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Common Standards Monitoring Guidance

for

Freshwater Fauna

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Joint Nature Conservation Committee

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1. Introduction

This chapter deals with Common Standards Monitoring (CSM) for white-clawed crayfish, freshwater pearl mussel and all freshwater fish species on SSSIs, ASSIs and Special Areas of Conservation (SACs). It provides guidance on the identification of attributes, targets and methods of assessment for these species where these are notified or qualifying interest features. Amphibians are included in the Reptiles and Amphibians guidance, the otter is covered by the Terrestrial Mammals guidance, and other freshwater invertebrates are dealt with by the Invertebrates guidance.

2. Interest features

The following freshwater faunal species, included on Annex II of the Habitats Directive, are qualifying features on cSACs in the UK:

Austropotamobius pallipes (white-clawed (or Atlantic stream) crayfish)
Margaritifera margaritifera (freshwater pearl mussel)
Petromyzon marinus (sea lamprey)
Lampetra planeri (brook lamprey)
Lampetra fluviatilis (river lamprey)
Alosa alosa (allis shad)
Alosa fallax (twaite shad)
Salmo salar (Atlantic salmon)
Cobitis taenia (spined loach)
Cottus gobio (bullhead)

Details of their distribution and ecology can be found on the JNCC website (Jackson and McLeod, 2002; McLeod *et al*., 2002 – www.jncc.gov.uk), the web-site for the Life in UK Rivers project (www.english-nature.org.uk/lifeinukrivers/index.html), and a number of other publications (e.g. Holdich, 2002 – crayfish; Bauer and Wachtler, 2001 – pearl mussel; Maitland and Campbell, 1992 – fish).

The following additional fish species may also be qualifying features on SSSIs:

Gasterosteus aculeatus (three-spined stickleback) - spineless morphotype
Coregonus lavaretus (powan, schelly, gwyniad)
Coregonus albula (vendace)
Salvelinus alpinus (Arctic charr)

This guidance encompasses all the species listed above.

3. Attributes and targets

Guidance on setting conservation objectives for monitoring each of the freshwater faunal interest features referred to in section 2 is summarised in a set of generic Favourable Condition Tables (FCTs: Tables 2-11). Where appropriate, the guidance for several similar species has been combined in a single table (lampreys – sea lamprey, brook lamprey, river lamprey; whitefish – powan, vendace; shads – allis shad, twaite shad). These tables list the attributes (mandatory and discretionary) which should be assessed for each species and give guidance on target setting.

A combination of direct (population) and indirect (habitat) attributes have been selected for each species to enable a sound assessment of condition to be made. Sustainability of the species is an important consideration when selecting attributes and setting targets. This is an integral part of the concept of favourable conservation status (FCS). For species, the key components used for assessing

conservation status include population dynamics, species range and habitat extent and quality, and the attributes used can be related to these elements (see Introduction to the monitoring manual, section 5).

For **population dynamics** the chosen attributes and targets vary between species to reflect ecological differences and current knowledge. Advice is given on target setting for appropriate measure(s) of population density and reproductive activity or age structure including, in some cases, distribution within the designated site. For some species target thresholds can be set whereas for others presence or absence may be the only practicable option at present.

The **habitat attributes** chosen are generally a subset of those in the relevant habitat section (rivers, lakes, ditches or canals). In some instances guidance is given on targets over and above that in the habitat tables where particular species requirements are known. Further discussion of this is given in the 'Introduction to Common Standards Monitoring for Freshwater Habitats and Species'.

Below each FCT is a separate table listing aspects of environmental disturbance that should be noted as an accompaniment to assessing condition. These activities (such as fish stocking, exploitation) are not condition targets but are intended to help set the context for condition assessment.

4. Methods of assessment

Recommendations are given in the tables on suitable methods to be used for monitoring each target, but further information can be found in a series of protocols which have been developed under the LIFE Rivers project or within the conservation agencies. The monitoring protocols will be available on the Common Standards Monitoring pages of JNCC's web-site (www.jncc.gov.uk). The methods described below are not obligatory but are included for information and advice.

The final assessment of condition rests with the statutory conservation agencies. However, it is important to stress that the field survey required for monitoring the condition of the 14 species listed above is not usually a task that can be undertaken by conservation agency staff. Most of the methods require specialist expertise that is normally available only through external contracts, although in some cases (e.g. freshwater pearl mussel) it would be feasible for appropriately trained staff in the conservation agencies to carry out field work themselves. It should be noted that data used for monitoring the condition of Atlantic salmon populations are held by other bodies (e.g. Environment Agency; Fisheries Research Services, Pitlochry; Scottish District Salmon Fishery Boards). The method for assessing condition has been designed with these data sources in mind.

Table 1 indicates the approach that will normally be required for each species.

Table 1: Field survey requirements for each of the 14 freshwater invertebrate and fish species occurring as interest features on SACs and SSSIs

Species	Approach to field survey
White-clawed crayfish	External contract; or by trained conservation agency staff
Freshwater pearl mussel	External contract; or by trained conservation agency staff
Sea lamprey	External contract
Brook lamprey	External contract
River lamprey	External contract
Allis shad	External contract
Twaite shad	External contract

Species	Approach to field survey
Atlantic salmon	Field survey not applicable. Conservation agency staff to judge condition on the basis of information held by other bodies (e.g. Environment Agency)
Spined loach	External contract
Bullhead	External contract
Three-spined stickleback - spineless morphotype	External contract
Powan, schelly, gwyniad	External contract
Vendace	External contract
Arctic charr	External contract

5. Assessing feature condition

5.1 Favourable/unfavourable condition

For freshwater faunal species features the general rule is that all mandatory attributes must meet their targets for the feature to be in favourable condition, unless otherwise stated in the accompanying notes. This means that any one attribute failing to meet its target will result in an unfavourable condition judgement for the interest feature. The discretionary attributes may be useful for informing the assessment but should not be used individually to 'fail' the feature.

5.2 Assessing the Trend in Condition of a Feature in Unfavourable Condition

If an **unfavourable** condition judgement is made then on subsequent monitoring visits the trend in the condition of the feature has to be assessed. If the feature has returned to favourability it is reported as **favourable recovered**. However, if it is still unfavourable it is necessary to decide whether the feature condition is declining, has not changed or is recovering.

The number of attributes for each interest feature that fail to meet their targets can be an indication of trend in condition. These include species population attributes. For example, if an interest feature has six attributes, two of which have failed to meet their targets in the first monitoring cycle, then the feature is **unfavourable**. If, at the next monitoring cycle, three attributes fail to meet the targets then the feature is **unfavourable and declining** in condition. If two attributes fail again then there is no change in the feature condition from the previous monitoring cycle, and the feature can be considered to be **unfavourable no change**.

Determining whether a feature can be classed as **unfavourable recovering** requires not only an assessment of the number of attributes failing to meet their targets compared with the previous reporting cycle, but also the effectiveness of management action taken. Only when appropriate management has been carried out on all attributes that failed in one reporting cycle and, as a result, they are likely to meet their targets in the next or subsequent cycles, can the interest feature be classed as **unfavourable recovering**. If management has been carried out so that one failed attribute meets its target in the next reporting round but there is no indication of improvement in another failed attribute, then the interest feature will continue to be **unfavourable no change** regardless of the fact that there are fewer failed attributes than in the previous reporting cycle.

Trend in feature condition will be reported at the end of each (6-year) monitoring cycle. Different attributes failing throughout the cycle should not affect the final reporting outcome, because for the purposes of CSM all attributes have the same weighting.

5.3 Partially Destroyed and Destroyed categories

When considering these categories, reference should be made to sections 17.5 and 17.6 of the general introduction to the monitoring manual. If a condition assessment for an interest feature on a site is **unfavourable** then a decision has to be taken on whether or not management action will address the problem. If no management action can be taken then a decision has to be made on whether the interest feature is partially or completely destroyed at that site. For example, if the viability of an Arctic charr population in a lake SSSI were severely affected by acidification, the feature might be classed as **destroyed** given the low probability that this situation could be reversed in the short to medium term.

The **partially destroyed** category is difficult to apply directly to species interest features, but could be applied to habitat attributes that affect species. Part of a river, for example, subject to heavy engineering, might no longer provide a suitable habitat for freshwater pearl mussel but if other parts of the site still retained natural substrate characteristics a **partially destroyed** classification might be appropriate.

6. Attributes tables for freshwater fauna

This section contains the attribute tables for monitoring individual interest features. They should be used in conjunction with the relevant sections of the guidance above to set conservation objectives in the form of attributes and targets for monitoring as appropriate to each specific interest feature.

7. References

Bauer G. and Wachtler K. (eds) (2001). *Ecology and Evolutionary Biology of the Freshwater Mussels Unionoidea*. Springer-Verlag, Berlin.

Holdich D.M. (2002). *Biology of Freshwater Crayfish*. Blackwell Science, Oxford.

Jackson D.L. and McLeod C.R. (eds) (2002). Handbook on the UK status of EC Habitats Directive interest features: provisional data on the UK distribution and extent of Annex I habitats and the UK distribution and population size of Annex II species. Version 2. *JNCC Report*, No. 312. www.jncc.gov.uk/publications/JNCC312/

Maitland P.S. and Campbell R.N. (1992). *Freshwater Fishes of the British Isles*. HarperCollins, London (New Naturalist Series).

McLeod C.R., Yeo M., Brown A.E., Burn A.J., Hopkins J.J. and Way S.F. (eds) (2002). *The Habitats Directive: Selection of Special Areas of Conservation in the UK*. 2nd edn. Joint Nature Conservation Committee, Peterborough. www.jncc.gov.uk/SACselection

Table 2. Favourable Condition Table (Generic Attributes)

Interest feature: White-clawed crayfish (*Austropotamobius pallipes*)

Reporting category: Other invertebrates

Attribute *=discretionary	**Target**	**Method of assessment**	**Comments**
Population densities and health	These should not differ significantly from those expected for the river type/reach under conditions of high physical and chemical quality, and in any case should not drop below recent levels.	Refer to the Life in UK Rivers standard survey and monitoring protocol for white clawed crayfish	Insufficient data are available on typical densities in different river types to set reliable targets. Monitoring units would be expected to average at least "moderate" abundance according to monitoring category protocols. However, crayfish densities may be lower than this on some units/rivers due to natural factors and it would be wrong to assume such lower densities necessarily constitute unfavourable condition. Determination of unfavourable condition should only be made where low densities are known to be related to an impact of some kind, or where historical survey data suggest that higher densities should be present. Regular monitoring on different river types using the standard protocol will provide data on which targets can be produced in the future.
	Absence of individuals infected with crayfish plague		Crayfish plague can be introduced by the entry of non-native crayfish species into a site, but also by a variety of other routes, including contaminated equipment (nets, boots, etc.) and stocked fish from infected waters[1]. Outbreaks of crayfish plague typically result in 100% mortalities, unless there are isolated headwaters with crayfish in the catchment. This target requires that the utmost care be taken in terms of fish stocking and general surveying/monitoring to ensure that plague vectors are not introduced. Disinfection or thorough drying of equipment (or perhaps dedicated equipment for use only in native crayfish rivers) and stocking fish from uninfected waters are vital elements. [1]Nationally agreed EN/EA policy on stocking fish into crayfish SSSIs/SACs should prevent stocking from catchments containing signal crayfish or known to have experienced plague. However, given that SAFFA S. 30 does not apply to fish farms, fish from high risk farms could conceivably be introduced, via apparently risk-free farms. EA/EN are addressing this issue at present.
	Thelohaniasis (Porcelain Disease) should not affect >10% population.	Determined during population monitoring	This disease rarely causes mass mortalities and may be present in a population at low levels without apparent harm. However, a prevalence exceeding 10% is of concern.
Water quality – **rivers**	Biological GQA Class: b	England and Wales only (EA standard monitoring protocol)	Generally, water quality should not be injurious to any life stage. A wide range of water quality parameters can affect the status of interest features, but standard biological monitoring techniques provide a reasonably integrated picture in relation to many parameters. All classified reaches within the site that contain, or should contain, crayfish under conditions of high environmental quality should comply with the targets given.

Attribute *=discretionary	**Target**	**Method of assessment**	**Comments**
	Chemical GQA Class: B	England and Wales only (EA standard monitoring protocol)	The Chemical GQA classification sets standards for dissolved oxygen (DO), biochemical oxygen demand (BOD) and ammonia. It therefore covers a number of water quality parameters that can cause problems within river systems. All classified reaches within the site that should contain crayfish under conditions of high environmental quality should comply with the target given.
	Soluble Reactive Phosphorus: Targets should be set in relation to river/reach type(s) and should be near background levels	Environmental agencies' monitoring programmes	Elevated phosphorus levels can result in enhanced plant growth leading to large diurnal sags in dissolved oxygen levels.
Water quality – **standing waters**	Equivalent quality to rivers		Standing water quality assessment schemes are under development across the UK; this will help to develop more specific crayfish targets.
*Water quantity - **standing waters** (wetted area)	No artificial reduction in wetted area		Reductions in water availability can be detrimental to crayfish populations. The situation is particularly acute in small standing waters where abstraction and natural drought can combine to cause significant loss of wetted water area and water depth (causing greatly increased predation and competition pressure) and even complete drying out of the bed (causing very high mortalities). Populations are therefore highly susceptible to the additional stress of abstraction during the summer dry period.
Flow – rivers	Flow regime should be characteristic of the river.	Gauging stations	River flow affects a range of habitat factors of critical importance to crayfish, including current velocity, water depth, wetted area, substrate quality, dissolved oxygen levels and water temperature. The maintenance of both flushing flows and baseflows, based on natural hydrological processes, is vital. Detailed investigations of habitat-flow relationships may indicate that a more or less stringent threshold may be appropriate for a specified reach; however, a precautionary approach would need to be taken to the use of less stringent values. As a guideline, at least 90% of the naturalised daily mean flow should remain in the river throughout the year. Naturalised flow is defined as the flow in the absence of abstractions and discharges. The availability and reliability of data is patchy - long-term gauged data can be used until adequate naturalised data become available, although the impact of abstractions on historical flow records should be considered.

Attribute *=discretionary	**Target**	**Method of assessment**	**Comments**
River morphology [Not on standing waters]	Maintain the characteristic physical features of the river channel, banks and riparian zone. Site specific targets should be based on advice in comments column.	Assess river morphology using RHS	A natural channel morphology provides a diversity of refuge and feeding opportunities. The proximity of different refuges facilitates foraging and the movement of individuals to different habitats with age. Operations that widen, deepen and/or straighten the channel reduce variations in habitat. New operations that would have this impact are not acceptable within an SAC, whilst restoration may be needed in some reaches. Extent of cobbles/ boulders: where they occur naturally, cobbles and boulders are used extensively by crayfish as refuge. Engineering works can result in the loss of large material – any works should at least replace the pre-works availability of such refuges. Extent of large woody debris: where they are present, fallen branches and trunks are used extensively by crayfish as refuge. Woody debris is typically removed during maintenance operations, but it is important to retain as much as possible, particularly where other forms of refuge are in short supply.
			Density of bankside refuges: these provide important refuges and are often lost during engineering operations. Any works should at least replace the pre-works availability of refuges. Extent of submerged and marginal vegetation: submerged higher plants provide cover away from the banks, and also represent a valuable food source. Marginal emergents also provide important cover and feeding opportunities. Vegetation management should be limited to no more than 50% of the channel width (submerged plants) and 50% of bank length (marginal fringe). Extent of overhanging riparian vegetation: this should cover at least 10% of bank length throughout the year, distributed in patches along the margins, and considerably more where other forms of refuge are in short supply. Extent of bankside tree cover: overhanging trees provide valuable shade and food sources and, in addition, supply woody debris to the river. Submerged tree-root systems provide important cover and refuges from flood flows.

Attribute *=discretionary	**Target**	**Method of assessment**	**Comments**
River substrate	River beds should be dominated by clean gravels.	Where there is a perceived risk of damage occurring, or where crayfish are already believed to be in decline, a fluvial audit of the catchment is recommended. This is a relatively new approach developed by fluvial geomorphologists in the UK; further guidance should be sought from freshwater specialists in the country conservation agencies.	Elevated levels of suspended solids can clog the respiratory structures of crayfish. As a guide, a target of <25 mg L^{-1} (annual mean) should be used, based on the EC Freshwater Fish Directive. Most river SSSIs/ ASSIs and SACs do not extend to the entire catchment. Some life-cycle stages are potentially susceptible to damage from siltation, the source of which may lie elsewhere in the catchment outside the site boundary. Sources of fines include run-off from arable land, land (especially banks) trampled by livestock, sewage and industrial discharges.
*Negative indicators	Non-native crayfish should be absent. If present, measures should be taken to control their numbers.		Once non-native crayfish species are established in a water body, native populations are usually eliminated quite rapidly, if not by competition and predation then by crayfish plague. If already present in an SAC, measures should be taken to control the spread of alien species and, if possible, reduce their numbers.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: White-clawed crayfish

Objective	Specified assessment method (if appropriate)	Comment
No stocking/transfers of white-clawed crayfish unless agreed to be in the best interests of the population.	Any stocking or re-introductions to conform to Life in UK Rivers re-introduction protocol	Little work has been undertaken on crayfish genetics. This advice takes the precautionary principle and assumes genetic diversity needs to be maintained and that there may be genetic differences between populations that could be of conservation significance. Care should be taken in any captive breeding programmes that in-breeding does not reduce genetic diversity.
No stocking of fish species at excessively high densities	Impact assessments of stocking consents on a catchment scale may be required to determine an acceptable level.	The presence of artificially high densities of fish creates unacceptably high levels of predatory pressure on juvenile crayfish.
Effective screening on all fish farm intakes and discharges	EA inspections	Escapes from fish farms are a form of uncontrolled introduction and should be prevented.
Reduction in plague transfer risk	Evaluation of potential vectors of plague	Movements of water, people and equipment from signal crayfish catchments pose a risk of plague transfer. Potential vectors include inter-catchment water transfer operations, movement of anglers, biologists (EA/EN/contract staff) and general public between water bodies.

Table 3. Favourable Condition Table (Generic Attributes)

Interest feature: Freshwater pearl mussel (*Margaritifera margaritifera*)

Reporting category: Other invertebrates

Attribute * = discretionary	**Targets**	**Method of assessment**	**Comments**
Population density	≥ 5 mussels per m^2 within sample transects.	Refer to the standard survey and monitoring protocol on the JNCC web-site (based on the protocol in the Life in UK Rivers project). For most rivers, surveys are carried out on 5 x 50m transects, located in suitable pearl mussel habitat within each Evaluated Corridor Section (ECS). In some small rivers where standard 50m transects cannot be used, individual quadrats can be surveyed instead	The density data from all transects within each Evaluated Corridor Section (ECS) should be aggregated and the resulting figure assessed against the target. In smaller rivers where 50m transects have not been surveyed, density data from all quadrats should be aggregated and assessed against the target.
Age structure	At least 20% of population ≤65mm and at least one mussel ≤ 30mm.	Refer to the standard survey and monitoring protocol on the JNCC web-site (based on the protocol in the Life in UK Rivers project). See 'Comments' for assessment of populations vulnerable to disturbance.	Population profiles should not be attempted where mussel beds are vulnerable to damage. In this case, the target is to find at least one pearl mussel ≤65mm. This results in a lower degree of confidence that the population is reproductively viable but should protect it from potential adverse disturbance during survey. The data on age structure from all transects within each ECS should be aggregated and the resulting figures assessed against the targets.
*Water quality	Biological GQA Class: a/A	England, Wales and N.I only (EA and EP standard monitoring protocol)	Generally, water quality should not be injurious to any life stage. A wide range of water quality parameters can affect the status of interest features, but standard biological monitoring techniques provide a reasonably integrated picture in relation to many parameters. All classified reaches within the site that contain, or should contain, freshwater pearl mussels under conditions of high environmental quality should comply with the targets given.

Attribute * = discretionary	**Targets**	**Method of assessment**	**Comments**
	Chemical GQA Class: A	England, Wales and N.I. only (EA and EP standard monitoring protocol)	The Chemical GQA classifications set standards for England & Wales and for Northern Ireland for dissolved oxygen (DO), biochemical oxygen demand (BOD) and ammonia. They therefore cover a number of water quality parameters that can cause problems within river systems. All classified reaches within the site that should contain freshwater pearl mussels under conditions of high environmental quality should comply with the targets given.
	Water Quality Class: A1	Scotland only (SEPA standard monitoring protocol)	The system in Scotland differs from that used elsewhere in the UK. A scale of five Water Quality Classes are used (A1, A2, B, C, D) for assessing water chemistry, biology, nutrients, aesthetic condition, and toxic substances. The overall classification of a water is given by the lowest class derived from these values. All classified reaches within the site that contain, or should contain, freshwater pearl mussel should comply with the targets given.
*Water quality: suspended solids	Annual mean <10 mg L^{-1}	Standard monitoring method	Elevated levels of suspended solids can clog the respiratory structures of fish and adversely affect mussel filter-feeding. In the absence of specific data the precautionary target of 10 mg L^{-1} (as used for salmon spawning areas) has been adopted.
*Water quality: Soluble Reactive Phosphorus	Targets should be set in relation to river/reach type(s) and should be near background levels (see guidance for Generic River SSSIs/ ASSIs).	Chemical analysis (EA/ SEPA/ EHS data)	Elevated phosphorus levels can result in enhanced plant growth leading to large diurnal sags in dissolved oxygen levels.
*Flow	As a guideline, flow should be at least 90% and not more than 110% of the naturalised daily flow throughout the year.	Gauging stations	River flow affects a range of habitat factors of critical importance to pearl mussels, including current velocity, water depth, wetted area, substrate quality, dissolved oxygen levels and water temperature. The maintenance both of occasional flushing flows and baseflows, based on natural hydrological processes, is vital. Detailed investigations of habitat-flow relationships may indicate that a more or less stringent threshold would be appropriate for a specified reach; however, a precautionary approach would need to be taken to the use of less stringent values. As a guide, at least 90% of the naturalised daily mean flow should remain in the river throughout the year. Naturalised flow is defined as the flow in the absence of abstractions and discharges. The availability and reliability of data is patchy – long-term gauged data can be used until adequate naturalised data become available, although the impact of abstractions on historical flow records should be considered.

Attribute * = discretionary	**Targets**	**Method of assessment**	**Comments**
*River substrate	Maintain very little or no silt and fine sand in substrate	Field observation.	Elevated levels of silt and fine sand can clog substrates used by juvenile mussels and can impair adult feeding/respiration. Most river SSSIs/ ASSIs and SACs do not extend to the entire catchment. Some life-cycle stages are potentially susceptible to damage from siltation, the source of which may lie elsewhere in the catchment outside the site boundary. Where there is a perceived risk of damage occurring, or where the species is already believed to be in decline, a fluvial audit of the catchment is recommended. This is a relatively new approach developed by fluvial geomorphologists in the UK; further guidance should be sought from the appropriate freshwater specialists in the country conservation agencies.
River morphology	Maintain the characteristic physical features of the river channel, banks and riparian zone	Assess % area of river bed covered by each category of the Wentworth scale Assess river morphology using RHS	Clean, coarse sand is required in stable conditions. In most rivers stability depends on the presence of cobbles or boulders. See 'Environmental disturbance' table for comments on engineering works. Extent of overhanging vegetation: this provides shade, keeping water temperatures optimal for the species and reducing growths of filamentous algae.
*Negative indicators: Signs of disturbance	No disturbance of existing mussel beds by instream activities		Relevant activities include fishing (wading in the river) and canoeing (at access points to the river). Engineering works that disturb river beds can be disastrous for mussel populations, so every effort needs to be made to leave them undisturbed. As a minimum, existing areas should be safeguarded, whilst habitat lost through engineering works should be reinstated.
*Negative indicators	Absence of rainbow trout and brook trout and any other non-native species that may impair juvenile densities of salmon and brown/sea trout.		Rainbow trout and brook trout are resistant to glochidial infection and are not, therefore, suitable host species. Stocking of these species will create competition with native salmonids and is likely to reduce host opportunities for glochidia.
*Fish host populations: juvenile salmonid densities (0+ and 1+ year classes)	Should be abundant (to be refined following the results of the Life in UK Rivers project on pearl mussel/fish host relationships)		An abundant supply of juvenile salmonids is vital to the survival of the larval stage. The relative importance of salmon and migratory and non-migratory brown trout populations to pearl mussel will vary between rivers. Physical and chemical conditions need to be suitable for the well-being of all life stages of salmonids, including free access up the river and conditions in the estuary and lower river where the juveniles of migratory salmonids are present.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Freshwater pearl mussel

Objective	**Specified assessment method (if appropriate)**	**Comment**

No stocking/translocation of pearl mussel unless agreed to be in the best interests of the population.		Translocation is not generally recommended as a conservation tool. It is a technique that has been little used, and must still be considered experimental. It is also an expensive activity and is likely to be unsuitable for juvenile mussels. Translocation (if feasible) should therefore be seen as a last resort. Little work has been undertaken on pearl mussel genetics. However, given the sedentary nature of pearl mussels, genetically discrete populations are likely.
No fishing for pearl mussels		Pearl mussel fishing is already prohibited under the 1981 Wildlife and Countryside Act.

Table 4. Favourable Condition Table (Generic Attributes)

Interest feature: Brook lamprey *(Lampetra planeri)*, river lamprey *(Lampetra fluviatilis)* and sea lamprey *(Petromyzon marinus)*

Reporting category: Fish

Delete references to any species that are not relevant when incorporating text into the favourable condition table for your site.

Attribute * = discretionary	**Targets**	**Method of assessment**	**Comments**
Population		Electrofishing of suitable habitat using quadrats. See the LIFE project methodology for details of the protocol.	Suitable habitat includes silt and sand beds in the river, either at the margins or in the main channel.
a. Age structure (*Lampetra* sp. only)	For samples of 50 or less, at least two distinct size classes should normally be present. If more than 50 ammocoetes are collected, at least three size classes should be present.		Lamprey ammocoetes grow at a reasonably steady rate and distinct size classes are usually apparent. Ammocoetes typically range from 10 – 150 mm, corresponding to up to six year classes. The largest ammocoetes are usually brook lampreys (river lampreys metamorphose at about 100 – 120 mm), while the smallest individuals are likely to be young-of-year sea lampreys, since this species spawns later in the year than *Lampetra*. The full range of age classes of ammocoete larvae, from 0+ up to metamorphosis should be present. However, sampling error may make these difficult to discern unless large samples are taken. If more than 100 lampreys are collected, at least three size classes should be present.

Attribute * = discretionary	**Targets**	**Method of assessment**	**Comments**
b. Distribution within catchment	Lampreys should be present at not less than 2/3 of sites surveyed. As a minimum, there should be no reduction in the distribution of ammocoetes within the catchment. Where barriers to migration or pollution issues are thought to be a problem, the population should be classed as being in unfavourable condition and targets for an appropriate increase should be set.		Distribution in the catchment should be appropriate to the natural geomorphology. Any accessible silt beds should be expected to contain ammocoetes of *Lampetra* spp, although in practice some beds are likely to be naturally unoccupied (e.g. due to washout). Any silt beds adjacent to or downstream of known *Petromyzon* spawning sites should contain *Petromyzon* ammocoetes. If the distribution of *Petromyzon* in the catchment is unknown, surveys of spawning sites should be carried out in June-July.
c. Ammocoete density	*Lampetra* spp: Optimal habitat: >10 m^{-2} Chalk streams >5 m^{-2} Overall catchment mean: >5m^{-2}		Density targets need to relate to river type (at least in broad terms), since production varies considerably. Chalk streams are not as productive as other systems because their low physical variability and low energy means that large, deep silt beds suitable for lampreys are rare. However, ammocoetes are still common in marginal habitat, among macrophyte beds etc., though at lower densities.
c. Ammocoete density (contd.)	*Petromyzon*: Ammocoetes should be present in at least four sampling sites, each not less than 5 km apart.		*Lampetra* ammocoetes cannot be distinguished in the field, so it will not normally be possible to set separate targets for *L. fluviatilis* and *L. planeri*. However, lampreys upstream of a natural barrier to migration will always be *L. planeri*. *Petromyzon* ammocoetes can be distinguished in the field, but typically occur at very much lower densities than *Lampetra* – approximately 1 ammocoete in 50 in UK rivers is normally *Petromyzon*. Setting of density targets for this species is therefore impractical.
d. Spawning Activity* (Sea Lamprey only)	No reduction in extent of spawning activity year on year	Direct observation or redd counts	Sea lamprey ammocoetes are typically much less numerous than river / brook lamprey ammocoetes, so this may be the only cost-effective means of determining that a healthy spawning population is present. Sea lampreys spawn in June – August (depending on the river) and are usually easily observed at traditional spawning sites during these months.
Water quality	Biological GQA Class: b/B	England, Wales & N.I only (EA & EP standard monitoring protocol)	Generally, water quality should not be injurious to any life stage. A wide range of water quality parameters can affect the status of interest features, but standard biological monitoring techniques provide a reasonably integrated picture in relation to many parameters. All classified reaches within the site that contain, or should contain, lamprey under conditions of high environmental quality should comply with the targets given.

Attribute * = discretionary	**Targets**	**Method of assessment**	**Comments**
	Chemical GQA Class: B	England, Wales and N.I. only (EA & EP standard monitoring protocol)	The Chemical GQA classifications set standards for England & Wales and for Northern Ireland for dissolved oxygen (DO), biochemical oxygen demand (BOD) and ammonia. They therefore cover a number of water quality parameters that can cause problems within river systems. All classified reaches within the site that should contain lamprey under conditions of high environmental quality should comply with the targets given.
	Water Quality Class: A2	Scotland only (SEPA standard monitoring protocol)	The system in Scotland differs from that used elsewhere in the UK. A scale of five Water Quality Classes are used (A1, A2, B, C, D) for assessing water chemistry, biology, nutrients, aesthetic condition, and toxic substances. The overall classification of a water is given by the lowest class derived from these values. All classified reaches within the site that contain lamprey should comply with the target given.
	Suspended solids*: Annual mean <25 mg L^{-1}	Environmental agencies' monitoring programmes	Elevated levels of suspended solids can clog the respiratory structures of fish. The target of 25mg L^{-1} is based on the EC Freshwater Fish Directive.
	Soluble Reactive Phosphorus*: *Targets should be set in relation to river/reach type(s and should be near background levels)*	Environmental agencies' monitoring programmes	Elevated phosphorus levels can result in enhanced plant growth leading to large diurnal sags in dissolved oxygen levels.
Flow	As a guideline, flow should be at least 90% and not more than 110% of the naturalised daily flow throughout the year.	Gauging stations	River flow affects a range of habitat factors of critical importance to lampreys, including current velocity, water depth, wetted area, substrate quality, dissolved oxygen levels and water temperature. The maintenance of both flushing flows and baseflows, based on natural hydrological processes, is vital. Detailed investigations of habitat-flow relationships may indicate that a more or less stringent threshold may be appropriate for a specified reach; however, a precautionary approach would need to be taken to the use of less stringent values. As a guideline, at least 90% of the naturalised daily mean flow should remain in the river throughout the year. Naturalised flow is defined as the flow in the absence of abstractions and discharges. The availability and reliability of data is patchy - long-term gauged data can be used until adequate naturalised data become available, although the impact of abstractions on historical flow records should be considered.
*River morphology	No artificial barriers significantly impairing adults from reaching existing and historical spawning grounds.	Planning consents	Lampreys can pass some potential barriers by attaching themselves to structures or river banks by their suctorial discs and creeping up by strong bursts of swimming. The passability of barriers by different species and sizes of lampreys should be assessed on a site-specific basis, most sensibly by survey of the upstream limit of distribution of each species.
River morphology	River habitat SSSI features should be in favourable condition.	Assess river morphology using RHS.	Where there is a risk of damage occurring, or where lamprey are already believed to be in decline, a fluvial audit of the catchment is recommended. This is a relatively new approach developed by fluvial geomorphologists in the UK; further guidance should be sought from the

Attribute * = discretionary	**Targets**	**Method of assessment**	**Comments**
	Note: In a few cases the SAC is not underpinned by an SSSI. Where this is the case the target is to maintain the characteristic physical features of the river channel, banks and riparian zone. Where fluvial audit has taken place, the audit should indicate that sediment transport processes both within the catchment and the river channel are appropriate for the maintenance or enhancement of lampreys for the foreseeable future. Areas of spawning and nursery habitat identified by the audit should not show signs of decline.		appropriate freshwater specialists in the country conservation agencies. The characteristic channel morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the spawning, juvenile and migratory requirements of the species. Lamprey species require a combination of coarse substrates for spawning and stable beds of fine sandy/silty material for larval development. The close proximity of these habitats facilitates movement to new preferred habitats with age. Operations that widen, deepen and/or straighten the channel reduce variations in habitat. New operations that would have this impact are not acceptable within the SAC, whilst restoration may be needed in some reaches. Area of spawning habitat: Defined as well-oxygenated gravel / pebble-dominated (1.5-11 cm) substrate of at least 10cm depth, overlain by a range of water depths (0.2-1.5 m). River and sea lamprey typically spawn in deeper water than brook lamprey, but in larger river reaches brook lamprey also spawn in deeper areas. Elevated levels of fines (particles <0.83 mm) can interfere with egg survival. Most river SSSIs/ ASSIs and SACs do not extend to the entire catchment. Some life-cycle stages are potentially susceptible to damage from siltation, the source of which may lie elsewhere in the catchment outside the site boundary. Sources of fines include run-off from arable land, land (especially banks) trampled by livestock, sewage and industrial discharges. Area of nursery habitat: Defined as open-structured, aerated, silty and sandy substrates, between 2 and 40cm depth, typically overlain by less than 0.5 m of water. Slack-water channel margins are particularly important, whilst silt accumulations behind weirs can also be valuable in impounded sections. The requirements of the three species are similar and so they are often found in the same nursery beds, but in deeper water (up to 2.2 m) sea lamprey are more likely to dominate. Brook lamprey will be the only species present above impassable weirs. Area of emergent marginal vegetation: Emergent vegetation within marginal nursery habitat stabilises the substrate and greatly increases habitat suitability. Extent of bankside tree cover: This helps to provide temperature micro-gradients within the channel, which provides greater flexibility in habitat selection.
*Negative indicators	No stocking of other fish species at excessively high densities.	Impact assessments of stocking consents on a catchment scale may be required to determine an acceptable level.	The presence of artificially high densities of salmonids and other fish will create unacceptably high levels of predatory and competitive pressure on juvenile lampreys and adult brook lamprey.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Lampreys

Objective	Specified assessment method (if appropriate)	Comment
No stocking/transfers of lampreys unless agreed to be in the best interests of the population.	No specific monitoring required.	It is uncertain whether there are significant genetic differences between lamprey populations of the same species. Since they are of no angling interest, deliberate transfers between sites are unlikely to have been undertaken in the past, such that the natural genetic character of populations is likely to be intact. The degree of fidelity to natal spawning grounds in unclear. Any agreed introductions should involve local stock as a precaution.
Zero exploitation until further notice	Fishery byelaw enforcement and angler education	Lampreys have recently become popular in the UK as bait for pike fishing. There are also indications that UK populations are sought after as a delicacy in Europe, where stocks are declining. Adult lampreys are usually caught by trapping, whilst juvenile lampreys can be removed by sieving, netting or digging out nursery habitat. Anecdotal evidence of adult trapping suggests heavy losses of fish on some rivers. It may take 8-10 years for an ammocoete to reach maturity .In the absence of adequate knowledge of population dynamics and sustainable yields; exploitation is not acceptable within SACs.

Table 5. Favourable Condition Table (Generic Attributes)

Interest feature: Twaite shad *(Alosa fallax)* and Allis shad *(Alosa alosa)*

Reporting category: Fish

Attribute	Target	Method of Assessment	Comments
Population: Adult run size	Adult run size should comply with an agreed target for each river. No drop in the annual run size greater than would be expected from variations in natural mortality alone.	Fish counters	The use of hydroacoustic counters for estimating run size is currently being investigated by the Environment Agency.
Population: Juvenile densities	Juvenile densities should exceed a specified minimum target at least two years in six.	Seine netting in lower rivers and estuaries	Methodology has been developed by the LIFE project. Further testing is required to establish its viability.
Population: Spawning Distribution	No decline in spawning distribution.	Kick sampling during May and June	Where there are man-made barriers to migration, the site should automatically be classed as unfavourable. Historic records and GIS data should be used to determine the likely extent of spawning on affected catchments and set monitoring sites accordingly.
Water quality	Biological GQA Class: b/B	England, Wales & N.I only (EA & EP standard monitoring protocol)	Generally, water quality should not be injurious to any life stage. A wide range of water quality parameters can affect the status of interest features, but standard biological monitoring techniques provide a reasonably integrated picture in relation to many parameters. All classified reaches within the site that contain, or should contain, twaite or allis shad under conditions of high environmental quality should comply with the targets given.
	Chemical GQA Class: B	England, Wales & N.I. only (EA & EP standard monitoring protocol)	The Chemical GQA classifications set standards for England & Wales and for Northern Ireland for dissolved oxygen (DO), biochemical oxygen demand (BOD) and ammonia. They therefore cover a number of water quality parameters that can cause problems within river systems. All classified reaches within the site that should contain twaite or allis shad under conditions of high environmental quality should comply with the targets given.
	Water Quality Class: A2	Scotland only (SEPA standard monitoring protocol)	The system in Scotland differs from that used elsewhere in the UK. A scale of five Water Quality Classes are used (A1, A2, B, C, D) for assessing water chemistry, biology, nutrients, aesthetic condition, and toxic substances. The overall classification of a water is given by the lowest class derived from these values. All classified reaches within the site that contain shad should comply with the target given.

Attribute	Target	Method of Assessment	Comments
	Suspended solids: Mean value <25mg L^{-1} between April and September	Environmental agencies' monitoring programmes	Elevated levels of suspended solids can clog the respiratory structures of fish. The target of 25mg L^{-1} is based on the EC Freshwater Fish Directive.
Flow	Flow regime should be characteristic of the river.	Gauging Stations	River flow affects a range of habitat factors of critical importance to shad, including current velocity, water depth, wetted area, substrate quality, dissolved oxygen levels and water temperature. The maintenance of both flushing flows and baseflows, based on natural hydrological processes, is vital. Detailed investigations of habitat-flow relationships may indicate that a more or less stringent threshold may be appropriate for a specified reach; however, a precautionary approach would need to be taken to the use of less stringent values. As a guideline, at least 90% of the naturalised daily mean flow should remain in the river throughout the year. Naturalised flow is defined as the flow in the absence of abstractions and discharges. The availability and reliability of data is patchy - long-term gauged data can be used until adequate naturalised data become available, although the impact of abstractions on historical flow records should be considered. Shad are particularly sensitive to flow. The ideal regime is one of relatively high flows in March-May, to allow maximum penetration of adults upstream, followed by rather low flows in June-September, which ensures that the juveniles are not washed prematurely into saline waters and grow rapidly under warmer conditions. The release of freshets to encourage salmonid migration should therefore be discouraged on shad rivers.
*River morphology	No artificial barriers significantly impairing adults from reaching existing and historical spawning grounds.	Video / fish counter monitoring at obstacles identified as problematic.	Artificial barriers are probably the single most important factor in the decline of shad in Europe. Impassable obstacles between suitable spawning areas and the sea can eliminate breeding populations of shad. Both species (but particularly allis shad) can make migrations of hundreds of kilometres from the estuary to spawning grounds in the absence of artificial barriers. Existing passes are often not effective for shad, and any new provisions need to take their requirements into account.
River morphology	River habitat SSSI features should be in favourable condition. Holding areas in particular should be maintained. Water depth during the spawning and incubation periods should be 50-75 cm. Note: In a few cases the SAC is not underpinned by an SSSI. Where this is the case the target is to maintain the characteristic physical features	Assess river morphology using RHS and fluvial audit Fluvial audit should indicate that sediment transport processes in the catchment and channel should be appropriate for the maintenance of holding areas and spawning sites.	The characteristic channel morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the spawning, juvenile and migratory requirements of the species. The close proximity of different habitats facilitates movement to new preferred habitats with age. Operations that widen, deepen and/or straighten the channel reduce variations in habitat. New operations that would have this impact are not acceptable within the SAC, whilst restoration may be needed in some reaches. Holding areas are defined as pools of at least 200 cm depth, with cover from features such as undercut banks, vegetation, submerged objects and surface turbulence. Spawning habitat is defined as stable, clean gravel/pebble-dominated (approximately 70%) substrate without an armoured layer and with <10% fines in the top 30cm.

Attribute	Target	Method of Assessment	Comments
	of the river channel, banks and riparian zone.		
*Negative indicators	No stocking of other species at excessive densities in spawning or nursery areas.	Impact assessments of stocking consents on a catchment scale may be required to determine an acceptable level.	Artificially enhanced densities of other fish may introduce unacceptable competition or predation pressure.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Twaite shad and Allis shad

Objective	Specified assessment method (if appropriate)	Comment
No stocking of shad unless agreed to be in the best interests of the population, or as part of a restoration project.	No specific monitoring required.	Available evidence suggests that shad have a high degree of fidelity to natal spawning grounds. There are genetic differences between populations that may have adaptive significance. The nature conservation focus is on securing appropriate habitat for the species and the management of losses from fishing.
All exploitation should be undertaken sustainably without compromising any components of the stock. No deliberate netting for shad until sustainable takes can be determined. Minimisation of by-catch		Anglers occasionally fish for shad, and they are sometimes taken in quite large numbers. Further research is necessary to define sustainable levels of angling. If this shows there is cause for concern, a temporary cessation of fishing activity in the vicinity of known spawning grounds during the spawning period should be considered, particularly where shad are known to be taken regularly. Commercial fishermen also take shad as a by-catch, with whitebait and shrimp fishing being of particular concern. Changes in fishing methods need to be promoted to minimize captures, whilst both anglers and trawlermen should be encouraged to return alive any individuals caught. Controls on exploitation should include migratory passage to the SAC within territorial waters, including estuarine and coastal net fisheries, as well as exploitation within the SAC from rod fisheries.

Table 6. Favourable Condition Table (Generic Attributes)

Interest feature: Atlantic salmon *(Salmo salar)*

Reporting category: Fish

Attribute *=discretionary	**Target**	**Method of Assessment**	**Comments**
Adult run	Total run size at least matching an agreed reference level, including a seasonal pattern of migration characteristic of the river and maintenance of the multi-sea-winter component.	Fish counters where available Rod catch data	Comprehensive guidance on determining favourable condition in relation to adult salmon population parameters can be obtained in *Cowx, 2002.
Juvenile population densities	These should not differ significantly from those expected for the river type/reach under conditions of high physical and chemical quality.	Electrofishing	Comprehensive guidance on determining favourable condition in relation to juvenile salmon population parameters can be obtained in *Cowx, 2002.
Water quality: These targets relate to nursery and spawning grounds. Water quality should also be sufficient to permit the passage of migratory fish at all times.	Biological GQA Class: a/A	England, Wales and N.I. only (EA and EP standard monitoring protocol)	Generally, water quality should not be injurious to any life stage. A wide range of water quality parameters can affect the status of interest features, but standard biological monitoring techniques provide a reasonably integrated picture in relation to many parameters. All classified reaches within the site that contain, or should contain, Atlantic salmon under conditions of high environmental quality should comply with the targets given.
	Chemical GQA Class: A	England, Wales and N.I. only (EA and EP standard monitoring protocol)	The Chemical GQA classifications set standards for England & Wales and for Northern Ireland for dissolved oxygen (DO), biochemical oxygen demand (BOD) and ammonia. They therefore cover a number of water quality parameters that can cause problems within river systems. All classified reaches within the site that should contain salmon under conditions of high environmental quality should comply with the targets given.
	Water Quality Class: A1 or A2	Scotland only (SEPA standard monitoring protocol)	The system in Scotland differs from that used elsewhere in the UK. A scale of five Water Quality Classes are used (A1, A2, B, C, D) for assessing water chemistry, biology, nutrients, aesthetic condition, and toxic substances. The overall classification of a water is given by the lowest class derived from these values. All classified reaches within the site that contain, or should contain, Atlantic salmon should comply with the targets given.

Attribute *=discretionary	**Target**	**Method of Assessment**	**Comments**
	Suspended solids: Annual mean <10 mg L^{-1} (nursery grounds). Annual mean <25 mg L^{-1} (migratory passage).	Standard monitoring method	Elevated levels of suspended solids can clog the respiratory structures of salmon. The target of 25 mg L^{-1} is based on the EC Freshwater Fish Directive; a more precautionary figure has been used for salmon to help protect juvenile stages.
Water quality (contd.)	Soluble Reactive Phosphorus: Targets should be set in relation to river/reach type(s) and should be near background levels (see guidance for Generic River SSSIs/ ASSIs).	Chemical analysis (EA/ SEPA/ EHS data)	Elevated phosphorus levels can result in enhanced plant growth leading to large diurnal sags in dissolved oxygen levels.
Flow	As a guideline, flow should be at least 90% and not more than 110% of the naturalised daily flow throughout the year. Existing flow criteria for salmon should also be complied with.	Gauging stations	River flow affects a range of habitat factors of critical importance to designated interest features, including current velocity, water depth, wetted area, substrate quality, dissolved oxygen levels and water temperature. The maintenance of both flushing flows and baseflows, based on natural hydrological processes, is vital. Detailed investigations of habitat-flow relationships may indicate that a more or less stringent threshold may be appropriate for a specified reach; however, a precautionary approach would need to be taken to the use of less stringent values. As a guideline, at least 90% of the naturalised daily mean flow should remain in the river throughout the year. Naturalised flow is defined as the flow in the absence of abstractions and discharges. The availability and reliability of data is patchy – long-term gauged data can be used until adequate naturalised data become available, although the impact of abstractions on historical flow records should be considered. Headwater sections are particularly vulnerable to abstraction, and downstream migration of perennial heads, other than in drought conditions, is a sign of unfavourable condition.
*River morphology	No artificial barriers significantly preventing adults from reaching existing and historical spawning grounds, and smolts from reaching the sea.	Baseline survey, then check every 6 years.	In all river types, artificial barriers should be made passable. Natural barriers to potentially suitable spawning areas should not be circumvented** Appropriate steps should be taken to ensure that migrating smolts are not entrained in off-takes from the river (such as in fish-farm intakes).
River morphology	Maintain the characteristic physical features of the river channel, banks and riparian zone. Site specific targets should be set based on advice in comments column.	Assess habitat suitability using HABSCORE.	The characteristic channel morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the spawning, juvenile and migratory requirements of Atlantic salmon. The close proximity of different habitats facilitates movement to new preferred habitats with age. Operations that widen, deepen and/or straighten the channel reduce variations in habitat. New operations that would have this impact are not acceptable within an SAC, whilst restoration may be needed in some reaches. Spawning habitat: defined as stable coarse substrate without an armoured layer, in the pebble to

Attribute *=discretionary	**Target**	**Method of Assessment**	**Comments**
			cobble size range (16-256 mm) but with the majority being <150 mm. Water depth during the spawning and incubation periods should be 15-75 cm. Coarse woody debris should not be removed from rivers as it plays a significant role in the formation of new gravel beds, except where infrastructure, human life or property is under threat. Fry habitat: indicated by water of <20 cm deep and a gravel/pebble/cobble substrate. Parr habitat is indicated by water 20-40 cm deep and similar substrate. Holding areas: defined as pools of at least 1.5 m depth, with cover from features such as undercut banks, vegetation, submerged objects and surface turbulence. Areas of submerged and marginal plants: juvenile salmon in chalk rivers use submerged and marginal vegetation as cover. Cutting operations should aim to leave at least 50% of the vegetation. Bankside tree cover: overhanging trees provide valuable shade and food sources, whilst tree root systems provide important cover and flow refuge for juveniles.
River substrate	Suitable spawning sites should be dominated by clean gravels.	Visual observation.	Elevated levels of fines (particles <0.83 mm) can interfere with egg and fry survival through suffocation of eggs and loss of interstitial refugia for fry. Most river SSSIs/ ASSIs and SACs do not extend to the entire catchment. Some life-cycle stages are potentially susceptible to damage from siltation, the source of which may lie elsewhere in the catchment outside the site boundary. Sources of fines include run-off from arable land, land (especially banks) trampled by livestock, sewage and industrial discharges. Where there is a perceived risk of damage occurring, or where salmon are already believed to be in decline, a fluvial audit of the catchment is recommended. This is a relatively new approach developed by fluvial geomorphologists in the UK; further guidance should be sought from the appropriate freshwater specialists in the country conservation agencies.
*Negative indicators	No introduction, or stocking, of other species, or sub-species, at excessively high densities in salmon spawning and nursery areas.	Liaison with fisheries officers. Impact assessments of stocking consents on a catchment scale may be required to determine an acceptable level.	The presence of artificially high densities of other fish creates unacceptably high levels of predatory and competitive pressure on juvenile salmon.

* Cowx, I. (2002). *A Standardised Survey and Monitoring Protocol for the Assessment of Atlantic Salmon, Salmo salar, Populations in SAC Rivers in the UK*. LIFE in UK Rivers Project Report.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Atlantic salmon

Objective	Specified assessment method (if appropriate)	Comment
The management objectives of SAC salmon populations are to attain naturally self-sustaining populations. Stocking should not be routinely used as a management measure.	Liaison with fisheries officers and, in England and Wales, by input into Salmon Action Plans as and when these are reviewed.	The nature conservation aim is to provide conditions in the river that support a healthy and natural 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*
Effective screening on all fish farm intakes and discharges.		Escapes from fish farms are a form of uncontrolled introduction and should be prevented.
All exploitation should be undertaken sustainably without compromising any components of the stock.	Liaison and agreement with fisheries officers	Controls on exploitation should include migratory passage to an SAC within territorial waters, including estuarine and coastal net fisheries, as well as exploitation within an SAC from rod fisheries*

**In England and Wales, a Habitats Regulations Fisheries TAG guidance note is available on salmon management on SACs, covering conservation limits stocking, exploitation and habitat issues such as impassable barriers

Table 7. Favourable Condition Table (Generic Attributes)

Interest feature: Arctic charr *(Salvelinus alpinus)*

Reporting feature: Fish

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
Population size/density	Minimum requirement should be the confirmation that Arctic charr are present and spawning successfully.	Gill netting with NORDIC design nets in conjunction with quantitative hydroacoustics. Ageing should be carried out using otoliths. In some cases morphometric and genetic assessment may be required to determine whether potential morphs are genetically distinct.	Up to 10 age-classes may be present; however, more commonly only four or five may be present; pattern of consistent recruitment should be visible. Juvenile (0+ and 1+) fish should comprise 70% of the total number of individuals within the Arctic charr population. In oligotrophic lakes, total Arctic charr abundance should not fall below a level of 37 individuals ha^{-1}. For mesotrophic waters, Arctic charr densities should not fall below 520 individuals ha^{-1}. Where possible other population attributes should be recorded e.g. age-class structure, sex ratio. If found to be present the age class structure of morphotypes should also be assessed.
* Water quality: oxygen	Hypolimnion should not become anoxic; oxygen levels in the hypolimnion should exceed 4 mg L^{-1}	See methods for standing water SSSIs/ ASSIs.	
Water quality: pH/ANC	pH > 5.5	See methods for standing water SSSIs/ ASSIs.	
Water quality: nutrients	Mean annual TP should be set at ≤20 µg L^{-1} or when hindcasting/ palaeolimnology are used the TP level should not exceed the error margin of the model applied.	See methods for standing water SSSIs/ ASSIs.	

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
*Hydrology	There should be a natural hydrological regime. Where river spawning occurs the flow should be maintained in its natural regime for the period that the charr rely on the riverine habitat.	See methods for standing water SSSIs/ ASSIs.	
*Habitat composition: littoral and benthic habitats	The physical structure of the lake bottom utilised by the various morphs of charr that can be found at a site should be maintained.	See methods for standing water SSSIs/ ASSIs.	This is principally used for spawning and feeding. No clear information is available for the spawning requirements of Arctic charr. Known spawning grounds should comply with targets for salmonids. No loss of spawning substrate should be recorded between sampling events.
*Negative indicators	No introduction or translocation of any fish species, including Arctic charr, from other localities.		The genetic integrity of the morphs present in a population should be maintained.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Arctic charr

Objective	**Specified assessment method (if appropriate)**	**Comment**
Any exploitation of charr should be done on a sustainable basis.		

Table 8. Favourable Condition Table (Generic Attributes)

Interest feature: *Coregonus lavaretus* (powan, schelly, gwyniad) and *Coregonus albula* (vendace)

Reporting category: Fish

Attribute *=discretionary	**Target**	**Method of assessment**	**Comments**
Age class structure	Minimum requirement should be confirmation that coregonids are present and spawning successfully. Juvenile fish (0+ and 1+) should comprise 70% of individuals in surveys carried out using quantitative hydroacoustics. Targets for overall fish density will be set once reference values are calculated for each waterbody.	Spatially targeted and short-duration gill netting using NORDIC design nets in conjunction with quantitative hydroacoustics.	Comparisons with European populations have shown that those subject to commercial exploitation have a larger proportion of young fish. Discernible age classes up to at least 9+ years but may extend up to 13+; no loss of age classes; usually a domination of 3+ and 4+ individuals in gill net catches but older fish should also be well represented; pattern of consistent recruitment should be visible. Catch returns cannot be used as it is illegal to fish for these species.
* Water quality: oxygen	Hypolimnion should not become anoxic; oxygen levels in the hypolimnion should exceed 4 mg L^{-1}	See methods for standing water SSSIs/ ASSIs	Sediment input should be minimized due to potential knock-on effect on water quality. Disturbance and redistribution of sediment may have knock-on effects on water quality.
Water quality: pH/ANC	pH > 5.5	See methods for standing water SSSIs/ ASSIs	
Water quality: nutrients	Mean annual TP should be set at ≤20 µg L^{-1} or when hindcasting/ palaeolimnology are used the TP level should not exceed the error margin of the model applied.	See methods for standing water SSSIs/ ASSIs	
* Hydrology	There should be a natural hydrological regime. Levels should be stable during the winter spawning period.	See methods for standing water SSSIs/ ASSIs	Llyn Tegid and Haweswater have highly modified hydrological regimes as do some Arctic charr sites
* Habitat composition	Maintenance of littoral and pelagic zones with no barriers to movement between them. Summer habitat: Well-oxygenated hypolimnion >20 m deep; high altitude lakes of lesser depth may be adequate.	See methods for standing water SSSIs/ ASSIs	Any proposals for artificial structures should be assessed in relation

Attribute *=discretionary	**Target**	**Method of assessment**	**Comments**
* Spawning habitat	No increase in artificial structures Areas of clean gravel or winter macrophyte growth should be available for spawning during winter.		to potential impacts on habitat, fish movement and spawning area access. Sediment input should be minimized due to potential knock-on effect on spawning habitat. Disturbance and redistribution of sediment may have knock-on effects on habitat. Spawning habitat described for *C. albula* in Bassenthwaite. No precise habitat information available for *C. lavaretus.*
* Food supply	Available littoral/benthic fauna (including *Asellus*, bivalves, chironomid larvae and gastropods) and open water zooplankton (especially *Daphnia* and *Bosmina* sp.)		Availability of zooplankton immediately after hatching is a critical factor in determining year class strength. Secondary production may show considerable inter-annual variation and is dependant on a variety of limnological factors.
*Negative indicators	No introduction of predatory fish (e.g. ruffe or pike or ferox trout) or competitors (e.g. roach and charr).		

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Powan (schelly, gwyniad) and Vendace

Objective	**Specified assessment method (if appropriate)**	**Comment**
No *Coregonus* stocking. No fish stocking or use of live bait. Fish farms should not be established on lakes with coregonid populations due to threats from nutrient enrichment, disease, etc. Protected status of species should be maintained to prevent commercial exploitation.		

Contextual information
A palaeolimnology study (including quantitative reconstructions of TP and pH) should be carried out at all standing waters supporting *C. lavaretus* to determine trends in acidification or enrichment.

Table 9. Favourable Condition Table (Generic Attributes)

Interest feature: Spined loach *(Cobitis taenia)*

Reporting category: Fish

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
Adult population densities	There should be no reduction in densities from existing levels, and in any case no less than 0.1 m^{-2}	Electrofishing in rivers, hand trawl in drains.	Routine Environment Agency monitoring is not capable of providing suitable data. A least-cost methodology for monitoring this attribute is being investigated, involving the sampling of representative reaches within an SAC.
Age structure	At least three year-classes should be present at significant densities. At least 50% of the population should consist of 0+ fish	Analysis of length frequency distribution from sampling will reveal cohorts.	
Water quality Water quality in **rivers** (i.e. classified watercourses under the EA River quality Survey)	Biological GQA Class: b	Environment Agency's General Quality Assessment scheme. Assess every 5 years.	Generally, water quality should not be injurious to any life stage. A wide range of water quality parameters can affect the status of interest features, but standard biological monitoring techniques provide a reasonably integrated picture in relation to many parameters. All classified reaches within the site that contain, or should contain, spined loach under conditions of high environmental quality should comply with the targets given.
Water quality in **rivers**: River Ecosystem Class.	Chemical GQA Class: B	Environment Agency's General Quality Assessment scheme. Assess every 5 years.	The Chemical GQA classification sets standards for dissolved oxygen (DO), biochemical oxygen demand (BOD) and ammonia. It therefore covers a number of water quality parameters that can cause problems within river systems. All classified reaches within the site that should contain spined loach under conditions of high environmental quality should comply with the target given.
Water quality in **rivers**: Suspended solids	Annual mean <25mg L^{-1}	Environment Agency's monitoring programmes	Elevated levels of suspended solids can clog the respiratory structures of fish. The target of 25mg L^{-1} is based on the EC Freshwater Fish Directive.

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
Water quality in **rivers**: Soluble Reactive Phosphorus	*Targets should be set in relation to river/reach type(s and should be near background levels)*	Environment Agency's monitoring programmes	Elevated phosphorus levels can result in enhanced plant growth leading to large diurnal sags in dissolved oxygen levels.
Water quality in **ditches** (i.e. not classified by EA): Biological water quality	Equivalent to Class 'b' in the Biological module of the General Quality Assessment scheme		Generally, water quality should not be injurious to any life stage. A wide range of water quality parameters can affect the status of interest features, but biological monitoring techniques provide a reasonably integrated picture in relation to many parameters. A suitable methodology for monitoring biological quality in ditches will need to be agreed with the Environment Agency.
Water quality in **ditches**: Dissolved oxygen, ammonia, BOD	Equivalent quality to Chemical GQA Class 'C'		
Water quality in **ditches**: Soluble Reactive Phosphorus	0.1 mg L^{-1} annual mean		Excessive enrichment with phosphorus increases the risk of impacts on the submerged plant community, which the spined loach uses for cover.
Flow **(rivers)** [Habitat extent and quality]	Flow regime should be characteristic of the river.	Gauging stations	River flow affects a range of habitat factors of critical importance to spined loach, including current velocity, water depth, wetted area, substrate quality, dissolved oxygen levels and water temperature. The maintenance of both flushing flows and baseflows, based on natural hydrological processes, is vital. Detailed investigations of habitat-flow relationships may indicate that a more or less stringent threshold may be appropriate for a specified reach; however, a precautionary approach would need to be taken to the use of less stringent values. As a guideline, at least 90% of the naturalised daily mean flow should remain in the river throughout the year. Naturalised flow is defined as the flow in the absence of abstractions and discharges. The availability and reliability of data is patchy - long-term gauged data can be used until adequate naturalised data become available, although the impact of abstractions on historical flow records should be considered.
*River morphology	No artificial barriers significantly impairing essential fish movement	Initial survey then planning consents	Free movement within the channel is necessary to ensure maintenance of genetic diversity (and therefore population viability) and to provide the potential for recolonisation of waters that have become artificially denuded of spined loach. New instream structures should be avoided, whilst the impact of existing structures needs to be evaluated.

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
River morphology [*not in standing waters*]	Maintain the characteristic physical form of the river channel	Assess river morphology using RHS	A natural channel morphology provides the diversity of breeding/nursery habitat, cover from predators, refuge against high flows, and feeding opportunities that best meet the full life cycle requirements of the species. The close proximity of riffles and pools is particularly important for this sedentary animal. Operations that widen, deepen and/or straighten the channel reduce variations in habitat. New operations that would have this impact are not acceptable within the SAC, whilst restoration *may/will* be needed in some reaches.
Substrate character	Maintain natural substrate character	The Life in UK Rivers project has produced recommendations for assessing siltation in rivers. Quantitative methods are expensive and will be difficult to link to unclear ecological requirements of the species.	Extent of sandy substrates: Ideally substrates should be at least 20% sand and no more than 40% silt. Whilst the species can tolerate silt and mud, it has a preference for sandy substrates, and these substrates should be maintained and/or restored in watercourses where sufficient hydraulic energy can be generated. If the organic content becomes too high, reduced oxygen availability near the sediment/water interface may lead to enhanced egg and juvenile mortality. High sediment cohesiveness is likely to affect the feeding process. Extent of submerged and marginal plants: A mosaic of bare substrate and submerged beds of higher plants provides optimal conditions in relation to feeding, cover from predators and spawning (which occurs on submerged plants). Marginal emergents also provide important cover and feeding opportunities. Vegetation management should be limited to no more than 50% of the channel width (submerged plants) and 50% of bank length (marginal fringe), cut in patches. Most river SSSIs/ ASSIs and SACs do not extend to the entire catchment. Some species or life-cycle stages (e.g. juvenile pearl mussels, salmon eggs and fry) are potentially susceptible to damage from siltation, the source of which may lie elsewhere in the catchment outside the site boundary. Where there is a perceived risk of damage occurring, or where the designated species is already believed to be in decline, a fluvial audit of the catchment is recommended. This is a relatively new approach developed by fluvial geomorphologists in the UK; further guidance should be sought from the appropriate freshwater specialists in the country conservation agencies.
*Negative indicators	No stocking/transfers of fish species at excessively high densities	Fishery stocking consents. Impact assessments of stocking consents on a catchment scale may be required to determine an acceptable level.	Excessively high densities of predatory and benthivorous fish species can cause unacceptably high predation pressure and alter sediment characteristics and sedimentary food supply in ways that are highly detrimental to spined loach. Care needs to be taken to ensure that stocking exercises do not keep the densities of such species at unnaturally high levels.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Spined loach

Objective	**Specified assessment method (if appropriate)**	**Comment**

No stocking/transfers of spined loach unless agreed to be in the best interests of the population.	No specific monitoring required.	Genetic differences have been found in spined loach populations in Europe, and there is no reason why they should not exist in England. Considering the wide range of environmental conditions in which the spined loach is found (from swiftly flowing streams to drainage ditches), such differences may well have adaptive significance. Since the species is of no angling interest, deliberate transfers between sites are unlikely to have been undertaken in the past, such that the genetic integrity of populations is likely to be intact.
Effective screening on all fish-farm intakes and discharges	Environmental Agency's monitoring/ consenting programmes	Escapes from fish farms are a form of uncontrolled introduction and should be prevented.

Table 10. Favourable Condition Table (Generic Attributes)

Interest feature: Spineless morphotype of the three-spined stickleback *(Gasterosteus aculeatus)*

Reporting category: Fish

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
Population size/density	Minimum requirement should be the confirmation that spineless sticklebacks are present and spawning successfully. Initial work suggests a favourable condition threshold on one spineless stickleback per m^2. Where possible, other population attributes should be recorded e.g. age-class structure.	Hand-held trawl – ten 10 m trawls at three locations within each lake.	Absolute abundance may be used as an indicator once a number of surveys have been carried out at locations which host spineless morphs. Typically up to five age classes may be present in any given year. A pattern of continuous recruitment must be visible and underyearling (0+) fish must comprise at least 40 % of the population.
Water quality: pH/ANC	pH > 5.5 Dissolved calcium levels should be monitored and a baseline set for each locality.	See methods for standing water SSSIs/ ASSIs.	
Water quality: nutrients	Mean annual TP should be set at ≤10 µg L^{-1} or when hindcasting/palaeolimnology are used the TP level should not exceed the error margin of the model applied.	See methods for standing water SSSIs/ ASSIs.	
*Hydrology	There should be a natural hydrological regime.	See methods for standing water SSSIs/ ASSIs.	
*Habitat composition: littoral and benthic habitats	The physical structure of the lake bottom utilised by spineless sticklebacks should be maintained.	See methods for standing water SSSIs/ ASSIs.	Changes in habitat quality through the loss of fringing macrophytes (particularly sedge species) should be avoided.
*Negative indicators	No stocking of any fish species which may predate spineless sticklebacks, including Arctic charr.		The genetic integrity of the morphs present in a population should be maintained.

Objective	**Specified assessment method (if appropriate)**	**Comment**

Populations of any new or existing populations of piscivorous birds (i.e. divers or grebes) should be monitored.		Rapid increases in the numbers of piscivorous birds may exert an impact on population size and habitat use of spineless sticklebacks – a morphotype which has no anti-predator defences.

Table 11. Favourable Condition Table (Generic Attributes)

Interest feature: Bullhead *(Cottus gobio)*

Reporting category: Fish

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
Population	see sub-attributes below	Single-pass electrofishing in August / September. Data analysis as in a-c. below.	For details see the LIFE in UK Rivers Project protocol
a. Adult population densities	There should be no reduction in densities from existing levels, and in any case no less than 0.2 m^{-2} in upland rivers (source altitude >100m) and 0.5 m^{-2} in lowland rivers (source altitude ≤100m).	Density estimates	Routine Environment Agency monitoring is not capable of providing suitable data. A least-cost methodology for monitoring this attribute has been developed by the LIFE in UK rivers project, involving the sampling of representative reaches within an SAC.
b. Distribution within SAC	Bullheads should be present in all suitable reaches. As a minimum, no decline in distribution from current.	GIS analysis of distribution within catchment	In the UK, bullhead are widespread in any flowing water at an altitude of less than 300 m. Well oxygenated water over a gravel / pebble / cobble substrate is preferred (and is essential for successful reproduction). Riffles are a favoured microhabitat. Very sluggish water with a clay / silt substrate or cold, steep-gradient upland sections with numerous cascades and boulder / bedrock substrate should be viewed as sub-optimal. Bullheads can occur in very small channels (<1 m wide) where they may be the only fish species present. Bullhead are very poor colonists, to the extent that catchments may contain many individual subpopulations. It is not feasible to assess each of these individually, but it is very important that there is no loss of these populations, and that access routes between them are not impeded (see environmental disturbance notes below).
c. Reproduction/ Age Structure	Young-of-year fish should occur at densities at least equal to adults.	Length-frequency analysis of selected samples	Young-of-year fish should be easily identifiable using length-frequency analysis. In September they are typically less than 30 mm long. Young-of-year are often much more numerous than adults, so the current target is rather conservative (to allow for natural variation in recruitment and habitat type). A ratio of 3 or 4:1 for Y-O-Y: adults is not unusual. It may be necessary to refine this target at a site-specific level.

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
Water quality: NB All water quality data should be available on request from the respective environment agencies (EA, SEPA)	Biological GQA Class: b or above	Environment Agency's General Quality Assessment scheme. Assess every 5 years. England &Wales only (EA standard monitoring protocol)	Generally, water quality should not be injurious to any life stage. A wide range of water quality parameters can affect the status of interest features, but standard biological monitoring techniques provide a reasonably integrated picture in relation to many parameters. The river quality classifications used in all parts of the UK have a biological component. All classified reaches within the site that contain, or should contain, bullhead under conditions of high environmental quality should comply with the targets given.
	Water Quality Class: A2 or above	Scotland only (SEPA standard monitoring protocol)	The system in Scotland differs from that used elsewhere in the UK. A scale of five Water Quality Classes are used (A1, A2, B, C, D) for assessing water chemistry, biology, nutrients, aesthetic condition, and toxic substances. The overall classification of a water is given by the lowest class derived from these values. All classified reaches within the site that contain, or should contain, bullhead should comply with the targets given.
	Chemical GQA Class: B or above	England & Wales only (EA standard monitoring protocol)	The Chemical GQA classification sets standards for dissolved oxygen (DO), biochemical oxygen demand (BOD) and ammonia. It therefore covers a number of water quality parameters that can cause problems within river systems. All classified reaches within the site that contain, or should contain, bullhead under conditions of high environmental quality should comply with the target given.
	Suspended solids*: Annual mean <25 mgL^{-1}	Environmental agencies' monitoring programmes	Elevated levels of suspended solids can clog the respiratory structures of fish. The target of 25 mg L^{-1} is based on the EC Freshwater Fish Directive.
	Soluble Reactive Phosphorus*: *Targets should be set in relation to river/reach type(s) and should be near background levels*	Environmental agencies' monitoring programmes	Elevated phosphorus levels can result in enhanced plant growth leading to large diurnal sags in dissolved oxygen levels.
Flow	Flow regime should be characteristic of the river.	Gauging stations	River flow affects a range of habitat factors of critical importance to bullhead, including current velocity, water depth, wetted area, substrate quality, dissolved oxygen levels and water temperature. There should be >5 cm water depth over riffles in summer. The maintenance of both flushing flows and baseflows, based on natural hydrological processes, is vital. Detailed investigations of habitat-flow relationships may indicate that a more or less stringent threshold may be appropriate for a specified reach; however, a precautionary approach would need to be taken to the use of less stringent values. As a guideline, at least 90% of the naturalised daily mean flow should remain in the river throughout the year. Naturalised flow is defined as the flow in the absence of abstractions and discharges. The availability and reliability of data is patchy - long-term gauged data can be used until adequate naturalised data become available, although the impact of abstractions on historical flow records

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
			should be considered.
River morphology	Weed cutting should be limited to no more than half of the channel width	Routine statutory agency consenting process	The importance of submerged higher plants to bullhead survival is unclear, but it is likely that where such vegetation occurs it is used by the species for cover against predators. Weed cutting should be limited to no more than half of the channel width in a pattern of cutting creating a mosaic of bare substrate and beds of submerged plants.
	Woody debris removal should be minimised, and restricted to essential activities such as flood defence	Routine statutory agency consenting process	Bullheads are particularly associated with woody debris in lowland 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.
	No significant impediment to essential fish movement between reaches. However, debris dams and woody debris should be retained where characteristic of the river/reach	Initial survey followed by planning process	Vertical drops of >18-20 cm are sufficient to prevent upstream movement of adult bullheads. They will therefore prevent recolonisation of upper reaches affected by lethal pollution episodes, and will also lead to constraints on genetic interactions that may have adverse consequences. New instream structures should be avoided, whilst the impact of existing structures needs to be evaluated.
River morphology	River habitat SSSI features should be in favourable condition. Note: In a few cases the SAC is not underpinned by an SSSI. Where this is the case the target is to maintain the characteristic physical features of the river channel, banks and riparian zone. No reduction in extent of slack-water refuges, unsilted coarse substrate or high canopy tree cover through anthropogenic activity	Assess river morphology using RHS and fluvial audit	The characteristic channel morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the spawning, juvenile and dispersal requirements of the species. The close proximity of different habitats facilitates movement to new preferred habitats with age. Operations that widen, deepen and /or straighten the channel reduce variations in habitat. New operations that would have this impact are not acceptable within the SAC, whilst restoration may be needed in some reaches. Points to consider include:- Extent of unsilted coarse (gravel / pebble / cobble) dominated substrate: males guard sticky eggs on the underside of stones. Larger stones on a hard substrate providing clear spaces between the stream bed and the underside of pebbles / cobbles are therefore important. Elevated levels of fines can interfere with egg and fry survival. Sources of fines include run-off from arable land, land (especially banks) trampled by livestock, sewage and industrial discharges. Most river SSSIs / ASSIs and SACs do not extend to the entire catchment. Some life-cycle stages are susceptible to damage from siltation, the source of which may lie outside the site boundary. Where there is a perceived risk of damage occurring, or where the species is believed to be in decline, a fluvial audit of the catchment is recommended. This is a relatively new approach developed by fluvial geomorphologists in the UK; further guidance should be sought from the appropriate freshwater specialists in the country conservation agencies. Extent of slack-water refuges: these provide important refuges against high flow conditions. Suitable refuges include pools, submerged tree root systems and marginal vegetation with >5 cm water depth.

Attribute * = discretionary	**Target**	**Method of assessment**	**Comments**
			Extent of high canopy tree cover: the relative importance of shade compared with the provision of woody debris is unclear, but the maintenance of intermittent tree cover in conjunction with retention of woody debris ensures that habitat conditions are suitable. *In lowland reaches without any riparian trees, it may be desirable to introduce a limited amount of cover.*
*Negative indicators	Absence of non-native crayfish	Crayfish surveys in catchments thought to be at risk	Bullhead densities have been found to be negatively correlated with densities of non-native crayfish in the River Great Ouse, suggesting competitive and/or predator-prey interactions.
	No stocking of other fish species at excessively high densities.	Routine statutory agency monitoring. Impact assessments of stocking consents on a catchment scale may be required to determine an acceptable level.	The presence of artificially high densities of salmonids and other fish will create unacceptably high levels of predatory and competitive pressure on juvenile and adult bullhead.

Aspects of environmental disturbance to be noted as an accompaniment to assessing condition: Bullhead

Objective	**Specified assessment method (if appropriate)**	**Comment**
No stocking / transfers of bullhead unless agreed to be in the best interests of the population.	No specific monitoring programme required	Bullheads are relatively sedentary and interactions between populations in different parts of the catchment and in different catchments are likely to be limited, suggesting the existence of genetically discrete populations. Since they are of no angling interest, deliberate transfers between sites are unlikely to have been undertaken in the past, such that the genetic integrity of populations is likely to be intact.
Effective screening on all fish farm intakes and discharges	Routine statutory agency monitoring	Escapes from fish farms are a form of uncontrolled introduction and should be prevented.