# Monitoring the Freshwater Pearl Mussel

*Margaritifera margaritifera*

Conserving Natura 2000 Rivers

Monitoring Series No. 2

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# Conserving Natura 2000 Rivers

This protocol for monitoring the freshwater pearl mussel (*Margaritifera margaritifera*) has been produced as part of **Life in UK Rivers** – a project to develop methods for conserving the wildlife and habitats of rivers within the Natura 2000 network of protected European sites. The project's focus has been the conservation of rivers identified as Special Areas of Conservation (SACs) and of relevant habitats and species listed in annexes I and II of the European Union Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC) (the Habitats Directive).

One of the main products is a set of methods for monitoring species and habitats, which complements reports containing the best available information on their ecological requirements. Each report has been compiled by ecologists who are studying these species and habitats in the UK, and has been subject to peer review, including scrutiny by a Technical Advisory Group established by the project partners. In the case of the monitoring techniques, further refinement has been accomplished by field-testing and by workshops involving experts and conservation practitioners.

Conservation strategies have also been produced for seven different SAC rivers in the UK. In these, you can see how the statutory conservation and environment agencies have developed objectives for the conservation of the habitats and species, and drawn up action plans with their local partners for achieving 'favourable conservation status'.

**Life in UK Rivers** is a demonstration project and, although the reports have no official status in the implementation of the directive, they are intended as a helpful source of information for organisations trying to set conservation objectives and to monitor for 'favourable conservation status' for these habitats and species. They can also be used to help assess plans and projects affecting Natura 2000 sites, as required by Article 6.3 of the directive.

## Favourable conservation status

The purpose of designating and managing SACs is to maintain at, or restore to, 'favourable conservation status' the habitats and species listed on annexes I and II of the directive.

The conservation status of a natural habitat can be taken as favourable when:

- Its natural range and areas it covers within that range are stable or increasing.
- The specific structure and functions necessary for its long-term maintenance exist and are likely to exist for the foreseeable future.
- The conservation status of its typical species is favourable.

The conservation status of a species may be taken as favourable when:

- Population data indicate that the species is maintaining itself on a long-term basis as a viable component of its natural habitats.
- The species' natural range is neither being reduced nor is likely to be reduced for the foreseeable future.
- There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis.

The conservation status of a species or habitat has thus to be assessed across its entire natural range within the European Union, in both protected sites and the wider countryside, and over the long term.

## Monitoring techniques

The Habitats Directive requires the condition of the habitats and species for which an SAC has been designated to be monitored, so that an evaluation can be made of the conservation status of these features and the effectiveness of management plans. An assessment of conservation status must, therefore, be applied at both site and network level.

Standard monitoring methods and a coherent assessment and reporting framework are essential to allow results to be both compared and aggregated within and across EU member states.

While the directive outlines the data reporting required from member states at a national level, it did not set out detailed assessment techniques for data collection at habitat and species level.

The Conserving Natura 2000 Rivers series of monitoring protocols seeks to identify monitoring methods and sampling strategies for riverine species and the *Ranunculus* habitat type that are field-tested, cost-effective, and founded on best scientific knowledge.

Titles in the monitoring and ecology series are listed inside the back cover of this report, and copies of these, together with other project publications, are available on the project website: www.riverlife.org.uk.

# Contents

# Summary

This protocol has been developed to provide standardised methods for:

- Baseline surveys of unstudied populations.
- The assessment of the conservation status of freshwater pearl mussel populations within individual rivers.
- Collecting data for comparison with previous surveys in a monitoring programme.
- Collecting data on environmental variables that might influence the status of mussel populations.

This protocol is suitable for use in both SACs (Special Areas of Conservation) and other rivers, which may or may not have been surveyed before. However, the recommended transect approach can only be carried out in wadeable rivers. Populations in deeper waters may be an important component of the freshwater pearl mussel resource, and monitoring techniques will therefore be needed for such reaches.

# 1 Introduction

In the UK, the freshwater pearl mussel (*Margaritifera margaritifera*) is declining throughout much of its range, and is protected under both European and UK legislation. A series of sites is being designated as SACs for the species, and a costed Biodiversity Action Plan has been prepared to encourage measures for its long-term survival in the UK.

Standardised monitoring protocols are needed to ensure a consistent approach is taken to the monitoring of populations on individual sites, and to enable the collation of records for the species across its UK range. The information will be used by conservation agencies and environmental regulators to study population trends and environmental impacts, plan and prioritise river management, and assess the results of actions. It will also inform the requisite report to Europe on the conservation status of the species.

This protocol contains sampling techniques suitable for use at any riverine site that supports the species in the UK. These are based on tried and tested methods, developed mainly by Scottish Natural Heritage, and represent current best practice.

# 2 Preparation

## 2.1 Licensing

The freshwater pearl mussel is fully protected under Schedule 5 of the Wildlife and Countryside Act (1981) and the 1985 Wildlife (Northern Ireland) Order. All surveyors must therefore be licensed by the relevant statutory conservation agency (English Nature, the Countryside Council for Wales, Scottish Natural Heritage or the Department of Environment Northern Ireland) before undertaking any survey work that involves handling the species. At least 15 days are needed to process applications. Specific approval is also needed prior to carrying out any survey work within candidate SAC rivers.

All surveys must be carried out by, or under the supervision of, an experienced licence holder, and all licence conditions must be complied with.

## 2.2 Access

Permission for access must be obtained in advance from the landowner(s).

## 2.3 Health and safety

All survey work must adhere to health and safety procedures, and the following safe working practices are particularly recommended.

- Always work in pairs or groups, using sticks to assist balance and wearing life jackets where appropriate. Waist or chest waders should not be worn as they encourage working in conditions that are too deep or fast flowing. Only wade in water up to thigh depth. Do not enter the water if the bed of the river is not clearly visible, or if the flow makes wading difficult. When in doubt, do not wade.
- Wear warm and protective waterproof clothing and gloves, carry spare dry clothes, food and drink. Always carry a first-aid kit and mobile phone.
- Be aware of the risk posed by Weill's disease. Contact with ticks from vegetation can lead to Lyme disease, so appropriate action should be taken to reduce tick bites. Symptoms of Lyme disease and Weill's disease are similar to 'flu. If you develop any symptoms within weeks of potential contact, or if you have a red rash at the site of a tick bite, report immediately to a doctor, emphasising the exposure risk.
- Never eat food with hands contaminated with river water, and never allow contact between river water and exposed cuts. Wear protective gloves where necessary.
- Always use a system for reporting in. Tell someone responsible where you are going, when you expect to return and what to do if you do not return on time.

## 2.4 Equipment

- Glass-bottomed bucket
- RHS survey forms
- Standard recording forms
- Range finder
- OS base map (at least 1:10000, preferably 1:2500)
- Tape measure
- Site markers
- $1m^2$ quadrat
- Dial callipers (mm)
- Digital camera (or 35 mm camera with 50 mm lens & spare slide film)
- Waterproof clipboard
- Global Positioning System (GPS) receiver

## 2.5 Training

For the protocol to be carried out reliably, all surveyors must be appropriately trained in both mussel survey and River Habitat Survey (RHS) techniques. It is essential that surveyors are familiar with

techniques for mussel survey and the identification of suitable substrate. It is also a requirement that RHS surveyors should be formally accredited and trained. If it is necessary to identify Evaluated Corridor Sections, then it is also appropriate for surveyors to be familiar with SERCON (System for Evaluating Rivers for Conservation) techniques (Boon *et al*. 1996). Training may be arranged through the conservation agencies, or, for RHS, through the Environment Agency or Scottish Environment Protection Agency.

## 2.6 Mussel identification

All survey personnel must have some prior experience and training in the identification of the species.

*Margaritifera margaritifera* has a highly characteristic size and shape, and is generally the only mussel found in oligotrophic, neutral to mildly acidic, fast-flowing streams and rivers. The best key to its identity is that of Ellis (1962). *M. margaritifera* has anterior hinged teeth but lacks posterior lateral hinged teeth.

Problems usually only arise when dealing with juvenile specimens (up to 65 mm overall length). These are pale brown when very young but develop the characteristic darker periostracum (the outer proteinaceous layer of the shell) as they approach 65 mm. Even young specimens show the characteristic shape, being less rounded than small pea-mussel species (*Sphaerium* and *Pisidium* spp.). A pictorial identification key to the large freshwater mussels of Sweden, including *M. margaritifera*, is available at (www.nrm.se/ev/musselnyckel/index.html.en).

Mussels from relatively productive large rivers show little erosion at the umbo (protuberance at the anterior end) and have a slightly convex or straight ventral margin. Mussels from small, oligotrophic, fast-running rivers often have extensive erosion in the umbonal region and a concave ventral margin.

## 2.7 Timing and weather conditions

Surveys should only be carried out during periods of low flow between April and September. In small streams with very shallow water, it may be possible to survey for mussels in spring and autumn, although the time period with suitable light levels may be limited to 1–2 hours around midday. Anecdotal evidence suggests mussels bury more, and so are less visible, in cold water with high water levels. Surveys conducted in these conditions will therefore give less satisfactory results.

To ensure ideal and repeatable viewing conditions, counts should only be taken under the following conditions:

- Low flows, clear water
- Bright sunshine
- Between 10 a.m. and 4 p.m.

# 3 Standardised sampling protocol for a mussel population

The generic conservation objectives developed for the freshwater pearl mussel in UK SACs imply a requirement to monitor both population attributes (population density, age structure and recruitment) and attributes of the supporting habitat (flow regime, water quality, levels of suspended solids and phosphate, and river morphology). It will be necessary first to establish a baseline of information on the current distribution of the species within a catchment, and subsequently to use this information to set up a long-term monitoring strategy that seeks to record population density and dynamics over time.

## 3.1 Procedure if the mussel population is too low for standard sampling

If the mussel population in a river is either very small and/or very localised, then standard sampling may not be practical. In this case, an exhaustive, generalised search should be made, and any mussels or mussel beds mapped individually as closely as possible. The use of historical data and a focus on suitable substrate will assist such a search. If very few mussels are present, it may also be inappropriate to search a quadrat to provide mussels for an age profile. However, some effort should be made to disturb suitable substrate near the remaining mussels, to see if juveniles are present.

Snorkelling methods may be appropriate for use where trampling could damage a small population, or where mussels are at a particularly high density. Such surveys would have to be carried out in spring and autumn when water levels are higher. No attempt should be made to compare results from surveys using different methods.

For more typical river situations, proceed as follows:

**A. Subdivide the river into Evaluated Corridor Sections (ECSs) or similar monitoring units based on the methodology used in SERCON (System for Evaluating Rivers for Conservation), as set out in Boon *et al*. (1996).**

Some rivers may be too small and uniform to require subdivision, as ECSs are normally of ≥10 km length; in such cases, the river is regarded as one ECS or monitoring unit. This standard procedure will help organise the mussel survey and enable avoidance of areas that are inherently unsuitable for mussels.

**B. Assess the likelihood of mussels occurring in each unit, based on substrate characteristics. This will require an initial field evaluation of each unit.**

Mussels require clean, coarse sand in which to burrow. In favoured sites the sand is stabilised by the presence of cobbles or boulders. Units can only be judged unsuitable if they are either too silty or too torrential to allow the presence of clean, coarse sand throughout their length. It is likely that this will only apply in the lower reaches of large rivers or in erosional reaches with torrential flow. When in doubt, include all units. If RHS has been carried out on a river, this information can be used to guide the selection process.

Record the distribution of any mussel beds and areas of suitable substrate on base maps.

**C. Exclude from further survey units that are <u>certainly</u> unsuitable for mussels.**

If in doubt, continue to include each unit. In practice, it is likely that all areas will remain in the survey, except for deeper river reaches where a suitable methodology has yet to be developed.

**D. Make an initial general survey of mussel distribution within suitable units.**

If there is no existing knowledge of mussels in the river, undertake an initial general mussel survey. To optimise the chance of finding mussels, first choose the most likely unit(s), on the basis of the abundant presence of suitable substrate. This generalised assessment can be carried out to some extent when evaluating the river for subdivision.

Continue by entering the river at particularly suitable sites and searching for mussels using a viewing bucket in good searching conditions (see Section 2.7). Concentrate on ideal substrate and favoured locations, including under/near the bank beneath overhanging trees. Mussel surveys should only be carried out in favourable weather conditions.

If mussels are found, proceed to F. If no mussels are found, repeat the generalised searches in each likely area in each potentially suitable unit. Do not accept a negative result at any location until after two hours of searching. If dead mussel shells are found, continue as if live mussels had been found.

**E. If no mussels are found after a generalised search in all units and in particularly favourable areas, record mussels as absent**.

If no mussels are found, terminate the survey, unless specifically requested to continue. This might be appropriate if it is necessary to judge the suitability of environmental conditions in a river prior to a translocation programme, for example. In such a case, record features detailed in Section 4.

**F. Mussels present.** Proceed as follows.

**G. Confirm the identity of any mussels found** (see Section 2.6).

**H. Carry out a survey using a 50 m transect sampling programme with a semi-selective, stratified approach, as set out below.**

Mussels are highly clumped in their distribution, even in a river with a thriving population, and random placement of sampling stations runs a real risk that few or no mussels would be included in the samples. Consequently, a selective approach is recommended.

For all potentially suitable units, a survey of five 50 m transects should be carried out.

The preliminary selection of units will have involved some assessment of the nature of the substrate and the presence of mussels. On the basis of this, five general locations should be selected in each unit where mussels are present and/or environmental conditions appear suitable. As a guide, this is where clean, coarse sand is present in pockets sheltered by cobbles or boulders. If possible, these should be spread equally along the unit. If fewer than five generally suitable locations are available, but a location can accommodate more than one transect, the transects can be grouped. However, target notes are required to indicate this, so it is clear that mussels are very localised within the unit and the density recorded refers only to this limited area. The strong advantage of spatially distributed transects is that this is likely to include a representative range of mussel densities and indicate the status of the mussel population.

Note: In very small rivers, or rivers with very restricted mussel occurrence, monitoring work may disturb the few mussels present to an unacceptable degree. This possibility should be considered on a river-by-river basis and action agreed with the appropriate conservation agency. If there is insufficient space to allow five transects to be used, as many should be included as possible and target notes should record the limitation.

**I. The precise location of each 50 m transect should be chosen so that it includes mussels, wherever possible.**

Within each selected general location, each start position should be chosen so that some mussels will be included within the transect. A start position must be at least 1 m out from the river bank to avoid areas which might dry out in low flow conditions.

**J. The starting location of each 50 m transect should be recorded using GPS, target notes and the use of a positional photograph.**

Rivers are dynamic systems, so mussel bed locations will not be stable between sampling occasions and it may not be possible to re-position a transect precisely. Nevertheless, it is preferable to locate a transect as close as possible to the original location in case a return visit is required.

Current GPS will allow easy re-location to within about five metres, assisted by reference to well chosen photograph(s) and target notes of bankside features.

The location must be recorded using a 10 figure National Grid Reference (two letters plus 10 figures), and must be marked on an OS base map (at least 1:10000, preferably 1:2500) and on a sketch map, including local features, made on the reverse of the recording form. Note that not all maps are fully accurate, especially for unstable rivers. The position of all samples must be marked clearly on the sketch map or base map, coded to allow ease of transfer to a database, and with target notes referring to

obvious landmarks. The position and direction from which the photograph is taken should also be marked.

A photograph should be taken, in an upstream direction, showing the start point and length of the sampling area. Additional photographs should be taken of any notable features. It is preferable for such photographs to be taken using a digital camera, so that the image may be stored and reproduced easily. It is also possible to make a video recording of typical groups of mussels, filmed through a glass-bottomed bucket. This provides a visual record of the density and condition of the mussels.

**K. The placement of transects on currently mussel-free, but apparently suitable, areas close to mussel beds will allow assessment of any re-colonisation or relocation of mussels.**

In rivers where previous actions such as pearl fishing or pollution have led to mussel loss, it may be desirable to assess whether mussels can re-colonise suitable areas. If such an assessment is required, additional transects should be undertaken in apparently suitable but unoccupied substrate.

**L. Transects should be sampled using the standardised methodology.**

The standard procedure is as follows:

- The transect is worked upstream from the start point. Using a viewing bucket, all mussels that are seen without removing stones or other mussels are counted in a 1m wide strip, 50 m long. These are recorded as 'visible' mussels. The starting point should be in an area that clearly never dries out, wherever possible at least 1m from the bank. The transect is progressed upstream and outward from the bank in a slightly diagonal direction, as long as it includes potentially suitable substrate.
- If it becomes clear that more than 250 mussels are present in a transect, the transect strip count is abandoned and, instead, five quadrats are carried out at 10, 20, 30, 40 and 50 m intervals. The numbers of mussels present in these is multiplied up to provide a 50 m estimate.
- A $1m^2$ quadrat is searched more thoroughly at 10 m, 20 m, 30 m, 40 m and 50 m intervals. In these quadrats all 'visible' mussels are counted and carefully removed to a bucket of river water. Mussels should be kept for as brief a period as necessary, typically 10–15 minutes. All loose stones and other obstructions should also be removed. The underlying sand should be gently disturbed and all 'buried' mussels now revealed should be counted and removed, with special care taken to include small mussels (see N for a discussion of mussel measurement).
- Replace all stones in the quadrat as close to the original arrangement as possible, and return all juveniles, placing them under stones as found. Adults should then be placed carefully back into the available spaces within the quadrat, from whence they will relocate themselves.
- If the aim of the survey is to determine whether the mussel population is in favourable condition, quadrat sampling should be stopped as soon as 50 mussels (of which at least 20% are juveniles) have been recorded (10 per $m^2$) to avoid further mussel disturbance. (See Section 7 for assessment and reporting of favourable condition).
- If a baseline record of abundance is needed against which to compare future surveys, then all five quadrats should be completed, even if the threshold values have been achieved.

**M. The presence of dead mussels must be recorded**.

A count should be made of all dead mussel shells in each transect, with target notes indicating whenever possible whether they seem to have died of natural causes (often seen as paired shells with only a small gape), or have been torn open by pearl fishermen (often left in piles of widely open shells on the riverbank). A search should also be made of the river bank within 100 m of the transect and all dead shells recorded. These should be removed to avoid advertising the presence of mussels, and a

decision made by the relevant statutory agency of where they should be kept for future study.

**N. At least 150 mussels, chosen randomly, should be measured to provide a population profile. If the population is too low, a population profile cannot be obtained.**

At least 150 mussels, but not generally more than 250, should be measured carefully along their longest axis to the nearest 1 mm.

These must be chosen without any size bias, usually including all that have been found in the quadrats, but not those present in the general transects. If less than 150 are present in the five quadrats, then extra quadrats should be searched carefully, to ensure that cryptic juvenile mussels are included in the selection, rather than just 'visible' mussels.

It is essential to record the numbers of juvenile mussels (conventionally taken as < 65 mm) and recently recruited mussels (<30 mm) in each quadrat.

Size and age are related but a profile based only on length is difficult to interpret accurately. To obtain true ages, a calibration curve must be produced of external size in relation to age, by carrying out the ligament sectioning technique of Hendelberg (1961). This often involves killing some mussels, which may be unacceptable. The necessity for a true age profile must be agreed with the licensing authorities before planning the work. Generally, only one calibration curve is required for each river.

In small streams, or for small mussel beds, quadrat sampling may disturb a significant proportion of the population. This risk may be so serious that a decision is taken not to use invasive sampling, but merely to record 'visible' mussels. However, this will not permit the detection of juvenile mussels, most or all of which will be buried. Since the confirmation of favourable conservation status requires assessment of the proportion of juveniles, this restriction will prevent normal reporting.

If it seems that too few mussels are present to risk disturbing them, urgent discussions should be held with the relevant conservation agency to decide what strategy should be used.

All mussels that have been disturbed should be replaced carefully. If many are present in an area of generally suitable substrate then it is sufficient to replace them gently onto the surface of the substrate, from where they will rebury themselves in a suitable position. If only a small number are being counted and/or there is a strong current or little suitable substrate, then it may be better to lodge the mussels in a partly buried position in a suitable patch of substrate. In practice, where few mussels are involved, they can be quickly measured and gently replaced exactly where they were found. Care should be taken that they are placed the correct way up.

**O. Mussel numbers must be recorded and reported in a standardised way, using the correct terminology.**

On the standard recording form (see Appendix A), the total numbers are recorded directly, as are the numbers of juveniles (< 65 mm long) found; the numbers of dead shells; and the numbers of both visible and total mussels recorded in the quadrats. Date and time of survey, weather conditions, surveyor's name and location details should also be recorded.

To calculate the numbers of mussels in each transect, the proportionate numbers of buried to visible mussels in the quadrats should be used. This proportion allows adjustment of the numbers of 'visible' mussels in the overall transect to a final 'total' estimate of all mussels for the transect.

Scottish Natural Heritage (SNH) uses letter codes to refer to abundance categories for live mussels in each transect and therefore numbers in each 1 $m^2$ (see Table 1). These should be used in Scotland to refer to abundance for freshwater pearl mussel surveys. It is recommended that the following codes be used in England, Wales and Northern Ireland to assist with standardisation and reporting:

**Table 1. Abundance categories.**

| Numbers of live mussels per 50 x 1 m transect | Equivalent numbers of live mussels per $m^2$ | Abundance level (letter code) |
|---|---|---|
| 0 | 0 | E |
| 1 – 49 | 1 | D |
| 50 – 499 | 2 – 10 | C |
| 500 – 999 | 11 – 20 | B |
| ≥ 1000 | > 21 | A |

# 4. Other information relevant to determining pearl mussel conservation status

## 4.1 Key river features

Information on selected river features should be recorded for each transect. These are known to be related to favourable conservation status and are included in the generic favourable condition table for freshwater pearl mussel produced by the Joint Nature Conservation Committee (JNCC) (see www.riverlife.org.uk).

### 4.1.1 Substrate

An estimate, assessed by eye, of the percentage area of river bed covered by each of the Wentworth scale substrate grades should be made for each transect area (Wentworth 1922). In the favourable condition table, reference is made to the percentage of silt and fine sand in the top 30 cm of substrate, but recording this is currently beyond the scope of this mussel sampling protocol.

### 4.1.2 Algal cover

The extent of filamentous algal mats covering the transect area should be recorded as percentage area of cover. Favourable conditions refer to < 5% cover of such algae.

### 4.1.3 Bankside vegetation

The nature and extent of a 20 m width of the vegetation on the river bank adjacent to, and just upstream of, the transect should be recorded, using Phase 1 land-use categories, if appropriate. Adjacent land use is not included in the generic favourable condition table, but is known to be related to mussel presence (Hastie *et al*. 2002).

### 4.1.4 Flow characteristics

The characteristic flow type in the area of the transect should be recorded (such as 'glide' or 'run', as defined in RHS), as should the presence of any riffles within 100 m of the transect. Note that flow types may vary with the depth of water at the time of survey.

Factors known to affect mussels. Target notes should be made of any evidence of pearl fishing, pollution, use of sheep dips or any other factors known to affect mussel populations.

It is undoubtedly difficult for different recorders to standardise the percentage cover estimates that they make for substrate categories and for vegetation. However, it is possible to record these consistently within 10 % bands, and this is the minimum accuracy that should be achieved.

## 4.2 River Habitat Survey

A River Habitat Survey (RHS) should be carried out at each mussel sampling location. RHS records many features of relevance to pearl mussels which can contribute to an assessment of conservation status. It is therefore recommended that an RHS should be carried out, using accredited surveyors, at each transect location, and the results reported in the standard way to the Environment Agency for validation and storage.

RHS covers 500 m of river, so that more than one transect may be covered by each RHS site. Target notes should include whether the RHS section is typical of the ECS or unit. RHS data can be used as background contextual data to identify pressures on a river catchment.

# 5. Monitoring to assess whether the status of a mussel population has changed

## 5.1 Long-term monitoring based on re-surveys of 50 m transects

Monitoring should be based on a re-survey of the 50 m transects used in the original baseline survey. It is not possible to place the transect exactly on the original location but an attempt should be made to place it as close as possible to the original.

All other data collection should be carried out as for the original survey, with the exception of very small and vulnerable populations where identification that recruitment is occurring may be sufficient. Any significant changes in the topography of the river should be mapped.

The Habitats Directive specifies that a report on the conservation status of the features of community interest must be prepared every six years. For SSSIs and other rivers, the interval can be varied, depending on the needs of the conservation agency and any perceived threats or changes to the river concerned. However, for assessing whether a population is recruiting optimally, return visits should be made on a six- to 10-year cycle.

## 5.2 Assessment of changes in the condition of the mussel population

A comparison should be made between the mussel numbers, the population profile and all environmental features, both against the favourable condition table and against the results of the previous survey(s). All deficiencies and changes should be reported to the statutory agencies, together with any suggested actions that would improve the condition of the population.

It is recommended that, following a six- or 10-year interval, any decrease in mussel numbers sufficient to produce a change in abundance index or a change in condition status should trigger remedial action. Superimposition of population profiles will allow identification of a failure of recruitment. In such a failure, the six- to 10-year 'bands' of mussel numbers are seen to have moved across the profile to the next six- to 10-year category, without any replacement of mussels in the younger age bands (see example profile in Young *et al.* 2001).

# 6. General information

## 6.1 Additional river data

For each river, information on a series of environmental measurements and features should be collated if available. These contribute to determining favourable conditions for pearl mussel populations and may indicate possible threats and/or factors requiring remediation. Such data are likely to be available through the environmental protection agencies. If a choice of sites is available, data from the nearest routine monitoring site should be selected. The factors are as follows:

- River flow regime (throughout the year).
- Suspended solids (median value throughout the year and extreme quartiles).
- Average and year-by-year maximum soluble reactive phosphorus concentrations.
- Summarised water quality standards, including factors such as BOD, dissolved oxygen levels, pH and other relevant determinands.

The freshwater pearl mussel (particularly the juvenile life stage) is very susceptible to the effects of eutrophication and increased sedimentation. Eutrophication may be indicated by the presence of filamentous algae, high levels of phytoplankton and detritus formed by decay. These factors lead to a blocking of interstitial spaces and smothering of juveniles.

## 6.2 Numbers of salmonid fish, especially juveniles

A healthy mussel population can only exist if sufficient juvenile salmonid fish are present. Consequently, it is very valuable to know how many suitable fish are present.

It is necessary to use well-managed electro-fishing surveys to count juvenile salmonid fish, and in England and Wales the Environment Agency routinely collects such data. In Northern Ireland responsibility lies with the (NI) Rivers Agency, while in Scotland, riparian owners and District Salmon Fishery Boards generally carry out such work. An attempt should be made to collate the best data available, or to carry out an electro-fishing survey if this is permitted.

Favourable conditions for juvenile salmonids will vary between rivers. Advice should be sought from local fishery biologists, and favourable condition will be indicated by numbers of juvenile salmonids considered optimal for the river. If no such advice is available, then 0.2 juvenile fish $m^{-2}$ can be regarded as a generalised acceptable figure, but this must be used with caution. If juvenile fish numbers have been stable historically then this may indicate that an acceptable population is present.

# 7. Key monitoring targets

## 7.1 Favourable condition

A mussel population is considered to be in favourable condition if:

- There are more than or equal to 10 mussels $m^{-2}$ within the quadrats in the 50 m transect.
- If at least 20% are <65 mm long (less than 20 years old) and at least some are <30 mm long (less than 10 years old).

The population should be placed in one of the following JNCC Common Standards Monitoring categories:

| **Favourable** | **Unfavourable** |
|---|---|
| • Maintained | • Declining |
| • Recovered | • No change |
| | • Recovering |
| | • Partially destroyed (habitats) |
| | • Totally destroyed (habitats)/lost from site |

It is clear that sampling on at least two occasions is required to place populations in some of these categories. If the sampling carried out represents the only visit to that site, then the only categories that can be used are 'Favourable – Maintained', or 'Unfavourable – No change'. If no mussels are found, then the use of 'Unfavourable – Lost from site' can only apply if there are reliable historical records available.

# 8. Evaluation of data and reporting

## 8.1 Reporting mussel population status from each transect, unit and river

Clarity is required over the reporting of the Common Standards Monitoring categories for each sample. First, it is possible to consider each transect separately and to report the status of the population in each. However, to assign a status to a more meaningful population, it is recommended that the status is reported at the scale of each natural river reach (each ECS or similar monitoring unit), as well as for the entire river (site). In each ECS or unit there will be up to five transects, which may well differ in status, so a decision has to be made as to how many of these need to be 'favourable' before the whole ECS/unit can be so assigned. Data from Scottish surveys suggest that, in the zone of mussel occurrence, it is usual to have at least four out of five transects in favourable condition in each ECS. For an entire river, where transects will also have been carried out in only marginally suitable ECSs, assigning whole river status is even more difficult. Data from Scottish rivers that are generally accepted as having favourable mussel populations suggest that only one third of the transects may individually reach favourable status.

For a small river which counts as one ECS or unit and has fewer than five surveyed transects, it is recommended that all transects have to reach favourable condition before this can be applied to the whole river.

A report should be prepared for each river catchment, summarising the survey results. This should include the completed survey forms, site maps, photographs and the following information:

- ***Description*** of river type and adjacent land use. Summary of oldest and most recent positive mussel records.
- ***Results***: positive and negative findings from the survey, date(s), suitability of water quality and substrate. A short summary should be given of each transect count, listing the numbers of live and dead mussels found, presence or absence of juveniles, and the results of quadrat counts from the 50 m transects. The range of mussel sizes found should be briefly summarised.
- ***Comments***: a brief discussion of general accessibility in terms of geographical location and depth could be included. The results of the survey should be put into context by ascribing relative abundance and status criteria to the monitoring units. Comments should be made about juvenile recruitment in the river. Any threats implicated in the decline/extinction of current mussel populations should be discussed and the most important aspects specifically emphasised. Personal comments and observations should be reported where relevant.

The report should also detail the ratio of adults to juveniles, and the relative density of individuals per $m^2$. Length frequency diagrams should be prepared to give a population profile, if this information has been collected. Maps showing the river and the location of the monitoring sites should be included in the report.

In the UK. data should be recorded in spreadsheets in a format that is compatible with those used by the Biological Record Centre/National Biodiversity Network, the conservation agencies and environmental regulators.

# 9. Resources

Initial site selection and location of areas suitable for transects will take between one and three hours. Each transect will take approximately one hour, and each quadrat 20–30 minutes for both the sampling and completing the paperwork. Each RHS survey will take between 30 and 45 minutes. Time should also be allowed for travel to sites, some of which are extremely remote.

# References

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# Appendix A: Standard survey form – 50 m transect

| | |
|---|---|
| River name | Region and district |
| Location of site | |
| NGR | Date of survey |
| Time of survey | Weather conditions |

Name/contact address of surveyor

Were pearl mussels found? YES/NO

Number of adult mussels in 50 m transect

Number of juveniles (<65 mm) in quadrats

Number of dead shells found

Number of mussels in 1 $m^2$ quadrats: (record as initial number observed/numbers in full search)

| | | |
|---|---|---|
| 10 m | 20 m | 30 m |
| 40 m | 50 m | |

Photo number

Average river width m and depth m

Substrate type along transect survey, as % area covered

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| silt | fine sand | coarse sand | gravel | pebble | cobbles | boulders | bedrock |
| tiny | <0.5 mm | 0.5–2 mm | 2–4 mm | 4–64 mm | 64–256 mm | >256 mm | solid |

Main adjacent land-use types

Nature of bankside vegetation

Any recent evidence of destructive pearl fishing? YES/NO/NOT SURE

Were mussels measured? (If so, cross-refer to data location)

Further comments (note signs of human disturbance and pers. comms.)

Sketch map indicating position of transects and photographs

# Conserving Natura 2000 Rivers

## Ecology Series

1 Ecology of the White-clawed Crayfish, *Austropotamobius pallipes*
2 Ecology of the Freshwater Pearl Mussel, *Margaritifera margaritifera*
*3* Ecology of the Allis and Twaite Shad, *Alosa alosa* and *A. fallax*
*4* Ecology of the Bullhead, *Cottus gobio*
5 Ecology of the River, Brook and Sea Lamprey, *Lampetra fluviatilis*, *L. planeri* and *Petromyzon marinus*
*6* Ecology of Desmoulin's Whorl Snail, *Vertigo moulinsiana*
7 Ecology of the Atlantic Salmon, *Salmo salar*
8 Ecology of the Southern Damselfly, *Coenagrion mercuriale*
9 Ecology of the Floating Water-plantain, *Luronium natans*
10 Ecology of the European Otter, *Lutra lutra*
11 Ecology of Watercourses Characterised by *Ranunculion fluitantis* and *Callitricho-Batrachion* Vegetation

## Monitoring Series

1 A Monitoring Protocol for the White-clawed Crayfish, *Austropotamobius pallipes*
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These publications can be obtained from:

The Enquiry Service
English Nature
Northminster House
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Email: enquiries@english-nature.org.uk
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Fax: +44 (0) 1733 455103

They can also be downloaded from the project website: www.riverlife.org.uk

The Life in UK Rivers project was established to develop methods for conserving the wildlife and habitats of rivers within the Natura 2000 network of protected European sites.

Set up by the UK statutory conservation bodies and the European Commission's LIFE Nature programme, the project has sought to identify the ecological requirements of key plants and animals supported by river Special Areas of Conservation.

In addition, monitoring techniques and conservation strategies have been developed as practical tools for assessing and maintaining these internationally important species and habitats.

The freshwater pearl mussel is one of the longest-lived invertebrates, and one of the rarest. It has declined across Europe due to human impacts, such as pollution and siltation. It has a unique life cycle in association with trout and salmon, so is vulnerable to declines in these species, as well.

The freshwater pearl mussel is now protected by British and European legislation. Populations in Scotland contain almost half the world's remaining pearl mussels with active recruitment.

This report suggests monitoring methods that can be used to determine whether freshwater pearl mussel populations are in favourable condition, and what conservation action is necessary for their survival.

Information on Conserving Natura 2000 Rivers and the Life in UK Rivers project can be found at **www.riverlife.org.uk**

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