river bank vegetation for fishery purposes impacts on the flora and fauna. Low levels of grazing by suitable livestock are important in generating the full expression of riparian biotopes.	[1]HALCROW AND GEODATA. 2009 [2]EA 2010 updated 2012 [3]BLACK AND VEATCH. 2018. [6] FOREST RESEARCH. 2013. [7] NATURAL ENGLAND [8] ENVIRONMENT AGENCY. 1994-present R [9] WILLING M J 2015.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			The Strategic Framework for the Restoration of the River Avon reported 59% of the length of the River Avon, 36% Nadder, 33% Wylye, 23% Till, 6% Dockens and 2% Bourne to be partially, significantly or severely modified. Modifications include physical barriers to fish and sediment transport (over 120 structures and weirs on the river system) widening and/or deepening of channels, realignment, bank revetments, embankments, tree and large woody debris clearance. The River Avon Restoration Plan identifies options for the full restoration, rehabilitation or enhancement covering 78% of the length of the River Avon, 46% Nadder, 80% Wylye 78% Till, 31% Dockens and 70% of the Bourne.	
Structure and function (including its typical species)	**Riparian zone structure**	Restore a mosaic of natural woody and herbaceous (tall and short swards) vegetation to the riparian zone of the SAC	A mosaic of natural and semi-natural riparian vegetation types provides conditions for all characteristic in-channel and riparian biota to thrive, creating patches of tall and short riparian swards, a mixture of light and shade on the river channel, and tree root systems and a supply of large woody debris that add channel complexity. Patchy tree cover provides shade protection against rising water temperatures caused by climate change. 30% patchy riparian tree cover by length, and up to 50% where the local landscape character is naturally more wooded, but less where wetland wintering and breeding bird habitat is important, (in particular within the Avon Valley SPA) is generally considered optimal for in-channel and riparian habitats. Intensive cutting across significant proportions of the riparian zone is not appropriate. Ideally, grazing levels should be managed at low levels across whole riparian fields. Where this is not feasible, set-back fencing may be established with access provision for limited grazing within the riparian zone Particularly sensitive areas (e.g. exposed riverine sediments likely to support good invertebrate communities) may need to be fenced off to avoid any concentration of livestock activity, even if only present in low numbers. Close bankside fencing that excludes the development of a functional river corridor is not appropriate. Surveys have found that the riparian and floodplain vegetation to be severely degraded over much of the system. The *River Avon SAC Common Standards Monitoring Surveys 2008* (ECUS) report commented on the managed nature of the catchment, with riparian areas often managed for fisheries (with paths, fishing pegs and sometimes whole banks mown) and heavily managed areas such as gardens locally frequent. Extensive bank re-profiling also affects the naturalness of the bank vegetation and riparian zone, with the dis-connectivity of the river from its immediate flood plain resulting in the replacement of natural marginal/inundation communities	[1]HALCROW AND GEODATA. 2009 [6] FOREST RESEARCH. 2013.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			with vegetation more typical of agricultural land, such as tall herbs and rank vegetation or improved or semi-improved grassland. *The vision and strategy for Riparian woodland planting and management to improve River Ecology in the River Avon and River Frome* (Forest Research May 2013) identified that 26-30% by length of the SAC lacks riparian shade and the structural complexity and habitats associated with riparian tree cover. The vision also identified 120ha of riparian land where tree planting would benefit the river's ecology.	
Structure and function (including its typical species)	**Woody debris**	Restore the presence of coarse woody debris within the structure of the river channel	Dead woody material that falls into streams ('woody debris') plays an important role in increasing habitat diversity, providing shelter for fish, supplying a food source for aquatic invertebrates, and for slowing the passage of nutrients downstream. Woody debris is therefore a key feature of healthy rivers. Woody debris should be left in situ, unless there are overriding reasons of public safety (for example to prevent flooding or bridge collapse). Large woody debris generated naturally by native riparian trees should be present and helping to shape the physical structure of the channel (except in upland areas above the natural tree line). In smaller watercourses, temporary debris dams should be a feature of channel dynamics. Woody debris should be left in situ, unless there are overriding reasons of public safety (for example to prevent flooding or bridge collapse). The Framework for the Restoration of the River Avon identified that bank side trees, and associated in-channel woody debris, is the most important missing element of the rivers and is the main driver of physical habitat (and substrate) diversity.	[1] HALCROW AND GEODATA. 2009 [2]EA 2010 updated 2012 [3]BLACK AND VEATCH. 2018.
Structure and function (including its typical species)	**Flow regime**	Restore the natural flow regime of the river, with daily flows as close to what would be expected in the absence of abstractions and discharges (the naturalised flow). The winterbourne type and signature (River Till) should be characteristic of the natural hydrological	The natural flow regime both shapes and sustains characteristic biotope mosaics, affecting factors such as current velocities and bed hydraulics, water levels and depths, wetted area, temperature regime and dissolved oxygen regime, All parts of the natural flow regime are important, including flushing flows, seasonal base-flows and natural low flows. Natural seasonal flow recession is critical in supporting the full expression of ephemeral habitats (marginal and riparian vegetation, exposed riverine sediments, ephemeral headwaters). The catchment and natural hydrological characteristics also have a fundamental influence on winterbourne types. The maintenance of base flows, dependant on naturally hydrological processes, are critical in supporting the full expression of both, the ephemeral plant and invertebrate communities	[10]AMEC [11] WESSEX WATER [12] ALLEN D.J. et al. 2014. [13] ENVIRONMENT AGENCY and WESSEX WATER.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
		conditions for the catchment. :	associated with the winterbourne habitat type, and the riparian vegetation mosaics that show hydroseral zonation between fen, swamp, unimproved chalk and neutral grassland habitats. Any significant impacts on the natural flow regime should be rectified sustainably by reducing flow modifications, not by artificial augmentation, or by altering channel form to fit reduced levels of flow. There should be no increase in the existing level of impact on the natural flow regime, and any significant impacts should be controlled to acceptable levels. Flow targets for WFD high ecological status (HES) should be used to avoid deterioration and for restoration where this is technically feasible. For the Dockens Water and the River Till winterbourne the flow targets are: <5% deviation at <Qn95 <10% deviation at >Qn95 This is not technically feasible for the following rivers;- Upper Avon, Lower Avon, Wylye, Bourne, Nadder and the perennial reach of the River Till For the Upper Avon, Wylye, Bourne, Nadder and the perennial reach of the River Till, the following flow targets (as given in the sites FCTs). are to be applied as a minimum: <10% deviation at <Qn95 (low flows) <10% deviation at Qn50-95 (low to moderate flows) <15% deviation at >Qn50 (moderate to high flows) Whilst these targets vary from the flow targets set out in the JNCC guidelines they were agreed locally between the Environment Agency and Natural England in 2008 based on hydrological and ecological data for the river. It is the EA's expert judgment that there is no justifiable new evidence to diverge from these targets. For the Lower Avon, the following flow targets (as given in the sites FCTs) and based on river size and river type, are to be applied as a minimum: <10% deviation at <Qn95 (low flows) <15% deviation at Qn50-95 (low to moderate flows)	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			<20% deviation at Qn10-Qn50 (moderate to high flows) <10% deviation at >Qn10 (high flows) Where multiple natural channels exist, flow targets should apply across all of these channels - any artificial channels should not create non-compliances in natural channels. The area of river within the River Avon SAC is predominantly within the perennial reaches of the river, although it includes the long reliable winterbourne and intermittent bourne of the River Till SSSI, a tributary of the River Wylye, which supports a very high conservation value invertebrate community. Consumptive ground water abstractions occur in the headwaters of the catchment. Non-consumptive surface water abstractions also occur within the SAC, with two very large fish farm abstractions occurring on the Lower Avon.	
Structure and function (including its typical species)	**Sediment regime**	Restore a natural load and supply of coarse and fine sediment to the river	Coarse sediment supply is essential for the stability of the river channel and for creating and sustaining key biotopes including riffles and exposed shingle banks. This can be interrupted by weirs and other impounding structures, and by dredging or extraction, and can result in channel incision and heavy bankside erosion that have consequences for both biodiversity and river management (e.g. flood risk). Excessive fine sediment supply can lead to the smothering of coarse substrates and the loss of flora and fauna dependent on them. Where fine sediment delivery is a problem, control measures need to be planned in the catchment. Coarse and fine sediment supply should reflect natural supply levels. Fine sediment delivery should not be enhanced by catchment or riparian management practices in ways that lead to siltation problems in the channel or unnaturally high levels of turbidity. Catchment scale evidence for fine sediment sources and the relative absence of bank erosion suggests these will be mostly fine sediments derived from the land. Routes from the land into the river network are prime targets for reducing sediment delivery. Fine sediments are conveyed readily throughout the system by the relatively long duration of high in-bank flows and therefore local sources have widespread impact. The river is also highly sensitive to local controls (i.e. hatches, weirs, debris fall, plan form variation etc.). This creates a system that is best managed for sediment supply at the catchment scale.	[14] NATURAL ENGLAND. 2015 [15] WESTCOUNTRY RIVERS LTD. 2016. [16] WESSEX CHALK STREAM AND RIVERS TRUST AND APEM. 2016. [17] ADAS 2016. [18] APEM (2011) [19] DEMONSTRATION TEST CATCHMENT. 2011-2017. [20] ENVIRONMENT AGENCY. WFD

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			SCIMAP outputs for the Avon catchment highlight a widespread potential for fine sediment erosion. Despite widespread vulnerability localised areas with relatively high sediment erosion vulnerability were identified around: • the streams flowing into the East and West Avon; • the slopes to the south of the River Nadder and the slopes to the north of the Sem and Upper Nadder; • the New Forest Streams especially Ditchend Brook in the north to Linford Brook in the south. And also; • the headwaters of the Wylye • the Bourne catchment south of Allington • a relatively small amount of sediment erosion vulnerability was shown in lowland areas to the southwest and in river floodplains. A more 'flashy' and extreme hydrograph due to climate change could increase future sediment loads in the river from terrestrial and riverine riparian sources during extreme high rain flow events impacting on the rivers biota.	
Structure and function (including its typical species)	**Thermal regime**	Maintain a natural thermal regime to the river (subject to a changing climate), ensuring that river water temperature should not be significantly and artificially elevated	Climate change is driving increases in river temperatures which will create stress for a range of characteristic riverine species, particularly those on the southern limit of their range. This must not be exacerbated by catchment activities that are likely to raise water temperatures further. Restoration of riparian tree cover to suitable levels will be needed in many cases, particularly in headwater streams, systems affected by alder phytophthora and river reaches lacking any riparian trees. Within the existing records there is evidence of increasing winter and summer water temperatures within the River Avon system (and UK climate modelling: UKCP09 projections predict river temperatures are expected to rise by between 2°C and 4°C by the 2050s compared to the long-term 1961-90 average temperature). It is also understood that a step change in climate at the end of the 1980s had an effect on rainfall patterns and temperature influencing conditions in riverine habitat within the River Avon, and impacting on the Atlantic salmon population, in particular. Channel modification and lack of riparian tree cover effects the resilience of the River Avon to increasing frequency or severity of drought and flood. 38% by length of the Avon, Wylye, Nadder and Till rivers are partially, significantly or severely modified and 26-30% by length of the SAC lacks riparian shade and the structural complexity and habitats associated with riparian tree cover.	[21] NATURAL ENGLAND AND RSPB. 2014. [22]ENVIRONMENT AGENCY. 2005. [23] ENVIRONMENT AGENCY 2009. [24] ENVIRONMENT AGENCY. 2012. . [6] FOREST RESEARCH. 2013. [1] HALCROW AND GEODATA. 2009 [25] WESSEX WATER AND WESSEX CHALK STREAM

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
				AND RIVERS TRUST
Structure and function (including its typical species)	**Biological connectivity**	Restore the free movement of the typical species of the SAC feature through the site	Many species, including fish and invertebrates, require natural freedom of movement to complete their life cycle in rivers and maximise their population size and genetic diversity. Longitudinal connectivity within the river channel and lateral connectivity between the channel and the floodplain are both critical to a healthy river ecosystem. Constraints to longitudinal movement such as debris dams are a natural feature of rivers and add to the complexity and diversity of the habitat. New artificial constraints to movement should be avoided and existing artificial constraints should be addressed through strategic river restoration as outlined above. Barriers should be removed where-ever possible to restore all aspects of habitat integrity - fish passes constitute a partial mitigation measure for longitudinal biological movement and should only be considered where it is not possible to remove the barrier. Where established, they should allow for the passage of as many characteristic species as possible, including Annexe II fish species such as lamprey species. The Restoration Strategy found over 120 structures and weirs currently present on the river system. The cumulative impact of these barriers must be considered.	[1]HALCROW AND GEODATA. 2009 [2]EA 2010 updated 2012 [3]BLACK AND VEATCH. 2018.
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 only having a minimal impact on the integrity of the habitat	Non-native species constitute a major threat to many river systems. Impacts may be on the river habitat itself (e.g. damage to banks and consequent siltation) or directly on characteristic biota (through predation, competition and disease), or a combination of these. For example, species such as signal crayfish have been responsible for much of the decline of native crayfish through competition, habitat damage and the introduction of crayfish plague. The UK Technical Advisory Group (UKTAG) of the Water Framework Directive produces a regularly updated classification of aquatic alien species (plants and animals) according to their level of impact. In general, high impact species are of greatest concern but low or unknown impact species may be included in the target on a site-specific basis where there is evidence that they are causing a negative impact (for example high cover values or abundances). Those taxa considered likely to colonise lakes, are indicated by an 'L' in the UKTAG guidance. Examples of such high-impact species may include Water Fern, New Zealand pgymyweed and the zebra mussel. The distribution and population density of signal crayfish is understood to be	[26] WILTSHIRE WILDLIFE TRUST 2013. [27] WILTSHIRE WILDLIFE TRUST. 2012. [28] WILTSHIRE WILDLIFE TRUST 2011-2014. [29] ENVIRONMENT AGENCY. 2013.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			presently limited to isolated populations within the catchment.	
Structure and function (including its typical species)	**Key structural, influential and/or distinctive species**	Restore and/or maintain the abundance of the species listed below to enable each of them to be a viable component of the Annex 1 habitat; Diverse fish community Running water invertebrate assemblages (chalk stream) Population of Otter *Lutra lutra* Population of Water vole *Arvicola amphibius* Plant communities characterised by pond water crowfoot *Ranunculus peltatus* and associated aquatic herbs and grasses High conservation value winterbourne macroinvertebrate assemblage	Some plant or animal species (or related groups of such species) make a particularly important contribution to the necessary structure, function and/or quality of an Annex I habitat feature at a particular site. These species will include; • **Structural** species which form a key part of the Annex I habitat's structure or help to define that habitat on a particular SAC (see also the attribute for 'vegetation community composition'). • **Influential** species which are likely to have a key role affecting the structure and function of the habitat (such as bioturbators (mixers of soil/sediment), grazers, surface borers, predators or other species with a significant functional role linked to the habitat) • **Site-distinctive** species which are considered to be a particularly special and distinguishing component of an Annex I habitat on a particular SAC. There may be natural fluctuations in the frequency and cover of each of these species. The relative contribution made by them to the overall ecological integrity of a site may vary, and Natural England will provide bespoke advice on this as necessary. The list of species given here for this Annex I habitat feature at this SAC is not necessarily exhaustive. The list may evolve, and species may be added or deleted, as new information about this site becomes available. The flora of the River Avon is rich and abundant with water crowfoots, starwort and pondweed species reflecting the varied geology and river conditions. The stands of swamp and fen vegetation along the river and associated wetlands provide habitat for the Desmoulin's whorl snail (see table 2 below). The invertebrate fauna of the Avon is extremely rich and contains most of the species associated with a large river running through calcareous areas. In the upper stretches, over clay, there is a reasonable range of mayfly species and a variety of gastropods. The middle reaches have the most diverse fauna, again especially mayflies and mollusca, including the very localised *Baetis atrebatinus*. The river also supports an extremely diverse fish fauna which in addition to the Annex II species include wild populations of migratory sea trout, brown trout, minnow, 3-spined stickleback, dace, stone loach, pike, grayling, perch, roach,	[30] ENVIRONMENT AGENCY [31] ENVIRONMENT AGENCY [32] WESSEX WATER.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			gudgeon. It is also of importance for characteristic river mammals such as the water vole and otter The River Till exhibits a long reliable winterbourne from intermittent through winterbourne and transitional to perennial plant communities with associated high conservation value 'classic' winterbourne macroinvertebrate communities including *Paraleptophlebia werneri*. The working assumption is that the biological standards to protect HES should generally be consistent with protecting the composition and abundance of the corresponding components of characteristic biological community - however, this has yet to be properly tested and there will be limitations to this which must be taken into account.	
Structure and function (including its typical species)	**Fisheries**	Restore fish densities to a level at or below the natural environmental carrying capacity of the river, and should not be increased above historical levels. Trout stocking should not elevate densities of adult trout (stocked plus natural) to more than 1-3 fish 100m², this being the estimated range of natural trout densities in SAC rivers. A site-specific estimate of natural trout densities (of between 1 and 3 fish 100m²) should be made and the stocking regime should be tailored to be compatible with this.	Fish stocking can cause elevated levels of competition and predation that may damage the characteristic biological community. Ideally, fishery management should be based on natural recruitment, with an emphasis on restoring characteristic river habitat in ways that promote natural recruitment. Exploitation should be controlled to suitable levels, and net limitations and catch-and-release techniques used where necessary to avoid population impacts. Fish introductions, exploitation and other removals should not interfere with the ability of the river to support self-sustaining populations of characteristic species. Stocking should be undertaken so as to avoid risks of disease transfer, including crayfish plague where white-clawed crayfish populations are at risk. Exploitation and removal should not cause significant suppression of characteristic fish species (e.g. Atlantic salmon, eel, pike) or affect the balance of the fish or wider biological community. The stocking of carp to still waters immediately adjacent to SAC rivers is undesirable if there is continuity between river and still water during periods of flood and no effective biosecurity measures are in place. Stocking for population conservation purposes should only be considered as an interim measure whilst underlying environmental problems are addressed, and should not be undertaken if natural recovery can be achieved in reasonable timescales. Fish should be sourced to avoid impacts on the genetic integrity of local populations (including sub-catchment genetics where appropriate, e.g. for salmon). The River Bourne is designated as a Wild Trout river. In 2012 netting in the estuary was banned under a local byelaw. Byelaws also regulate the salmon rod fishing	[31]ENVIRONMENT AGENCY [33] ENVIRONMENT AGENCY

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			methods and season. A voluntary agreement for 100% catch and release for Salmon has been operated since 2000. There is also a voluntary restriction where angling is not permitted above river temperatures of 19^0C (at Knapp Mill).	
Structure and function (including its typical species)	**Cover of submerged macrophytes**	Maintain a sufficient proportion of all aquatic macrophytes to allow them to reproduce in suitable habitat.	Removal of submerged vegetation (often referred to as 'weed-cutting') might be undertaken for flood risk management or fishery purposes. Except in situations of extreme flood risk, it is best practice for cutting to leave a mosaic of submerged and marginal vegetation, and should promote a characteristic diversity of plant species (in terms of cover, food supply and spawning substrate). It is recommended that where appropriate a weed management plan is developed for the site, allowing for higher levels of cutting at flood risk pinch-points, balanced by lower levels of cutting in other stretches. Weed-cutting should not interfere with the ability of the river channel to downsize through encroachment of marginal vegetation during the summer flow recession. Weed cutting is undertaken on parts of the Upper Avon, Wylye and Nadder for fishery purposes. For the most part it is undertaken in a sensitive manner, although the 2009 CSM report found that occasional reaches of the river were more intensively managed, leading to over-dominant *Ranunculus* growth to the detriment of both the biodiversity of the plant community and the diversity of habitat provided by the river as a whole. Weed cutting can have the effect of dramatically lowering water levels of the riparian zone and inadvertently effect species that depend on stable soil moisture conditions and ditch water levels such as Desmoulin's whorl snail.	[34] ENVIRONMENT AGENCY. 2010.
Structure and function (including its typical species)	**Screening of intakes and discharges**	Maintain the effective screening of all intakes and discharges likely to entrain a significant number of individuals of characteristic species	Intakes and discharges can be responsible for significant mortalities of fish. Long-distance migratory species such as Atlantic salmon sea trout and European eel can be particularly susceptible.	
Structure and function (including its typical species)	**Supporting off-site habitat**	Maintain habitats beyond the site boundary upon which characteristic biological communities of the SAC may depend	The characteristic biological communities of the site are dependent on the integrity of sections of river channel, riparian areas, and transitional and marine waters that lie outside of the site boundary. Headwater areas and tributaries may not fall within the site boundary, yet a range of species characteristic of the site may use these areas for spawning and juvenile development and be critical for sustaining populations within the site.	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			Fully developed riparian zones are essential to site integrity, yet part of this zone may lie outside of the site boundary, particularly if the river channel is operating under natural processes and moves laterally over time within the floodplain. The conditions experienced by long-distance migratory species (such as salmon, sea and river lampreys and eels) outwith the site (through the saline transition zone, estuary, coastal waters and into the high seas) are critical to the well-being of populations within the site. The headwaters and winterbournes of the upper Avon, Wylye, Bourne and Nadder, and tributaries such as the Ebble, Nine Mile River, Alan River, New Forest streams etc. are integral to the natural functioning of the whole river system and also support the habitats and species for which the site is notified. The geology of some of the headwaters result in soils susceptible to agricultural diffuse pollution issues and these local sources in the wider catchment have a widespread impact within the SAC. Along the SAC length of river channel itself, is often a complex network of back channels and streams resulting from the legacy of mills and water meadows. In particular, these smaller channels often provide important juvenile SAC fish habitat that is rarer within the SAC itself. The SAC river is also dependent on numerous springs that occur within the floodplain. These springs often also support wet fen and swamp habitat that may also provide conditions for the Desmoulin's whorl snail.	
Supporting processes (on which the feature relies)	**Water chemistry - alkalinity**	Maintain natural levels of alkalinity	Natural alkalinity levels are critical to characteristic biological communities, with many species adapted to certain parts of the alkalinity range. Mass transfers of water can disrupt the natural alkalinity regime. The Avon SAC has predominantly, and naturally, high alkalinity levels - c.200-250mg/l of calcium carbonate (CaCO3), even where it is influenced by clay geologies such as the Nadder. The Dockens water flowing off the acid heaths is low alkalinity.	[35] ENVIRONMENT AGENCY
Supporting processes (on which the feature relies)	**Water quality - nutrients**	Restore the natural nutrient regime with any anthropogenic enrichment above natural/background concentrations limited to levels at which adverse	Elevated nutrient levels interfere with competitive interactions between higher plant species and between higher plants and algae, leading to dominance by attached forms of algae and a loss of characteristic plant species (which may include lower plants such as mosses and liverworts). Through changes to plant growth and plant community composition and structure they also affect the wider food web, altering the balance between species with different feeding and behavioural strategies. The	[36] DAVID TYTHEDSLEY ASSOCIATES. 2015 [14] NATURAL ENGLAND. 2015.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
		effects on characteristic biodiversity are unlikely.	respiration of artificially large growths of benthic or floating algae may generate large diurnal sags in dissolved oxygen and poor substrate conditions (increased siltation) for fish and invertebrate species. The management focus is typically on phosphorus (P) in rivers, on the assumption that it can be more easily controlled at levels that limit the growth of plant species. However, nitrogen may also be important in river eutrophication and ideally co-limitation would be the management aim. As a minimum, the nutrient levels should be reduced to values appropriate to the river's typology and nutrient character. The target values given are based on a best fit of the river system into the river typology. For P, these levels are: Low altitude, low alkalinity headwaters (near natural nutrient character): 15ug/l P - Dockens Water Low altitude, high alkalinity headwaters (near natural nutrient character): 20 ug/l P - River Till (winterbourne reach) Low altitude, high alkalinity rivers (near natural nutrient character): 30ug/l P - River Till (perennial reach) Low altitude, high alkalinity, chalk or clay headwater (impacted in nutrient character): 40ug/l P - River Wylye (headwater waterbody) Low altitude, high alkalinity, chalk or clay rivers: (impacted in nutrient character): 50ug/l P - River Avon, River Wylye (headwater, middle and lower waterbodies), River Nadder, River Bourne At this SAC, elevated levels of phosphorus are preventing the targets from being achieved across much of the catchment and ongoing investigation by Bristol University and the British Geological Society aims to identify the contribution of phosphorus that may originate from the Upper Greensand geology within the upper reaches of the Avon, Nadder and the middle reaches of the Wylye. Future investigations will also aim to identify the interaction of factors that in near natural conditions may moderate the adverse effects of high phosphorus in groundwater, such as low nitrogen levels, high flow velocity, shade, low water temperature and phosphorus storage and release from sediment on the floodplain. These investigations will inform further local refinement of targets (for nutrients and other	[15] WESTCOUNTRY RIVERS LTD. 2016. [35] ENVIRONMENT AGENCY [37] ENVIRONMENT AGENCY. 2018. [19] DEMONSTRATION TEST CATCHMENT.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			factors) for the river that will limit the impact of nutrients to levels at which adverse effects on characteristic biodiversity are unlikely.	
Supporting processes (on which the feature relies)	**Water quality - organic pollution**	Maintain organic pollution levels at no more than; Dissolved Oxygen = 85% saturation Mean Biological Oxygen Demand = 1.5 mg L-1 Total ammonia = 0.25 mg L-1 NH3-N Un-ionised ammonia = 0.021 mg L-1 NH3-N	Organic pollution effects the biota in a number of ways, including direct toxicity (from ammonia and nitrite), reduced dissolved oxygen levels (from microbial breakdown of organic material), and nutrient enrichment. Reducing organic pollution levels reduces toxic effects but unmasks enrichment effects. Controlling the continuous input of low levels of organic material is critical to controlling the enrichment effect. The values given apply throughout the SAC not just at routine sampling points - assessment can be made by modelling (assuming full mixing of effluents at the point of discharge).	[35] ENVIORNMENT AGENCY
Supporting processes (on which the feature relies)	**Water quality - acidification**	At Dockens Water, maintain levels of acidity at those which reflect un-impacted conditions.	Acid deposition can cause major changes to flora, fauna and ecosystem functioning and affects organisms as diverse as diatoms, invertebrates and fish. Upland streams are particularly susceptible owing to the higher rainfall in these areas. Acid impacts are typically sporadic and tend to be greatest during the winter months. In humic (or peat-stained) waters, pH is naturally lower due to the presence of weak acids, and the pH standard is correspondingly lower for these waters. However, humic compounds also provide buffering capacity that helps to reduce fluctuations in pH. Acidification lowers dissolved organic carbon in these waters, reducing the buffering capacity and altering ecosystem functioning. The values given should be applied throughout the site, not just at routine sampling points. Note that, in respect of ANC, some allowance may need to be made for anthropogenically elevated levels of humic substances in rivers and streams draining degraded peat bodies - this artificially raises the buffering capacity of the water and may under-estimate the anthropogenic acid load. The values given are the same numerical values as used to protect high ecological status under the WFD in the UK. These are: ANC: mean ANC for all waters: >80 pH Clear Waters with DOC <10mg/L: mean >6.54 pH Humic Waters with DOC>10mg/L-1: mean >5.1	[35] ENVIRONMENT AGENCY

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
Supporting processes (on which the feature relies)	**Water quality - other pollutants**	Achieve at least '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 Environmental Quality Standards (EQS) for individual pollutants that are designed to protect aquatic biota with high levels of precaution. These values should be applied throughout the site, not just at routine sampling points. In addition to these pollutants, high levels of natural hormones, such as oestradiol, testosterone, 11-ketotestosterone, prostaglandins and the synthetic ones such as 17α-ethinyloestradiol, are known to occur downstream of fish farms and sewage treatment works. Further investigation is required to determine the significance of any impact on habitat integrity and also on the SAC species Atlantic Salmon. EQSs for the steroid oestrogens have been proposed under the requirements of the WFD.	[38] CEFAS. 2009. [39] ENVIRONMENT AGENCY. 2010.
Supporting processes (on which the feature relies)	**Air quality**	Maintain or, where necessary, restore concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System (www.apis.ac.uk).	This target has been included because 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 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.	[40] CENTRE FOR ECOLOGY AND HYDROLOGY
Version Control Advice last updated: **8 March 2019:** Following stakeholder feedback additional information include to clarify targets in “Flow regime” attribute				

Variations from national feature-framework of integrity-guidance: n/a

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Table 2: Supplementary Advice for Qualifying Features: S1016 Desmoulin's whorl snail *Vertigo moulinsiana*

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
Supporting processes (on which the feature and/or its supporting habitat relies)	**Conservation measures**	Restore the management measures (either within and/or outside the site boundary as appropriate) which are necessary to restore the structure, functions and supporting processes associated with the feature 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. A recent survey (2015) has reported an 86% decline in the population over the last 15 years (Willing M. J. 2015) with the species at threat of becoming extinct in the catchment. Whilst the period since 2000 has included extended summer flooding, long periods of drought and high summer and low winter temperatures management is also highlighted as a major contributory factor to the decline. Low ground moisture levels, shading from woody species and reeds, site damage from poaching and fen cutting, and flooding are all reported as causes for the decline or loss of the snail from individual sites. In addition the 'traditional' bank repair (in the form of chalking) which is common on the river, alters the soil and ground moisture conditions of the riverbank and top; and together with frequent cutting management of the river bank vegetation for fishery purposes impacts on the flora and fauna of the riparian edge. The two best remaining populations are not directly dependent on river water but from spring-lines and backwater hydrology (Jones's Mill and Porton Meadows). Restoration of a naturally functioning river and floodplain with a focus on the riparian edge and a network of back-water fen and swamp habitats as well as the in-river habitat is critical if this species is not to be lost from the catchment. Protection and management of the hydroseral zone (river margin through to the bank top) is necessary to protect the hydrological connectivity between the river and floodplain and to provide open areas of undisturbed tall fen and swamp vegetation.	[41] Killeen IJ (2003).

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
Supporting habitat: extent and distribution	**Extent of supporting habitat**	Restore the total extent of the feature's supporting habitat (subject to natural changes). A set target area is not appropriate; however, there should be no net reduction in the extent and area of the habitat present at notification; a minimum of 20km (4-6ha marginal and riparian swamp habitat) of river channel margins and the associated wetlands of the rivers Avon, Bourne and Wylye and 4.75ha of associated swamp, fen and ditch habitat.	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 to 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 habitats known or likely to support the feature at this SAC are fen and swamp vegetation and ditch habitats. A survey report in 2002 highlighted the meta population as vulnerable due to the restricted extent of the habitat within an intensively farmed catchment with the majority of habitat consisting of small fragmented sites. Since 2002 there has been an 86% decline in the population (Willing M. J. 2015) and the species is at threat of becoming extinct in the catchment. There is an urgent need, not just to restore and maintain the individual sites, as surveyed between 1996 and 2002, but to restore a functioning wetland network of fen, swamp and ditch habitats across the floodplain and integral to the river, both within and outside the SAC area. In particular, there is a need to focus restoration of the river on the riparian edge as well as the in-channel ecosystem.	[42]KILLEEN, I.J. 1996. [43] KILLEEN, I.J. & WILLING, M.J 2002. [9]WILLING M J 2015.
Supporting habitat: extent and distribution	**Distribution of supporting habitat**	Restore the distribution and continuity of the feature's supporting habitat, including where applicable its component vegetation types and associated transitional vegetation types, across the site	A contraction in the range, or geographic spread, of the feature (and its component vegetation) across the site will reduce its overall area, the local diversity and variations in its structure and composition, and may undermine its resilience to adapt to future environmental changes. Contraction may also reduce and break up the continuity of a habitat within a site and how well the species feature is able to occupy and use habitat within the site. Such fragmentation may have a greater amount of open edge habitat which will differ in the amount of light, temperature, wind, and even noise that it receives compared to its interior. These conditions may not be suitable for this feature and this may affect its viability. Sites of fen and swamp habitat are small and fragmented within the Avon catchment, both within the SAC and also within the wider catchment. They are therefore more vulnerable to edge effects and to drying out. The individual areas of habitat need to be restored to functioning habitats but they also need to lie within a hydrologically functioning network of fen,	[9]WILLING M J 2015.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			swamp and ditch habitats across the floodplain and integral to the river, both within and outside the SAC area. In particular, it is necessary to restore a natural river bank profile (and management) to allow a hydroseral zone of fen and swamp habitat to develop along the riparian corridor.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Adaptation and resilience**	Restore 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	This recognises the increasing likelihood of supporting 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 high, taking into account the sensitivity, fragmentation, topography and management of its supporting habitats. This means that this site is considered to be one of the most vulnerable sites overall and is likely to require the most adaptation action, most urgently. A site based assessment should be carried out as a priority. 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 advisable. A more 'flashy' and extreme hydrograph could impact on Desmoulin's whorl snail in a number of ways. Of particular concern is the potential for more summer droughts to dry out habitat and for extreme summer high rain flow events to flood sites. The species is particularly vulnerable and has low resilience to both these scenarios due to limited extent, and fragmented	[21] NATURAL ENGLAND AND RSPB. 2014. NATURAL ENGLAND, 2015.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			nature of the habitat across the site and wider floodplain. Restoration of a hydrologically functioning network of wetland habitats linking the hydroseral zone of the river and the floodplain (both within and outside the SAC) is critical in enabling the species to be resilient to changing prevailing conditions due to extremes in weather patterns – increased storminess and flooding to increased droughts through climate change.	
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 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 processes (on which the feature and/or its supporting habitat relies)	**Water quantity/quality**	Restore water quality and quantity to the standards given for the H3260 feature in table 1. Restore water quantity to provide conditions so that water levels are continuously at or above the ground surface throughout the year.	For many SAC features which are dependent on wetland habitats supported by surface and/or ground water, maintaining the quality and quantity of water supply will be critical, especially at certain times of year. Poor water quality and inadequate quantities of water can adversely affect the structure and function of this habitat type. Typically, meeting the surface water and groundwater environmental standards set out by the Water Framework Directive (WFD 2000/60/EC) will also be sufficient to support the achievement of SAC Conservation Objectives but in some cases more stringent standards may be needed to reflect the ecological needs of the species feature. The optimum water level for Desmoulin's whorl snail is where ground water levels are continuously at or above ground surface level (0-0.5m) and further site-specific investigations may be required to establish appropriate water quality standards for the SAC. The Desmoulin's whorl snail is especially vulnerable to a lowering of the water table and therefore sensitive to changes in hydrology due to water abstraction, drainage and also localised activities such as water level management (river and/or ditch), weed cutting and chalking of river banks.	
Supporting processes (on which the feature and/or its supporting	**Air quality**	Maintain or, where necessary, restore concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values	The supporting habitat of this feature is considered sensitive to changes in air quality. Exceedance of these critical values for air pollutants may modify the chemical status of the habitat's substrate, accelerating or damaging plant growth, altering its vegetation structure and composition (including food-plants) and reducing supporting habitat quality and population viability	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
habitat relies)		given for this feature of the site on the Air Pollution Information System (www.apis.ac.uk).	of this feature. 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.	
Supporting habitat: structure/ function	**Vegetation structure**	Maintain dense stands of tall vegetation within supporting habitat, which is typically >70cms tall by August, with an abundance of tussocks and decaying leaf litter.	Humidity is important to all whorl snails (Vertigo spp.) and the different species achieve their requirements by occupying different levels (i.e. vertical movement) within their microhabitats. Desmoulin's whorl snail is a climbing species on emergent vegetation, living over a large vertical range at different times of year. The snail may over-winter in the lower levels of vegetation, within tussocks or in amongst decaying layer of leaf litter and vegetation. Associated supporting vegetation is usually tall, bulky marginal plants such as reed sweet-grass *Glyceria*, sedges *Carex* spp, bur-reed *Sparganium* sp. and yellow flag *Iris pseudocorus* which characterise swamp and fen communities (such as NVC types S7, S5, S2, S3 & S6 swamp communities), but also in stands characterised by common reed *Phragmites*. Drift into communities characterised by common nettle *Urtica* populations can signal undesirable drying-out.	
Supporting habitat: structure/ function	**Vegetation composition - invasive non-native plants**	Ensure invasive non-native plants are either rare or absent within the site	Desmoulin's whorl snails are potentially or actually at risk from non-native invasive plants. Such plants are considered a major threat to their supporting habitat due to their rapid growth and dominance over native species and the difficulty of controlling them. Species of concern include Japanese knotweed (*Polygonum [Fallopia*] japonica), Himalayan [Indian] balsam (*Impatiens glandulifera*) and giant	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			hogweed (*Heracleum mantegazzianum*).These riparian plants may directly alter the composition of Desmoulin's whorl snail habitat by replacing preferred species and increasing shading.	
Supporting habitat: structure/ function	**Ground moisture**	Restore and then maintain appropriate hydrological and ground moisture conditions so that water levels are continuously at or above the ground surface throughout the year.	High groundwater levels throughout the year are considered to be one of the most important factors influencing the distribution of Desmoulin's whorl snail. For this feature, the water level must remain close to the surface so that the ground remains at least moist for most of the summer, although some seasonal drying appears to be acceptable. Relatively high groundwater also contributes to maintaining a high humidity in the vegetation. The optimal degree of ground moisture for this feature is usually measured as 2 or 3 using a version of the '5 Point Wetness scale' (Killeen & Moorkens 2003). Dry ground moisture levels occur across many of the areas of swamp and fen habitat where the snail has either declined or been lost since 2000. It is suspected that it may be a fall in the ground moisture levels since 2000 that has contributed to this decline either due to increased abstraction, climate change or individual site management that has lowered the water levels.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Water flow (rivers)**	Restore the natural flow regime of the river so that daily flows are as close to what would be expected in the absence of abstractions and discharges (the naturalised flow). (See the advice above for the H3260 habitat feature)	The natural flow regime both shapes and sustains the characteristic habitat mosaics of the river and its floodplain. All parts of the natural flow regime are important, including flushing flows, seasonal base flows and natural low flows. Any significant impacts on the natural flow regime should be rectified sustainably by reducing flow modifications. Peak flows are of particular importance in aiding the spread of individuals for colonization of suitable habitats downstream.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Mosaic of floodplain habitat**	Restore the extent and patterning of in-channel and riparian habitats which are characteristic of natural fluvial processes. (also see the advice above for the H3260 habitat feature)	Watercourses with a high degree of naturalness are governed by dynamic processes which result in a mosaic of characteristic physical features and habitats (or 'biotopes'), including a range that are important to Desmoulin's Whorl Snail. A range of physical habitat modifications to rivers (such as channel straightening, widening and deepening, bankside and bed protection, close floodbanks and impoundments) can disconnect them from their floodplain, resulting is disjointed distributions of suitable habitat for Desmoulin's Whorl Snail.	See references for the H3260 feature above

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			Rivers that have sections that are already significantly physically modified should be subject to a process for planning and implementing physical restoration measures. This should be based on restoring natural geomorphological processes (including where possible restoration of continuity between river and floodplain) as far as possible to allow restoration of characteristic and sustainable biotope mosaics, working within the practical constraints of essential flood protection for people and the built environment. In certain instances, important sections of river channel and areas of wetland habitat may lie outside the boundary of the site, but may still be integral to how the site functions.	
Population (of the feature)	**Abundance**	Restore a healthy adult: juvenile structure and population density (typically>250 individuals per m^2 in late summer), whilst avoiding deterioration from current levels as indicated by the latest peak count or equivalent.	This will ensure there is a viable population of the feature which is being maintained at or increased to a level that contributes as appropriate to its Favourable Conservation Status across its natural range in the UK. Due to the dynamic nature of population change, the target-value given for the population size or presence of this feature is considered to be the minimum standard for conservation/restoration measures to achieve. This minimum-value may be revised where there is evidence to show that a population's size or presence has significantly changed as a result of natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is designated, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account in any assessment.	[9] WILLING M J 2015. [42] KILLEEN, I.J. 1996. [43] KILLLEEN, I.J. & WILLING M.J. 2002. [45] WILLING, M.J. 2011.

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			Unless otherwise stated, the population size or presence will be that measured using standard methods, Plastic tray sampling, or white sheet beating surfaces are typically used as sample points in wetlands for assessments of this species. 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. Between 1996 and 2002 the snail was recorded as present at 62 sites across the SAC. Of these sites it was abundant at 3 sites, locally abundant at 1, very common at 4, common at 7 sites, locally common at 2, frequent at 6, occasional to frequent at 6, occasional at 13, sparse at 8, and rare at 6 Over the last 15 years there has been an **86% decline** in population along the length of the river and tributaries (Willing, 2015), and the species is at threat of being functionally extinct on the river system. The two best populations are located in sites supported by spring-lines and backwater hydrology (Jones's Mill and Porton Meadows) and therefore not directly dependent on river. There is an urgent need to both; restore and maintain the individual sites identified between 1996 and 2002 (including the length of hydroseral zone), and to restore/create a functioning fluvial system; a wetland network of fen, swamp and ditch habitats across the floodplain integral to the riparian river edge habitat, both within and outside the SAC area. In particular, there is a need to focus restoration of the river on the riparian edge as well as the in-channel ecosystem.	
Population (of the feature)	**Connectivity with other populations**	Restore the abundance and supporting habitat of Desmoulins whorl snail upstream of the SAC and the connectivity between populations.	This recognises the vulnerability of the upper-most populations of Desmoulin's whorl snail within a river system to localised extinction; it remains likely that colonies are moved during flood events to downstream sites, so the loss of headstream populations weakens the opportunities to overcome localised extinction events or adverse impacts further downstream within the SAC.	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			Restoration of a hydrologically functioning fluvial system, a network of wetland habitats linking the river, including the full extent of the hydroseral zone, and the floodplain (both within and outside the SAC), is critical to both restore the population and to enable the species to be resilient.	

Version Control
Advice last updated: n/a

Variations from national feature-framework of integrity-guidance: n/a

References

[9] WILLING M J 2015. *SAC Status reporting on Vertigo moulinsiana in England: Monitoring at selected sites on the Hampshire / Wiltshire River Avon and tributary rivers Wylye and Bourne* Natural England Article 17 Reporting on Vertigo snails in England). http//publications.naturalengland.org.uk/file/5317815198285824

[21] NATURAL ENGLAND AND RSPB. 2014*. Climate Change Adaptation Manual: 10. Rivers and Streams.* Natural England Publications available at*:* **http:*//* publications.naturalengland.org.uk/file/5558226472927232**

[41]KILLEEN IJ (2003). *Ecology of Desmoulin's Whorl Snail.* Conserving Natura 2000 Rivers Ecology Series No. 6. English Nature, Peterborough http://publications.naturalengland.org.uk/file/117011

[42] KILLEEN, I.J. 1996. *A survey of the River Avon and tributaries (Wiltshire/Hampshire) and associated wetland habitats to assess their importance for the snail Vertigo moulinsiana* and *A further survey of the River Avon and tributaries (Wiltshire) and associated wetland habitats to assess their importance for the snail Vertigo moulinsiana* Reports to English Nature. http://publications.naturalengland.org.uk/publication/5661922948022272 .

[43] KILLLEEN, I.J. & WILLING M.J. 2002. *Desmoulin's Whorl Snail (Vertigo moulinsiana) distribution survey of the River Avon cSAC.* Report to the Environment Agency **– Available from Environment Agency on request**.

[45] WILLING, M.J. 2011. *An assessment of Desmoulin's Whorl Snail Vertigo moulinsiana on the River Avon SAC, River Avon System SSSI and associated SSSIs*. Draft Report to Natural England - **Available from Natural England on request**.

Table 3: Supplementary Advice for Qualifying features: *S1106* Atlantic salmon *Salmo salar*

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
Supporting processes (on which the feature and/or its supporting habitat relies)	**Conservation measures**	Maintain management or other measures (within and/or outside the site boundary as appropriate) necessary to restore the structure, functions and supporting processes associated with the feature.	See relevant text in Table 1 above. Habitat outside the SAC boundary include the River Ebble, small tributaries, back streams and back waters is also important in providing habitat for the species, in particular fry and juvenile habitat.	[23] ENVIRONMENT AGENCY. 2009.
Supporting habitat: extent and distribution	**Extent of supporting habitat**	Restore the total extent of habitat(s) which support the feature; 498.24 hectares of H3260 habitat (water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation)	See relevant text in Table 1 above. The habitats known or likely to support the feature at this SAC are: running water, rivers and streams.	[23] ENVIRONMENT AGENCY. 2009. Also see references for the extent of the Habitat feature H3260
	Distribution of supporting habitat	Restore the distribution and continuity of the feature and its supporting habitat, including where applicable its component vegetation types and associated transitional vegetation types	See relevant text in Table 1 above.	[23] ENVIRONMENT AGENCY. 2009. Also see references for Habitat feature H3260.
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 relevant text in Table 1 above. Ongoing research strongly suggests that the crash in salmon population (which was also reflected in sea trout and river fly-life populations) at the end of the 1980s was as a result of dramatic climatic changes acting on temperature and rainfall patterns. It is now known that higher sea and river temperatures may be affecting salmon survival and migration in some years. Changes in river flows also affect the number of fish – by impacting on their migration, habitat and food availability. A more 'flashy' and extreme hydrograph could impact on salmonids in a number of ways. Of particular	[23] ENVIRONMENT AGENCY. 2009. [47] SOLOMON AND LIGHTFOOT. 2009 [25] ENVIRONMENT AGENCY (2012) [6] FOREST RESEARCH. 2013. [1] HALCROW AND GEODATA. 2009

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			concern is the potential for an increased sediment load in the river from terrestrial and riverine riparian sources during extreme high rain flow events. Restoration of the supporting habitat for water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation is critical in enabling the species to be resilient to changing prevailing conditions due to extremes in weather patterns – increased storminess and flooding to increased droughts and a long term trend for increasing river temperature through climate change.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Air quality**	See general advice for the H3260 habitat feature	See relevant text in Table 1 above.	
Supporting habitat: structure/ function	**Biotope (habitat) mosaic**	See general advice for the H3260 habitat feature	Within the river, a characteristic habitat mosaic shaped by natural processes provides the diversity of water depths, current velocities and substrate types necessary to fulfil the spawning, juvenile, adult and migratory requirements of salmon. Some river sections will be naturally sub-optimal for some salmon life stages, and this is just a characteristic of the river. The species requires adult holding areas (generally pools of at least 150 cm depth, with cover from features such as undercut banks, vegetation, submerged objects and surface turbulence), spawning habitat (stable, clean gravel/pebble-dominated substrate without an armoured layer and with <10% fines in the top 30cm, and with 15-75cm of overlying water), nursery habitat (for fry, water of <20 cm deep and a gravel/pebble/cobble substrate for parr, water 20-40 cm deep and similar substrate). Close juxtaposition of biotopes is needed to allow easy movement of individuals between suitable areas of the channel under different flow conditions and with age.	
	Riparian zone	See general advice for the H3260 habitat feature	High riparian tree cover is beneficial to salmon, in terms of physical habitat provision and combatting increasing temperatures caused by climate change. However, the extent of tree cover needs to be optimised to provide suitable conditions for the whole characteristic biological community.	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
	Woody debris	See general advice for the H3260 habitat feature	Woody debris is an important component of river habitat for salmon as well as the wider biological community.	
	Flow regime	See general advice for the H3260 habitat feature	The natural flow regime is critical to all aspects of the salmon life cycle, including migratory passage through the estuary and up the river to spawning grounds, egg incubation in redds, fry and parr habitat quality and extent, and downstream smolt migration.	
	Sediment regime	See general advice for the H3260 habitat feature	Natural levels of coarse sediment supply are critical to the maintenance of high quality juvenile and salmon habitat, maintaining spawning gravels and characteristic biotope mosaics. Excessive delivery of fine sediment, from the catchment or artificially enhanced bank erosion, can damage gills, impair vision and cause siltation of spawning and nursery areas.	
Supporting habitat: structure/ function	**Thermal regime**	See general advice for the H3260 habitat feature	Water temperature can affect egg development, fish survival, feeding and growth. The salmon is particularly vulnerable to increasing temperatures in the southern part of its English range, most notably in chalk streams. It is now known that higher sea and river temperatures may be affecting salmon survival and migration in some years. Studies have shown that in 2005 the Avon had the highest summer water temperature at its tidal limit of a range of southern chalk streams and rain fed rivers. Summer temperatures are reaching levels that may reduce the quality of eggs that female salmon produce and be directly impacting on parr survival. They may also be inhibiting migration into the river and increasing the mortality of adult salmonids. The operation of fish farms is known to be contributing to this temperature increase during these critical summer periods. It is also thought that the operation of some water meadow systems may affect river temperature.	[23] ENVIORNMENT AGENCY. 2009. [25] WESSEX WATER, WESSEX CHALK STREAM & RIVERS TRUST [22] ENVIRONMENT AGENCY. 2005. Also see references under Adaptation and resilience.
Supporting habitat: structure/ function	**Biological connectivity**	See general advice for the H3260 habitat feature	Freedom of movement throughout the river system is critical to all life stages of salmon. Barriers to adult migration have cumulative effects on the ability of individuals to reach spawning grounds and need to be considered in combination.	See references for habitat feature H3260.
	Water quality - nutrients	Restore the natural nutrient regime of the river, with any anthropogenic enrichment above natural/background concentrations limited to levels at which adverse effects on the feature are unlikely.	In addition to the wider ecosystem effects of eutrophication that have a detrimental effect on salmon habitat, enrichment can place salmon at a competitive disadvantage, for instance relative to brown trout. Salmon are efficient foragers that are adapted to low productivity environments, and increased productivity makes efficient foraging obsolete. Eutrophication and episodic pollution causes direct mortalities, whilst chronic pollution affects substrate condition through the build-up of excessive microbial populations. Salmon are particularly sensitive to reduce dissolved oxygen	See references for the H3260 habitat feature

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			levels, in the water column and within the gravel substrate of spawning redds (nests).	
	Water quality - organic pollution	See general advice for the H3260 habitat feature	The above comments on eutrophication are also relevant here. Episodic pollution causes direct mortalities whilst chronic pollution affects substrate condition through the build-up of excessive microbial populations. Salmon are particularly sensitive to reduce dissolved oxygen levels, in the water column and within the gravel substrate of spawning redds.	
	Water quality - acidification	See general advice for the H3260 habitat feature	Salmon are highly sensitive to acidification stress.	
	Vegetation composition: invasive non-native species	See general advice for the H3260 habitat feature	Species such as signal crayfish can have a serious effect on salmon habitat and can predate heavily on salmon juveniles if present at high densities. Chinese mitten crab has the potential to migrate long distances up rivers and damage marginal habitats used by both adult and juvenile salmon.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Fisheries - introduction of salmon and/or other fish species**	Ensure fish stocking/introductions do not interfere with the ability of the river to support self-sustaining populations of the feature.	The management aim is to provide conditions in the river that support a healthy, natural and self-sustaining salmon population, achieved through habitat protection/restoration and the control of exploitation as necessary. Stocking represents a loss of naturalness and, if successful, obscures the underlying causes of poor performance (potentially allowing these risks to perpetuate). It carries various ecological risks, including the loss of natural spawning from broodstock, competition between stocked and naturally produced individuals, disease introduction and genetic alterations to the population.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Fisheries - exploitation**	Ensure exploitation (e.g. netting or angling) of Atlantic salmon is undertaken sustainably without compromising any components of the population, including multi-sea winter fish and seasonal components of the adult run.	Controls on exploitation should include migratory passage within territorial waters, including estuarine and coastal net fisheries, as well as exploitation within the river from rod fisheries. In 2012 netting in the estuary was banned under a local bylaw. Bylaws also restrict the salmon rod fishing methods and season. A voluntary agreement for 100% catch and release for Salmon has been operated since 2000. There is also a voluntary restriction where angling is not permitted above river temperatures of 19^0C (at Knapp Mill). The River Bourne is designated as a Wild Trout river.	
	Control of livestock	See general advice for river habitat (H3260)	Over-grazing of riparian areas can have a dramatic effect on salmon habitat.	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
	grazing activity			
Supporting habitat: structure/ function	**Vegetation structure: cover of submerged macrophytes**	See general advice for river habitat (H3260)	In rivers where it naturally occurs, submerged and marginal aquatic vegetation is an important element of juvenile salmon habitat.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Screening of intakes and discharges**	See general advice for river habitat (H3260)	Salmon can be seriously affected by inadequate screening on their adult and smolt migrations, as well as on their smaller juvenile dispersion movements between spawning grounds and nursery areas.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Integrity of off-site habitats**	See general advice for river habitat (H3260)	Salmon populations are dependent on the integrity of sections of river channel and riparian areas, and transitional and marine waters that lie outside of the site boundary. Headwater areas and tributaries may not fall within the site boundary, yet salmon may use these areas for spawning and juvenile development and be critical for sustaining populations within the site. Fully developed riparian zones are essential for salmon habitat, yet part of this zone may lie outside of the site boundary, particularly if the river channel is operating under natural processes and moves laterally over time within the floodplain. The conditions experienced by salmon on their marine migration (through the saline transition zone, estuary, coastal waters and into the high seas) are critical to the well-being of populations within the river, and vice versa.	
Population (of the feature)	**Adult run size**	Restore the population to that expected under un-impacted conditions, allowing for natural fluctuations. This should include a seasonal pattern of migration characteristic of the river and maintenance of the multi-sea-winter component. As a minimum, the Conservation Limit for the river system should be complied with.	Impacts on physical, chemical or hydrological integrity, or from non-native species, or from exploitation in freshwater or marine and coastal waters, may suppress adult run size. Stocking may also artificially augment adult run size, and may mask environmental problems or generate impacts on naturally spawned individuals. The Conservation Limit should be based on the adult run size required to fully utilise all parts of the catchment that would be suitable for spawning and juvenile development under un-impacted conditions. The Knapp Mill Fish Counter is a reliable returning estimate of annual salmon numbers at this site. It is also used to provide data for annual stock estimates and egg deposition figures. Crucially this facility also provides data on the timing of fish migrations and how these respond to changes in	[48] ENVIRONMENT AGENCY

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			river flow and temperature.	
Population (of the feature)	**Spawning distribution**	Restore the distribution of spawning activity to reflect un-impacted conditions through the site, and avoid reductions in existing levels.	After a year or more at sea, adult salmon return from their feeding grounds back to their river. Once it is time for them to spawn they will migrate upstream to the areas of the SAC where they were born to spawn themselves. These spawning areas may be in small tributaries of river systems where there is clean gravel and a good flow of fresh clean water. Maintaining these spawning areas is critical to the successful reproduction and long-term viability of this feature. Redd count data is collected when environmental conditions are suitable. Although this data is not suitable as a stock assessment tool, it is valuable for identifying migration issues especially during low flow years and changes over time of the spawning range of migratory salmonids.	[48] ENVIRONMENT AGENCY
Population (of the feature)	**Juvenile densities**	Restore the densities of juvenile salmon at those expected under un-impacted conditions throughout the site, taking into account natural habitat conditions and allowing for natural fluctuations	Impacts on physical, chemical or hydrological integrity, or from non-native species, or from exploitation of spawning adults in freshwater or marine and coastal waters, may suppress juvenile densities. There is an annual juvenile salmonid survey programme at 13 sites in the Avon catchment. The sites were chosen on the basis that they represented typical juvenile salmonid habitat. Not all 13 sites are always monitored and currently 10 are surveyed. The data set enables salmonid densities to be compared across the sites in any year and crucially to identify changes in densities over time. To monitor the spread of the juvenile salmonid populations across the Avon Catchment an additional 14 sites are surveyed once every 6 years.	[48] ENVIRONMENT AGENCY
Version Control Advice last updated: n/a				
Variations from national feature-framework of integrity-guidance: n/a				
References [1] HALCROW AND GEODATA. 2009 *The Strategic Framework for the Restoration of the River Avon.* Report for Natural England, the Environment Agency and Wessex Water - Available from NE on request [6] FOREST RESEARCH. 2013. *The vision and strategy for Riparian woodland planting and management to improve River Ecology in the River Avon and River Frome.* Report for the Environment Agency - Available from Environment Agency on request [22] ENVIRONMENT AGENCY. 2005. *Anthropogenic Influences on the Temperature Regime in a Chalk River* - Available from Environment Agency on request				

Attributes	Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
[23] ENVIORNMENT AGENCY 2009. *The Hampshire Avon's Action Plan for Salmon and Sea Trout* - Available from Environment Agency on request [25] WESSEX WATER AND WESSEX CHALK STREAM AND RIVERS TRUST Temperature monitoring programme – Data available from Wessex Water and/or the Wessex Chalk Stream & Rivers Trust on request [47] SOLOMON AND LIGHTFOOT. 2009 *Variations in Salmon Abundance on Hampshire Avon – influences of climate throughout the life cycle* – Available from Environment Agency on request [48]ENVIRONMENT AGENCY monitoring data (including from Knapp Mill) - Available from Environment Agency on request			

Table 4: Supplementary Advice for Qualifying Features: S1095 Sea lamprey *Petromyzon marinus*; S1096 Brook lamprey *Lampetra planeri;* S1163 Bullhead*;*

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
Supporting processes (on which the feature and/or its supporting habitat relies)	**Conservation measures**	Maintain management or other measures (within and/or outside the site boundary as appropriate) necessary to restore the structure, functions and supporting processes associated with the features	See relevant text above in Table 1.	[49] MAITLAND P.S. 2003 [50] TOMLINSON M. L. & PERROW M. R. (2003).
Supporting habitat: extent and distribution	**Extent of supporting habitat**	Restore the total extent of habitat(s) which support the features; 498.24 hectares of H3260 habitat (water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation)	See relevant text above in Table 1.	
Supporting habitat: extent and distribution	**Distribution of supporting habitat**	Maintain the distribution and continuity of the features and their supporting habitat, including where applicable its component vegetation types and associated transitional vegetation types, across the site	See relevant text above in Table 1.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Adaptation and resilience**	Maintain the feature's ability, and that of their supporting habitat, to adapt or evolve to wider environmental change, either within or external to the site	See relevant text above in Table 1.	
Supporting processes (on which the feature and/or its supporting habitat relies)	**Air quality**	See the target above for the H3260 habitat feature	See relevant text above in Table 1.	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
Supporting habitat: structure/ function	**River biotope (habitat) mosaic**	See the target above for the H3260 habitat feature	Habitat conditions for lamprey species vary naturally in rivers. Some river sections may provide optimal habitat for some or all life stages whilst others may be largely unsuitable. Adult lamprey require spawning substrates of coarse material in which to deposit eggs in shallow scrapes ('redds'). Larval lamprey ('ammocoetes') live in silt beds, which are often in channel margins but in relation to sea lamprey are known to occur in deep water in main river reaches. Optimal conditions for Bullhead typically occur in relatively shallow, fast flowing reaches with coarse substrates (used for egg-laying and juvenile/adult cover). A characteristically diverse biotope mosaic allows the bullhead and other species to move within the channel to locate optimal habitat conditions in the face of a fluctuating flow regime. Pools, exposed tree root systems and marginal shallows are important high-flow refugia for the species. The advice for the H3260 habitat feature is based on natural river function, which provides a characteristic river habitat mosaic that can cater for both lamprey life stages to a degree.	
	Riparian zone	See the target above for the H3260 habitat feature	Active marginal vegetation including riparian trees provides important habitat for lamprey ammocoetes, as it encourages and stabilises the formation of silt beds in which the ammocoetes burrow. It also provides important cover for bullhead. A mosaic of vegetation types and sward heights provides suitable conditions for the whole characteristic biological community including bullhead. Riparian trees also add substrate diversity and aid the formation of silt beds and clean gravels. They also provide temperature gradients in the channel that improves the availability of suitable micro-habitat.	
	Woody debris	See the target above for the H3260 habitat feature	Woody debris is an important component of river habitat for lampreys and bullhead as well as the wider biological community. It encourages characteristic heterogeneity in biotopes and provides a mosaic of substrates types that lamprey species need to fulfil their life cycle. Bullheads are particularly associated with woody debris in lowland	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			reaches, where it is likely that it provides an alternative source of cover from predators and floods. It may also be used as an alternative spawning substrate.	
	Flow regime	See the target above for the H3260 habitat feature	The natural flow regime is critical to all aspects of lamprey and bullhead life cycle. For lamprey it shapes the characteristic biotope mosaic, maintains water in critical biotopes (including marginal silt beds), and provides adequate flows for migratory passage (which is important not only for river and sea lamprey but also brook lamprey in its shorter distance migrations within the river). For bullhead it maintains the high current velocities and substrate conditions that are optimal for the species.	
	Sediment regime	See the target above for the H3260 habitat feature	Natural levels of coarse sediment supply are critical to the maintenance of high quality spawning habitat for lamprey and bullhead species, maintaining bed substrates in optimal condition for egg-laying and juvenile and adult cover. Excessive delivery of fine sediment, from the catchment or artificially enhanced bank erosion, can cause siltation of egg-laying sites and juvenile and adult refugia.	
Supporting habitat: structure/ function	**Biological connectivity**	See the target above for the H3260 habitat feature	Lampreys can pass some potential barriers in river channels by attaching themselves to structures or river banks using their 'suctorial' discs and creeping up by strong bursts of swimming. However, many in-channel structures are known to either completely or partially block access to historical spawning grounds. Whilst in-channel structures can artificially generate both silt-beds and clean gravels, both of value to lamprey species, this is not a justification for their continued existence or the construction of new structures. Suitable habitat for lamprey and other species can and should be generated by natural processes - where physical restoration of the channel is required this may involve changes in the distribution of species within the river system. Sea lamprey will require safe passage between rivers, coastal waters and estuaries. Vertical drops of >18-20 cm are sufficient to prevent upstream movement of adult bullheads. They will therefore prevent recolonisation of upper	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
			reaches affected by lethal pollution episodes or drought, and more generally will also lead to constraints on genetic interactions that may have adverse consequences.	
	Water quality - nutrients	Restore the natural nutrient regime of the river, with any anthropogenic enrichment above natural/background concentrations limited to levels at which adverse effects on the features are unlikely.	Nutrient enrichment can lead to loss of substrate condition for bullhead and lamprey spawning, egg development and lamprey ammocoete growth, due to benthic algal growth and associated enhanced siltation and sediment anoxia. Lamprey species and Bullhead may be affected by both episodic and chronic organic pollution. Episodic pollution causes direct mortalities whilst chronic pollution affects substrate condition through the build-up of excessive microbial populations.	
	Water quality - organic pollution	See the target above for the H3260 habitat feature	Lamprey species may be affected by both episodic and chronic organic pollution. Episodic pollution causes direct mortalities whilst chronic pollution affects substrate condition through the build-up of excessive microbial populations.	
	Water quality - acidification	See the target above for the H3260 habitat feature	Brook lamprey and bullhead may be affected by acidification in low alkalinity headwaters.	
	Vegetation composition: invasive non-native species	See the target above for the H3260 habitat feature	Species such as signal crayfish can have a serious effect on lamprey and bullhead habitat (by destabilising banks and enhancing fine sediment input), and can predate heavily on bullhead, brook lamprey and ammocoetes of all lamprey species if present at high densities. Chinese mitten crab is also of concern, not only in the lower reaches of main river but due to its potential to migrate long distances upstream and can cause similar damage to habitat.	
	Fisheries - introduction of fish species	Ensure fish stocking/introductions do not interfere with the ability of the river to support self-sustaining populations of the features	The presence of artificially high densities of fish may create unacceptably high levels of predatory pressure on brook lamprey, ammocoetes of all lamprey species and bullhead. The management aim is to provide conditions in the river that support a healthy, natural and self-sustaining populations, achieved through habitat protection/restoration and the control of exploitation as necessary. Stocking represents a loss of naturalness and, if successful, obscures the underlying causes of poor performance (potentially allowing these risks to perpetuate). It carries various ecological risks, including the loss of natural spawning from brood-stock, competition between stocked and naturally produced individuals, disease introduction and genetic alterations to the population	
	Fisheries - exploitation	All exploitation (by netting or angling) of lamprey species	Controls on lamprey exploitation should include migratory passage within territorial waters, including estuarine and coastal net fisheries, as well as	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
		should be undertaken sustainably without compromising any of the attributes of the population	exploitation within the river.	
	Control of livestock grazing activity	See the target above for the H3260 habitat feature	Over-grazing of riparian areas can have a dramatic effect on lamprey and bullhead habitat, trampling marginal silt beds important to lamprey, eliminating marginal vegetation and generating excessive loads of fine sediment on spawning gravels.	
	Vegetation structure: cover of submerged macrophytes	See the target above for the H3260 habitat feature	In rivers where it naturally occurs, submerged and marginal vegetation can provide important cover for bullhead, particularly if coarse (cobble) substrates are in short supply for cover.	
	Screening of intakes and discharges	See the target above for the H3260 habitat feature	Adult lamprey, migrating sub-adult lamprey ('transformers') and bullhead can be caught in intakes and discharges, along with other fish species.	
	Integrity of off-site habitats	See the target above for the H3260 habitat feature	The lamprey populations of the site may be dependent on the integrity of sections of river channel, riparian areas and transitional and marine waters that lie outside of the SAC boundary. Headwater areas and tributaries may not fall within the site boundary, yet lamprey (particularly brook lamprey) may use these areas for spawning and juvenile development and be critical for sustaining the populations within the SAC. River and sea lamprey require safe passage through coastal waters and estuaries. Bullhead populations within the SAC may also be dependent on the integrity of sections of river channel and riparian areas that lie outside of the site boundary. Headwater areas and tributaries may not fall within the site boundary, yet bullhead may use these areas for spawning and juvenile development and be critical for sustaining populations within the site.	
Population (of the feature)	**Population abundance**	Maintain the abundance of the lamprey and bullhead populations at a level which is close to that expected under un-impacted conditions throughout the site (subject to natural habitat conditions and allowing for natural fluctuations), whilst avoiding deterioration from its current level	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	[51] APEM. 2008. [48] ENVIRONMENT AGENCY

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
		as indicated by the latest count or equivalent.	natural factors or management measures and has been stable at or above a new level over a considerable period (generally at least 10 years). The values given here may also be updated in future to reflect any strategic objectives which may be set at a national level for this feature. Given the likely fluctuations in numbers over time, any impact-assessments should focus on the current size of the site's population, as derived from the latest known or estimated level established using the best available data. This advice accords with the obligation to avoid deterioration of the site or significant disturbance of the species for which the site is designated, and seeks to avoid plans or projects that may affect the site giving rise to the risk of deterioration. Similarly, where there is evidence to show that a feature has historically been more abundant than the stated minimum target and its current level, the ongoing capacity of the site to accommodate the feature at such higher levels in future should also be taken into account in any assessment. Unless otherwise stated, the population size or presence will be that measured using standard methods, such as peak mean counts or breeding surveys. This value is also provided recognising there will be inherent variability as a result of natural fluctuations and margins of error during data collection. Whilst we will endeavour to keep these values as up to date as possible, local Natural England staff can advise that the figures stated are the best available. Surveying to inform Wessex Waters Low Flow Studies in 2006-7 found brook lamprey to be widely distributed through the catchment from the headwaters and upper perennial reaches to the lower tributaries. The same surveys found bullhead to be well distributed throughout the catchment at relatively high numbers although densities are highly variable and were found to be abundant (>140 individuals in 5 minutes of sampling) at many sites	
	Juvenile densities	Maintain juvenile densities at those expected under un-impacted conditions throughout the site, taking into account natural habitat conditions and	Maintaining the density of young lampreys is important as this will have a significant influence on the overall abundance of the population. Impacts on physical, chemical or hydrological integrity, or from non-native species, may suppress juvenile densities of bullhead.	

Attributes		Targets	Supporting and/or Explanatory Notes	Sources of site-based evidence (where available)
		allowing for natural fluctuations		
Version Control Advice last updated: n/a				
Variations from national feature-framework of integrity-guidance: n/a				
References [49] MAITLAND P.S 2003. *Ecology of the River, Brook and Sea Lamprey*. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough. **http://publications.naturalengland.org.uk/file/118013** [50] TOMLINSON, M. L. & PERROW M. R. (2003). *Ecology of the Bullhead*. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough. **htpp://publications.naturalengland.org.uk/file/111020** [51] APEM. 2008 *River Avon SAC Low Flows Project Ecological Investigation Final Report for Wessex Water.* AMP5 Low Flow Investigation for the Environment Agency. - ***Available from Wessex Water on request***				