North South 2 Project

Monitoring Methods Report Freshwater Pearl Mussel Sub-basin Plans

Photo courtesy of Eugene Ross – Tralee IT

Produced by NS 2, funded by DEHLG

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1 INTRODUCTION

NS2 brief – description of freshwater pearl mussel task

A key objective of the Water Framework Directive is to achieve compliance with relevant standards and objectives for water dependent habitats and species protected under the Habitats Directive. The freshwater pearl mussels (pearl mussel) (*Margaritifera margaritifera* and *Margaritifera durrovensis*) are on Annex II of the Habitats Directive and, because they are particularly sensitive to environmental pressures, may require catchment specific measures in addition to the Programme of Measures (POMs) developed at the RBD level under the River Basin Management Plans. The aim is to ensure that their water related habitat requirements are achieved so that the populations can achieve favourable condition – that is they are recruiting. The 2007 Habitats Directive Article 17 Conservation Assessment Report (NPWS, 2007) concluded that all Irish populations, including the 27 SAC populations (Figure 1.1 and Table 1.1), are in unfavourable condition due to a deterioration in water quality and, in particular, to the loss of juvenile habitat in the substratum through eutrophication and siltation.

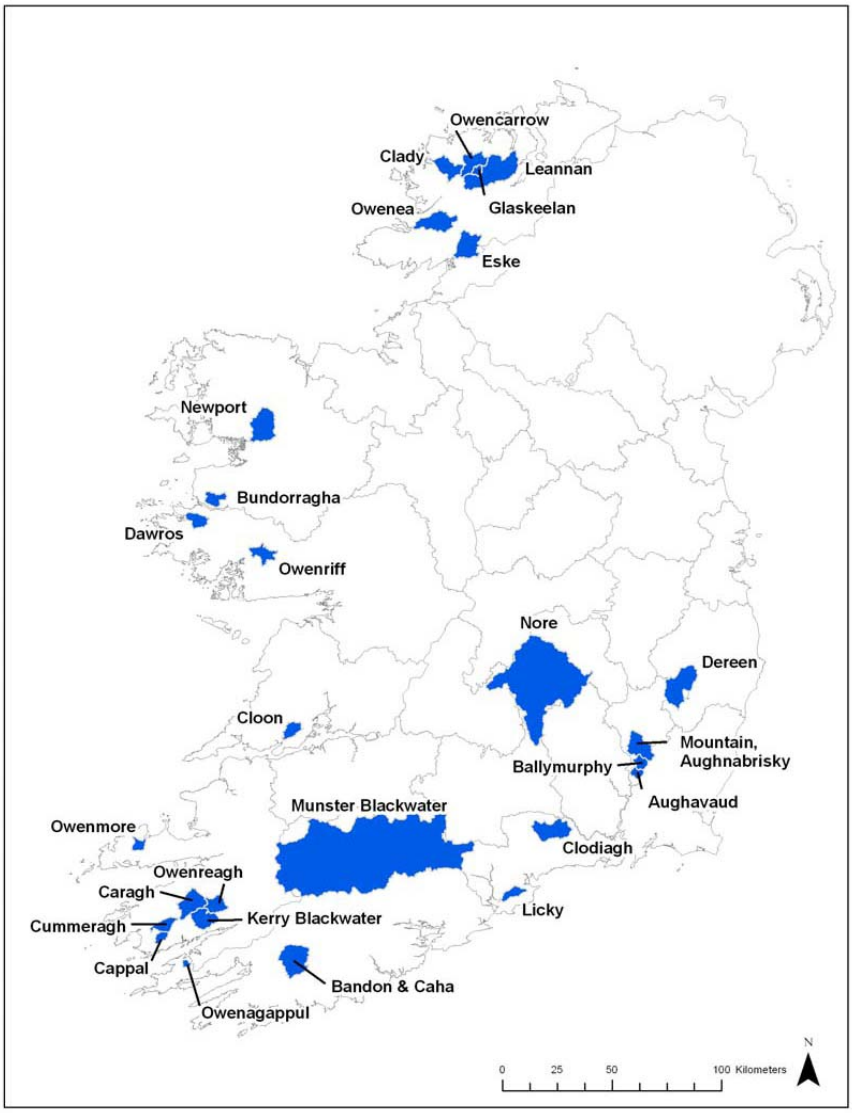


Figure 1.1 Map of the catchments of the specified pearl mussel populations

Table 1.1 List of the 27 sub-basin catchments designated as SACs for freshwater pearl mussel populations

	Freshwater pearl mussel population[1]	SAC Site Code	SAC Site Name	Rivers and lakes containing *Margaritifera* (list not exhaustive)
1	Bandon	002171	Bandon River cSAC	Bandon & Caha
2	Aughavaud (Barrow)	002162	River Barrow and River Nore cSAC	Aughavaud
3	Ballymurphy (Barrow)	002162	River Barrow and River Nore cSAC	Ballymurphy
4	Mountain (Barrow)	002162	River Barrow and River Nore cSAC	Mountain, Aughnabrisky
5	Bundorragha	001932	Mweelrea/ Shreefry/ Erriff Complex cSAC	Bundorragha
6	Caragh	000365	Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment cSAC	Caragh, Owenroe, Meelagh, Caraghbeg, Glashawee, Lough Beg Stream, Lough Acoose, Cloon Lough
7	Clady	000140	Fawnboy Bog/ Lough Nacung cSAC	Clady
8	Owenriff (Corrib)	000297	Lough Corrib cSAC	Owenriff, Glengawbeg
9	Currane	000365	Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment cSAC	Capall, Cummeragh
10	Dawros	002031	The Twelve Bens/ Garraun Complex cSAC	Dawros
11	Eske	000163	Lough Eske and Ardnamona Wood cSAC	Eske
12	Kerry Blackwater	002173 & 000365	Blackwater River (Kerry) cSAC & Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment cSAC	Blackwater, Kealduff, Derreendarragh
13	Gearhameen (Laune)	000365	Killarney National Park, Macgillycuddy's Reeks and Caragh River Catchment cSAC	Gearhameen & Owenreagh
14	Glaskeelan (Leannan)	002047	Cloghernagore Bog and Glenveagh National Park cSAC	Glaskeelan
15	Leannan	002176	Leannan River cSAC	Leannan
16	Allow (Munster Blackwater)	002170	Blackwater River (Cork/Waterford) cSAC	Allow
17	Licky	002170	Blackwater River (Cork/Waterford) cSAC	Licky

[1] Population named after river of highest stream-order that contains mussels.

	Freshwater pearl mussel population[1]	SAC Site Code	SAC Site Name	Rivers and lakes containing *Margaritifera* (list not exhaustive)
18	Munster Blackwater	002170	Blackwater River (Cork/Waterford) cSAC	Munster Blackwater (main channel)
19	Newport	002144	Newport River cSAC	Newport
20	Nore	002162	River Barrow and River Nore cSAC	Nore
21	Owencarrow	002047	Cloghernagore Bog and Glenveagh National Park cSAC	Owencarrow
22	Owenea	000197	West of Ardara/Maas Road cSAC	Owenea
23	Owenmore	000375	Mount Brandon cSAC	Owenmore
24	Ownagappul	001879	Glanmore Bog cSAC	Ownagappul & Barrees
25	Cloon (Shannon Estuary)	002165	Lower River Shannon cSAC	Cloon
26	Derreen (Slaney)	000781	Slaney River Valley cSAC	Derreen
27	Clodiagh (Suir)	002137	Lower River Suir cSAC	Clodiagh

A significant aspect of the NS 2 brief is to develop sub-basin plans and programmes of measures for these 27 SAC populations to restore the water- and substrate-habitats to the quality required by fully functioning, recruiting peal mussel populations.

The sub-basin plans must comply with the Draft EC Environmental Objectives (Freshwater Pearl Mussel) Regulations 2008. The Ecological Quality Targets for designated pearl mussel sites require the achievement of high status for macroinvertebrates, phytobenthos (filamentous algae and diatoms), macrophytes and siltation, the details of which are provided in the fourth schedule of the Draft Regulations These are detailed below in Table 1.2.

Table 1.2 Ecological Quality Objectives for Freshwater Pearl Mussel Sites

Element	Objective	Notes
Macroinvertebrates	EQR $\geq$0.90	High status
Filamentous algae (Macroalgae)	Trace or Present (<5%)	Any filamentous algae should be wispy and ephemeral and never form mats
Phytobenthos (Microalgae)	EQR$\geq$0.93	High status
Macrophytes – rooted higher plants	Trace or Present (<5%)	Rooted macrophytes should be absent or rare within the mussel habitat
Siltation	No artificially elevated levels of siltation	No plumes of silt when substratum is disturbed

Towards this end, a robust monitoring programme is required to assess the status of the pearl mussel populations, their habitat and to gain a detailed understanding of the pressures within the upstream catchments in order that proposed programmes of measures will stand up to scientific scrutiny.

Health and Safety

Sampling water bodies involves some inherent dangers that fieldworkers must be familiar with. This monitoring manual does not identify particular hazards and it is the responsibility of those sampling, and their managers, to appraise, and act upon, those risks, and to establish compliance with national, and other regulatory issues identified by their employers. Specific guidance may also exist for the processing of samples for individual biological elements. For all surveys that require access over private, or otherwise protected land, appropriate authorisation should be obtained prior to embarking on reconnaissance or survey work. To this end, a field survey access letter has been provided by the National Parks and Wildlife Service (NPWS) for use by all surveyors as part of this project (Appendix A). In addition, a specific NPWS license is required under the Wildlife Act (1979) for working with the pearl mussel i.e. a license to capture wild animals for educational scientific or other purposes. Those surveyors, for which this is required, have obtained the relevant license.

RPS as part of their Integrated Management System have developed risk assessments and safe systems of work for the hazards that may be associated with working near or in water, and all RPS staff are required to become familiar with and adhere to these documents. Personal protective equipment necessary for fieldwork, is also made available to survey staff e.g. life jackets.

Each sub consultant employed by RPS is also required to have their own health and safety statement to cover the hazards that may be involved in their specific surveys. Copies of these statements have been received from all sub consultants.

2 METHODOLOGIES

2.1 FRESHWATER PEARL MUSSEL

Initial Population Surveys

Where maps of distribution and approximate abundance of the freshwater pearl mussel are not available, a general survey is undertaken.
This is not equivalent to either a standard Stage 1 or Stage 2 survey (Anon., 2004), but lies in between, by mapping distribution and giving an estimate of abundance rather than merely presence or absence (Stage 1) or a full population abundance estimate (Stage 2).

For monitoring purposes, the rivers are divided into appropriate survey sections. The river and tributaries are either waded upstream and examined using a bathyscope or snorkelled downstream (as per Anon., 2004). Densities are evaluated according to the ACFOR scale, using four condensed abundance categories:

1. Abundant (over 250 per 100m of channel, but may be up to 250/m²)
2. Frequent to Common (20 – 250 per 100m)
3. Occasional (less than 20 per 100m)
4. Absent

The overall distribution and abundance information accumulated on a river can then be used to derive a population estimate. Where more accurate estimates of population abundance are required, such as where the population is small, the information can be augmented by a Stage 2 survey in selected stretches.

Like all pearl mussel survey methods, it is important to follow the safety precautions outlined in Anon. (2004), such that two workers are always present, and where two surveyors are needed in the water (i.e. when the river channel is >3m in width), a bank manager is present to document the survey and act as safety officer. Similarly, all pearl mussel survey must take place during suitable weather and river conditions in order to attain reliable results, survey cannot be carried out when rivers are in flood, or under conditions of poor visibility, for instance:

- when a river is recovering from heavy rains or is highly coloured
- when it is raining
- in overcast (i.e. more than 60% cloud cover) conditions, or at dawn or dusk.

All surveyed sections are delimited by GPS references, the use of hand held GPS is sufficient for this purpose.

Population demographics and juvenile searches

As lack of recruitment of young mussels is the main way in which mussel populations decline, it is important to establish whether effective recruitment is taking place. This is done by measuring enough individual mussels to establish the population profile. As exact aging of mussels cannot be carried out on live individuals, mussel lengths are measured and ages are estimated by fitting size profiles to age profiles established in previous studies. More accurate aging is carried out by slicing the ligament that joins the two valves together and counting the annual growth rings, As this kills the animal, it is no longer a standard method. However, it is possible to do on freshly dead animal shells following a kill.

The size/age structure of a population is determined by removing all of the mussels from a fixed area of substrate and measuring them. The location of each quadrat surveyed must be carefully noted using a site description and GPS location. This has to be done in a stable area of mussel habitat such that it will not destabilise the disturbed area or the area surrounding it. Firstly a 0.5m x 0.5m metal quadrat is placed on the river bed and the number of mussels visible from the surface is counted. The visible mussels are then carefully removed from the quadrat with as little disturbance to the substrate as possible. The substrate is then disturbed with the fingertips and any additional mussels counted and removed. Finally, an aluminium framed sampling net, equipped with a 0.5mm nylon mesh bag, is placed vertically on the downstream side of the quadrat and the substrate is gently agitated with the

fingertips to allow any remaining mussels to come to the surface and any very young (<15mm) individuals to be swept by the water current into the net. All mussel lengths are measured using a Vernier callipers and the population demographic profile established. An example of a good and bad demographic profile is shown in Figure 2.1. The measured mussels are then carefully reburied in the substrate they were taken from. In addition, all dead shells found in the surveys are collected and measured. Sufficient quadrats need to be sampled to provide at least 250 mussels from the river. It is important to collect information regarding the habitat quality with the quadrat information. An example of the form for quadrat survey is given in Appendix B.

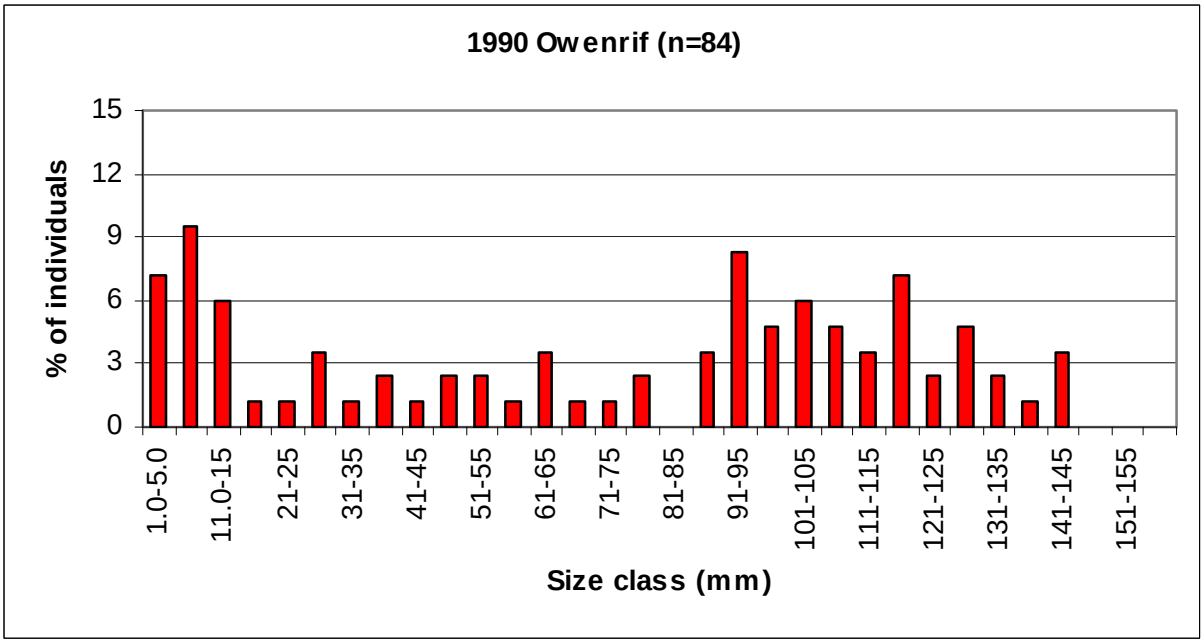
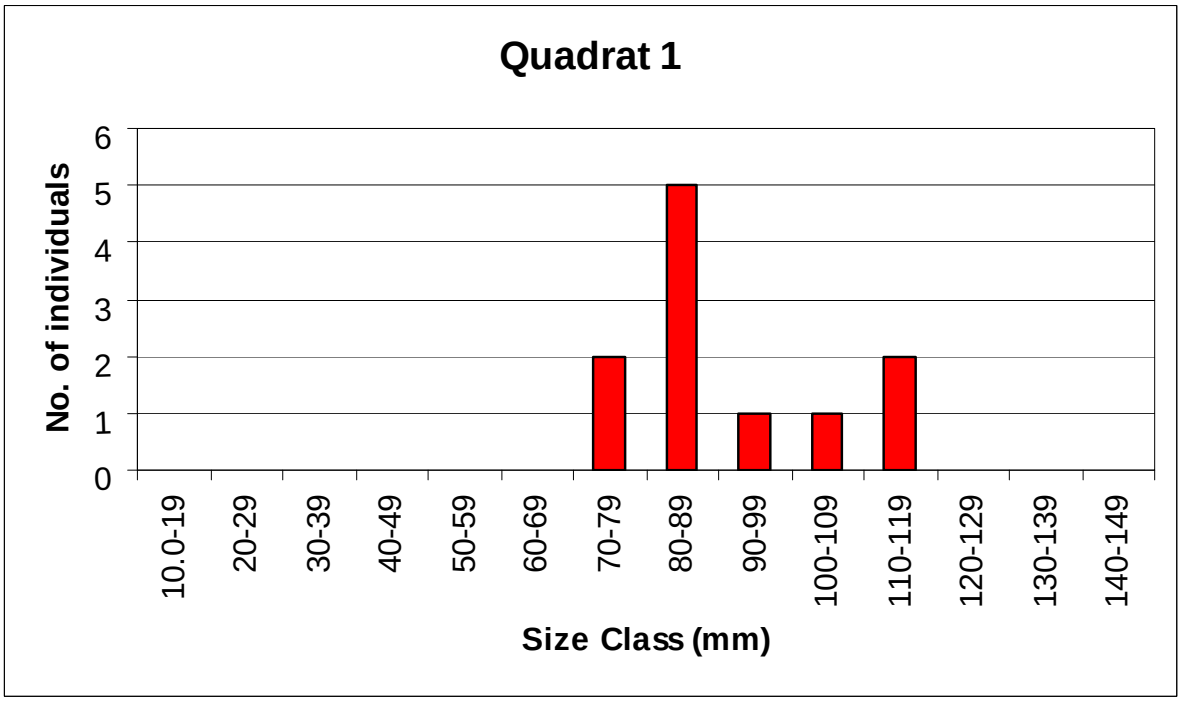


Figure 2.1 Examples of good and bad demographic profiles from quadrat measurements.
a) Example of excellent demographic profile



b) Example of unsatisfactory demographic profile

Baseline monitoring transects

Monitoring transects are set up to a) provide an accurate population profile across the width of the river and b) to set up a baseline to monitor for change in mussel numbers and mussel distribution across the width of the river. Transects do not normally give good information about gradual decline in the short term, for example through reduced recruitment patterns, but are useful in showing significant losses of adult mussels, or significant changes in mussel distribution. In a healthy population, mussels will be equally plentiful across the width of a river if their habitat is present. In a negatively impacted population, losses will usually occur in midstream areas before bank side areas. The transects are placed in areas that will be easy to relocate, and are likely to show negative impacts if they occur. Transects are marked by more than one means (e.g. by pegs and by landmark marking), photographed with visible landmarks, carefully described and located by GPS. The transects are delineated by stretching a length of chain in a straight line across the river channel (generally) at right angles to the current. The chain is fixed in place at both banks and at several points in the channel using aluminium pegs. One metre lengths of cord, attached to the chain at intervals of 1m, are fixed into the stream substrate directly downstream of the chain using aluminium pegs, thereby dividing the transect into quadrats of $1m^2$. A 30 metre long tape measure is also run across the top of the chain to aid location. The surveyor snorkels or wades across the river downstream of the transect, taking great care not to trample other mussels. The number of mussels visible on the substrate surface in each constituent 1 metre quadrat of each transect are counted. Mussels are not removed from the substrate or disturbed in any way during these transect counts. This is very important, as the transect method is designed to measure distribution changes that are occurring in the river as a result of habitat improvements or declines.

As well as recording the number of mussels in each $1m^2$ quadrat, the percentage cover of the various substrate fractions, macrophytes and filamentous algae are also noted. These are summarised in a standard form for Transect Survey (Appendix C).

Redox potential measurements

The juvenile stage of the pearl mussel requires the safety of remaining within the river bed gravels, before growing to a size that allows the emergence of the filtering siphons into the open water body. While the juvenile mussels remain within the river bed gravels, they filter the interstitial water within the gravels. Where the gaps between the gravel stones get clogged with fine silt, the flow of water in the interstices becomes very restricted. Without adequate water movement and replacement, oxygen levels are soon exhausted and young mussels die. The decline in interstitial water quality in silted gravels has been detailed by Buddensiek (1989), Buddensiek *et al*. (1993). Fine sediments in gravels were shown to increase mortality in juvenile mussels to 100% (Buddensiek, 2001).

The differences in the redox potential between the water column and the substrate correlate with differences in oxygen levels, and thus, the level of clogging of the interstices by fine sediments (silt). These data are of greatest significance for juvenile mussels which require full oxygenation of the sediment. In suitable juvenile mussel habitat, there should be very little loss of redox potential between the open water and the gravels below. There should not be a significant reduction in redox potential to depths to 10cm (Geist & Auerswald, 2007).

Plate 2.1 Redox potential measurement

The equipment comprises a 0.7m long probe fitted with a platinum tipped electrode, a reference potassium chloride electrode and a meter with a millivolt display. A reading is obtained by holding both electrodes in the water column until a stable reading is obtained (typically this would be 500-540mV). With the KCl electrode remaining in the water column, the platinum electrode is then inserted into measured depths in the substrate and a reading taken immediately. Separate readings are obtained for substrate depths ranging from 2cm to 8cm. Approximately 20 readings are taken at each site.

The results are plotted as scatter graphs with a linear trend-line added and the intercept set at the value of the redox potential of the open water. An example is shown in Figure 2.2.

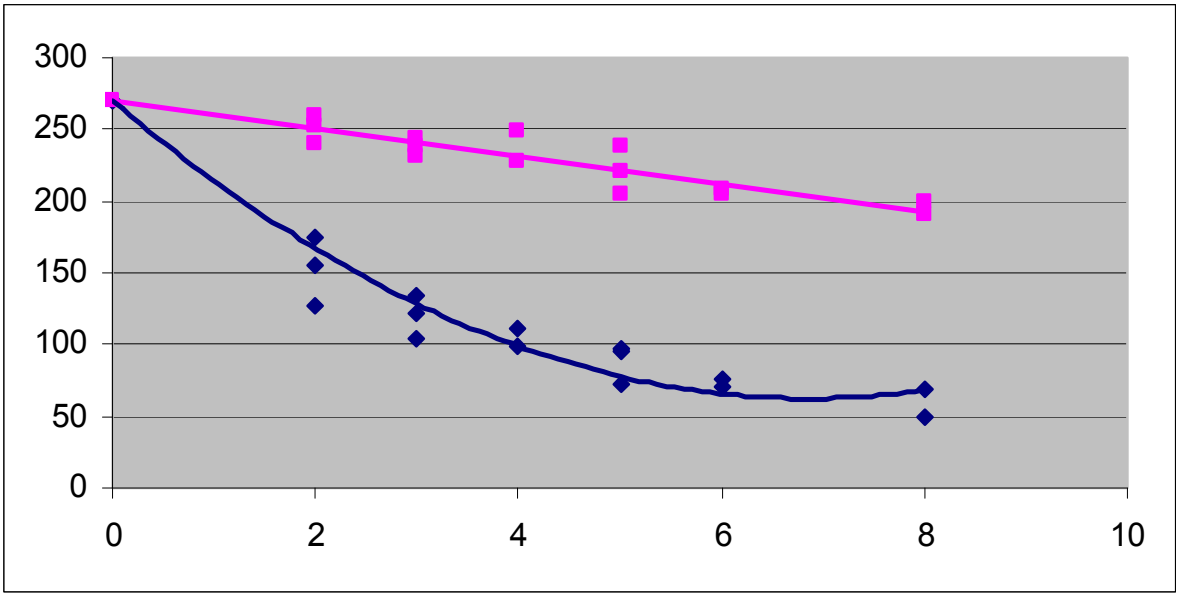


Figure 2.2 Examples of good and bad redox potential trendlines. Pink line shows results from area of suitable pearl mussel habitat quality, blue line is from poor habitat quality.

2.2 MACROINVERTEBRATES

Habitat assessment

Habitat assessment is carried out at each of the sites selected for invertebrate/water quality assessment. These sites are assessed in terms of:

- Stream width and depth

- Substrate type, listing substrate fractions in order of dominance, i.e. large rocks, cobble, gravel, sand, mud etc.
- Flow type, listing percentage of riffle, glide and pool in the sampling area
- Instream vegetation, listing plant species occurring and their percentage coverage of the stream bottom at the sampling site
- Dominant bankside vegetation, listing the main species overhanging the stream
- Estimated summer cover by bankside vegetation, giving percentage shade of the sampling site

Grid references are recorded at all sites using a GPS. Site photographs are taken using a digital camera.

Invertebrate sampling and water quality assessment

A kick and stone wash invertebrate sample is taken at each site (ISO 7828:1985) using standard methodology employed by the EPA. Each sample is retained in a large plastic bag at the sampling site. Sample processing and preservation is carried out under laboratory conditions within 24 hours of sampling. Mud is removed from each sample by sieving under running water through a 500µm sieve. Sieved samples are then live sorted for 30 minutes in a white plastic sorting tray under a bench lamp (ISO 5667-3:1994) and if necessary using a magnifying lens. Macroinvertebrates are stored in 70% alcohol. Preserved invertebrates are identified to the level required for the EPA Q-rating method (McGarrigle *et al*, 2002) using high-power and low-power binocular microscopes when necessary. The preserved samples are archived for future examination or verification. Based on the relative abundance of indicator species, a biotic index (Q-rating) is determined for each site in accordance with the biological assessment procedure used by the Environmental Protection Agency (Statutory Instruments No. 258 of 1998) and more detailed unpublished methodology (McGarrigle, Clabby and Lucey pers. comm.).

Table 2.1 Macroinvertebrate classification scheme for the WFD

Notes: A) The suffice '0' is added when there is evidence of an additional toxic influence on the invertebrate fauna e.g. Q3/0, Q4/0. An asterix after the Q value indicates something worthy of special attention, typically heavy siltation of the substratum. B) the colours used in the table below are those set out under Annex V of the WFD to be used for the presentation of monitoring results. C) EQR = Ecological Quality Ratio

Biotic Index	WFD Ecological Status Classification	EQR	EPA Water Quality	Quality Status
Q5	High	High-good boundary = 0.85	Good	Unpolluted Waters
Q4-5	High		Fair - Good	
Q4	Good	Good-moderate boundary = 0.75	Fair	
Q3-4	Moderate		Doubtful - Fair	Slightly Polluted Waters
Q3	Poor		Doubtful	Moderately Polluted Waters
Q2-3	Poor		Poor - Doubtful	
Q2	Bad		Poor	Seriously Polluted Waters
Q1-2	Bad		Bad - Poor	
Q1	Bad		Bad	

2.3 MACROPHYTES

The purpose of the macrophyte assessment is to detail the abundance of macrophytes (including filamentous algae) at stretches of river that are mapped as habitat for the freshwater pearl mussel, and to examine this abundance in relation to the Draft EC Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009. These draft Regulations require that macrophyte cover is trace or present at an abundance <5% within the pearl mussel habitat. The aim is to record macrophytes at all sites sampled for other elements.

Macrophyte sampling is recommended to be carried out between the 1st of May and 30th of September inclusive. Nevertheless, it is recommended that macrophyte recording is conducted during every visit to the river, in order to maximise the number of observations. If possible comparative surveys in subsequent years should be undertaken at the same time as in previous years (NS Share, River Macrophytes methods manual).

The survey will involve a semi-quantitative estimate of the abundance of aquatic macrophytes, which can be performed by each member of the sampling team surveying within the pearl mussel habitat. An examination of the entire survey unit will be performed from the bank and will avoid trampling on the pearl mussel habitat. Macrophyte data will be recorded on the general "survey site condition assessment form" that has been generated specifically for the purposes of this project (Appendix D). The presence of all macrophytic assemblages will be recorded as per the survey form, and their abundance estimated.

The survey form also records other elements such as bankside vegetation, % shading of the channel, average water depth, average length of the survey area, river velocity, area of survey, and substrate cover (%).

2.4 PHYTOBENTHOS

Definition

Annex V of the Water Framework Directive (WFD) provides definitions of ecological quality in rivers and lakes that are based on four biological quality elements one of which is 'macrophytes and phytobenthos'. The element 'macrophytes and phytobenthos' comprises of two groups that have traditionally been treated more-or-less separately by researchers for a number of reasons. Notable amongst these reasons is simply the differing scale of the organisms concerned, with a difference of six orders of magnitude between the largest rooted macrophytes and the smallest unicellular algae. Nonetheless, there is some blurring of distinctions, with larger algae such as *Cladophora* and the Charales, routinely included in macrophyte survey techniques in some countries (e.g. UK; Holmes *et al*., 1999), but not in others (Robach *et al*., 1996).

Algal-based methods have tended to focus on the diatoms, which often form a large part of the algal diversity at sites and have the added advantage of being relatively easy to analyse in the laboratory. However, an awareness of the entire phytobenthos, rather than just isolated components, should, inform a better understanding of the ecological functioning of a river. The definition of 'phytobenthos' is problematical, and this is discussed in Kelly *et al*., 2006. However for the purposes of this work, the definition from the draft CEN Guidance standard for the survey, sampling and laboratory analysis of phytobenthos in shallow running water (2007) is used:

All phototrophic algae and cyanobacteria that live on or are attached to substrata or other organisms, rather than suspended in the water column. NOTE: For the purposes of this standard, other organisms that have competitive interactions with phytobenthos, or which act as substrata (e.g. bryophytes), may also be included in survey methods.

Existing approaches to surveying phytobenthos

The phytobenthos of any stretch of a river or lake often consists of many species and shows marked spatial heterogeneity and rapid temporal change (Holmes & Whitton, 1981). Any attempt to develop a comprehensive list of the phytobenthos present at a site is a time-consuming task, involving close analysis of all habitats within the site that are capable of acting as substrates, as well as the taxonomy

of several large taxonomic groups. A number of these will require special treatment in the laboratory in order to view features (e.g. reproductive organs, flagellae number) that are necessary for species level identification. The result of such a procedure would provide some insight into the overall biodiversity of the site but at a high cost, in terms of time and resources. This is particularly important if spatial or temporal comparisons of abundance are to be made, as these require a high level of taxonomic skill in order to identify all the organisms likely to be encountered. It is not surprising that few methods have been developed with the specific intention of routine environmental monitoring, as required for the WFD, and that attention has tended to focus on a few taxonomic groups (e.g. diatoms) and a few common substrata (e.g. cobbles). A number of countries have attempted to develop practical methods based on the entire phytobenthos, and these are outlined in Kelly *et al*., 2006. Below, the methodologies which will be employed in this project are outlined.

Filamentous algae

Two macroalgal sampling methods will be adopted as part of the NS2 survey. The first method has been detailed as part of the macrophyte assessment above and will estimate the abundance of macrophytes including filamentous algae. All surveyors will complete the site condition assessment form at each site they visit. The second method which will be used is detailed below and will be carried out by the phytobenthos surveyor. The result will be a comprehensive assessment of both the abundance and composition of the filamentous algal assemblage at freshwater pearl mussel habitat locations. The survey will establish a baseline dataset for the filamentous algae, which can be compared to during repeated sampling occasions and in particular to observe whether measures implemented within catchments lead to improved water quality, which can be measured through an observed reduction in filamentous algal abundance.
Analysis of the phytobenthos at a site / survey unit consists of three stages, which can be combined in various ways to give a number of survey / sampling strategies, each applicable to different purposes. These stages are:

1. Survey: a detailed inspection of a defined length of the river or stream, recording the nature of the stream environment, the substrata available for phytobenthos and the nature and abundance of any phytobenthic growth forms present.
2. Sampling: removal of small quantities of some or all the phytobenthic growth forms for subsequent examination in the laboratory.

3. Laboratory analysis**:** identification and abundance assessment of the organisms present in the growth forms.

In a few cases (e.g. *Hildenbrandia rivularis*), species-level determinations can be made in the field but in most cases, the identities of macroscopic algae should be checked in the laboratory.

These three stages can be combined in different ways, and for the purposes of this survey the following methodology will be employed:

> Macroscopic Phytobenthos Survey (MPS): detailed survey of all of the phytobenthic growth forms that are visible with the naked eye, with sampling and laboratory analysis confined to checking the identities of macroscopic algae. MPS provides semi-quantitative estimates of the abundance of those taxa that are visible to the naked eye. It is recommended for trend monitoring and, particularly, for detecting changes in abundance of those algae such as *Cladophora, Didymosphenia* and *Hydrodictyon* which are capable of proliferating to 'nuisance' quantities.

The location of the selected survey unit within a given site should be defined in field notes by reference to permanent bankside objects. The survey units at each site will be the same length: 10 m is recommended, and will be used for this survey. The samples should be collected from the main channel of the river (i.e. that zone that is normally submerged). The flood zone should be avoided.

A detailed examination of the entire survey unit will be performed using a bathyscope if observation of the stream bed is hampered by depth or surface turbulence, and also taking care not to trample in pearl mussel beds. The presence of all phytobenthic assemblages will be recorded and their abundance estimated. Small specimens of macroalgae will be removed for either bank-side or laboratory examination. Samples that are analysed shortly after sampling (within 48 hours) do not

need to be preserved before analysis, but should be kept in a cool dark place e.g. ice box, or placed in a refrigerator as soon as possible. If treated with care, many algal samples can be stored in a refrigerator or cool room for several days without deterioration. Otherwise, Acid Lugol's iodine will be used as a general preservative however this can obscure some of the identification characteristics of algae e.g. colour of the alga.

The abundance of each macroscopic element will be estimated using a simple descriptor scale, based on the percentage of the stream or river bed (within the survey unit) that is covered by the assemblage (Table 2). The quantification is based on "qualified judgement". Scales with about five levels balance the needs for reproducibility and spatial/temporal discrimination. Scales with a greater number of levels may appear to be more accurate but may be less reproducible.

Table 2.2 Descriptor scale for algal abundance estimates of macroscopically visible elements

Scale	Description of coverage at the survey unit
1	*Rare:* just visible in the field, covers < 1 % of the river bed
2	*Occasional*: covers 1 % to < 5 % of the river bed
3	*Frequent*: covers 5 % to < 25 % of the river bed
4	*Abundant*: covers 25 % to < 50 % of the river bed
5	*Dominant*: covers ≥ 50 % of the river bed

Timing of sampling

In Ireland, macroalgae are at peak development in late summer/autumn before the onset of the decomposition of the vegetation (Ní Chatháin, B., 2002; Kelly-Quinn *et al*., 2005). It is recommended that sampling is undertaken at low river levels. The composition of stream phytobenthos varies throughout the year and a single sample is not sufficient to characterise diversity in a reach fully although it will be sufficient as the basis for spatial comparisons amongst the various pearl mussel catchments and to provide a picture of the macroalgal composition and abundance which occurs within these catchments. Subsequent sampling of macroalgae at these sites should be undertaken at the same time of the year if a rolling monitoring programme is to be put in place.

Results and interpretation

In the case of MPS outlined above, the outcome will be a list of taxa along with 5-point semi-quantitative estimates of abundance. Each site result will be compared with the ecological quality objective set for macroalgae in the Draft European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2008 (see Table 1.2). Therefore, sites which have a macroalgal coverage equivalent to rare or occasional as detailed in Table 2.3 will be deemed acceptable, while those whose macroalgal coverage are frequent, abundant or dominant, will be considered for pressure examination and potentially subsequent measures to reduce pressures.

Diatoms

The use of diatoms as indicators of river water quality is widely accepted both in Europe and the USA. The methodology is based on the fact that all diatom species have tolerance limits and optima with respect to their preference for environmental conditions such as nutrients, organic pollution and acidity. Polluted waters will tend to support an increased abundance of those species whose optima correspond with the levels of the pollutant in question. Conversely, certain species are intolerant of elevated levels of one or more pollutants, whilst others can occur in a wide range of water qualities.

Sampling

Diatoms can be found growing on most submerged surfaces; however, the composition of the community varies depending upon the substratum chosen. Ideally, a single substratum should be used at all sites included in a survey. Areas of the river bed with naturally occurring moveable hard surfaces

(large pebbles, cobbles and boulders) are recommended wherever possible (EN13946, 2003), and indices such as DARLEQ (Diatom Assessment of River and Lake Ecological Quality) have been designed with this substrate as the preference. Cobbles will be the preferred substrate for the purposes of this survey, however given the nature of the present study, diatoms will also be sampled from the pearl mussel habitat and pearl mussel shells themselves at a selection of catchments with varying pearl mussel populations.

For the cobble sample collection, a detailed examination of the entire survey unit will be performed, using a bathyscope if observation of the stream bed is hampered by depth or surface turbulence, and to prevent trampling on pearl mussel beds. The survey length will be 10 m in length, as for macroalgal surveys described above. Riffles are the preferred section of a river for sampling cobbles, as these tend to have a good variety of natural hard surfaces, however cobbles will be preferentially removed from within or adjacent to pearl mussel beds if available. For pearl mussel habitat and mussel shell samples, samples will need to be collected from the location of the habitat within the river stretch which can vary from a central river stretch position, to a bank side location.

The following microhabitat conditions should be fulfilled as recommended in EN13946 (2003) if possible:

1) Areas of heavy shade should be avoided (if it cannot be avoided, then a note should be made to this effect). Areas very close to the bank should also be avoided, however this may not be possible when sampling from the pearl mussel habitat and pearl mussel shells.
2) The substrata shall be submerged for long enough to ensure that assemblages are in equilibrium with their environment. At least four weeks is recommended but the period depends upon environmental conditions. The precise depth is unimportant so long as the surfaces have not been exposed to air. All depths that can be easily sampled wearing waders are usually suitable, so long as these remain in the euphotic zone.
3) In general, samples should be collected from within the main flow of the river at the sample site. Zones of very slow current (approx. $\leq$20 cm s^{-1}) should be avoided as these allow the build-up of loosely attached diatoms, silt and other debris. As mentioned above, this may not be possible to avoid at some pearl mussel habitat locations, therefore a note of such conditions will be made if encountered.

Where suitable hard substrata/mussels are very abundant, a random sampling strategy will be used within the defined survey site/mussel habitat. At least five cobbles/mussels will be sampled at each site. An area of approximately 10 cm^2 or more from each hard substrate, or the entire pearl mussel, will be brushed with a stiff toothbrush and the resultant diatom material transferred directly from the stone in to a white tray. The substratum/mussel is then replaced back in to the river, and the process repeated for the other replicate substrata. The final combined diatom material from the five hard substrata/mussels is then transferred to a labeled sampling container.

Preservation is required to stop cell division of diatoms and decomposition of organic matter. No preservative is necessary if the sample is to be processed within a few hours of collection, as long as steps are taken to minimize cell division (i.e. by storage in cool, dark place). Lugols iodine can be used for short-term storage, and will be used to preserve samples during this survey.

Timing of sampling

In Ireland, diatom assemblages appear to be at peak development in early spring and again in the autumn, and normally correspond with low abundances of macroalgae on substrata which may allow for a competitive advantage at these times of the year (Ní Chatháin, B., 2002; Kelly-Quinn *et al*., 2005). It is recommended that sampling is undertaken at low river levels. As mentioned under filamentous algae above, the composition of stream phytobenthos varies throughout the year and a single sample is not sufficient to characterise diversity in a reach fully although it will be sufficient as the basis for spatial comparisons amongst the various pearl mussel catchments and to provide a picture of the diatom composition and abundance which occurs within these catchments. Subsequent sampling of diatoms at these sites should be undertaken at the same time of the year if a rolling monitoring programme is to be put in place.

Diatom pre-treatment and microscopic examination

Samples will be placed in a cool, dark place on return to the laboratory and allowed to stand for at least 24 hours after which suspended material will have settled to the bottom of the jar and the clear supernatant can be poured off carefully. Alternatively, the sample can be centrifuged. A preliminary microscopic examination of the sample will be performed in order to look for unusual features (e.g. large numbers of empty frustules). A portion of the sample will be retained in case problems are encountered during the preparation process.

For accurate identification of diatoms, it is necessary to remove all the cell contents and mount the diatoms using a mountant with a high refractive index. This can be effected by exposure to strong oxidizing agents. A cold acid (permanganate) method of cleaning will be used (EN13846, 2003).

The cleaned diatom suspension is then dried on a coverslip, and mounted on a glass slide. Naphrax will be used as the mounting medium. Ideally, the preparation should have between 10 to 15 valves per field at a magnification of 1000 x. The slide will be labeled with, details of location and sampling date.

Diatom valves will be identified and counted in random fields of view at 1000 x until 300 valves per slide are enumerated and identified. The identification of diatoms will follow the nomenclature in the monographs of Krammer and Lange-Bertalot (1986-1991), and any subsequent revisions of taxa will also be adhered to.

Results and Interpretation

The results of lab analysis will be an assessment of the relative abundance of diatoms at all sites sampled. These results will then be entered in to a Microsoft windows programme designed as part of the DARLEQ project – Diatom Assessment of River and Lake Ecological Quality. The program implements a classification algorithm using a metric based on a revised Trophic Diatom Index (TDI). Details of the metric, algorithm and derivation of the status class boundaries are provided in Kelly *et al*. (2006). The programme calculates the TDI score, Ecological Quality Ratio (EQR) and status class for each sample. EQRs are produced by comparing the observed TDI with that expected to be obtained if the site was at reference condition i.e. in the absence of eutrophication pressures. The Draft European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2008 (see Table 1.1), require pearl mussel sites to attain an EQR $\geq$ 0.93, which is the equivalent of high status. Therefore, sites which have a diatom EQR equivalent to high status, will be deemed acceptable, while those with an EQR less than this, will be considered for pressure examination and potentially subsequent measures to reduce pressures.

Quality control

The diatom analyst is also participating in a UK and Ireland quality assurance scheme for freshwater diatom analyses, which has the objective of ensuring confidence in the quality of the ecological evidence used to underpin regulation.

2.5 FISH

Juvenile salmonids are an essential factor in the lifecycle of the pearl mussel in acting as temporary hosts for the glochidial stage of the species. Implementation of the Sub-Basin Management Plans will require an understanding of the fish present within each of the rivers carrying pearl mussel populations.

Three questions need to be addressed:

- Are juvenile salmonids present?
- What age classes are present?
- Are glochidia attaching?

It is recommended that electrofishing would be carried out on each of the river stretches which have been identified and prioritised, in terms of their importance to the pearl mussel population, in order to obtain the necessary information on the fish stocks. It will also be necessary to examine the fish live to determine whether or not glochidia are attaching without the need to kill a portion of the sample.

Three sites should be sampled on each river with known populations, with each site extending up to 100m. It is anticipated that 10-30 fish specimens should be examined from each site. The work must be carried out in the months of April and May 2009 in order to determine presence or absence of last year's glochidia before they drop off during summer 2009.
The 27 sub-basin catchments designated as SACs for pearl mussels have been reviewed. These catchments have been prioritised according to the requirement for fish data, and fall into three distinct groups:

- Data required - Priority catchments (3)
- Data required - Non-priority catchments (15)
- Probably enough data / some data available (9)

Outline methodology

Limitations

To survey salmonids by electrofishing, it is important that the water temperature is greater than 5ºC – at lower temperatures juvenile salmonids become very inactive and tend to remain well hidden under substrate features on the riverbed. It is anticipated that water temperatures in these catchments during April / May should easily exceed 5ºC, but in the event of a cold spell producing a dip in water temperatures the survey would be suspended. Water temperature will therefore be recorded at each location before sampling is commenced.
The efficiency of electrofishing in capturing age 1 and 2 salmonids will be related primarily to channel width but also to habitat characteristics such as water depth, substrate type and flow rate. These age groups would be most likely found in water 40-65cm deep, with cobble/boulder substrate and a moderate flow rate. Attempting to capture these ages in shallow riffle areas with gravel substrate could be highly inefficient, particularly in larger channels of >5m width.

It is noted that electrofishing must be carried out in very specific sites in order to prevent trampling on pearl mussel beds. It will also be desirable to avoid salmonid spawning fords and shallow riffles so that recently emerged 0+ salmonid alevins/fry are not subjected to electrofishing.

It is possible that the survey may be temporarily suspended if rivers are in flood. Standard health and safety provisions would also dictate that electrofishing should not be carried out during moderate to heavy rainfall.

Proposed procedures

Electrofishing will be conducted in a team of three operators with the option of using two backpacks or a single backpack along with a stop net. The preferred method would be to electrofish with 2 backpacks in the usual upstream direction with the third operator removing fish to holding bins. Alternatively the stop net could be deployed with a single backpack operating in a downstream direction towards the stop net.

All juvenile trout and salmon caught will be retained for live examination to ascertain the presence or absence of glochidia. For maximum efficiency and least stress to the fish the fish will be lightly anaesthetised with either clove oil or benzocaine. Fish will also be measured to the nearest millimetre before return to the river. There is no guarantee that the electrofishing and anaesthetising of fish will not negatively impact on the glochidia where present, but this is considered to be a worthwhile risk as most glochidia are not currently surviving to become older juveniles.

2.6 HYDROMORPHOLOGY

The EPA use a WFD classification tool called the River Hydromorphology Assessment Technique (RHAT), developed through the North South Share project, to classify rivers in terms of their morphology, and this tool will be employed as part of this project. Details of the technique can be

found in 'River Hydromorphology Assessment Technique' – a training guide produced by the Northern Ireland Environment Agency. The following has been summarised from that document.
RHAT surveys will be used as a method to aid identification of high risk areas and will be correlated with ecological factors from other surveys. RHAT classifies river hydromorphology based on a departure from naturalness, and assigns a morphological classification directly related to that of the WFD: high, good, moderate, poor, and bad, based on semi-quantitative criteria. The eight criteria that are scored are:

1. Channel morphology and flow types
2. Channel vegetation
3. Substrate diversity and embeddedness
4. Channel flow status
5. Bank and bank top stability
6. Bank and bank top vegetation
7. Riparian land use
8. Floodplain connectivity

It is designed to be a rapid visual assessment based on information from desktop studies, using GIS data, aerial photography, historical data and data obtained from previous field surveys.

Classification of hydromorphology can be used to contribute to the status classification of water bodies at high ecological status only. However, RHAT plays a vital role in identifying why a water body might be failing to achieve good ecological status as it is based on the observed impact in the field. It can assist in deciding what indirect and direct efforts are needed to improve status and in helping to prevent further deterioration.

Guidance notes on the RHAT survey and a sample field sheet are included in Appendix E for information.

A summary of the procedure is provided here, taken from the NS Share report 'Guidelines for the Assessment of the Hydromorphological Status of Rivers as part of the requirements of the WFD. II Assessment Procedure':

1. This summary begins from the point where the river basin, the water body within the basin, and a representative set of general reach locations within the water body have been selected.
2. Using a map of the drainage network, select the *specific* reach to be assessed at the sampled location. This reach should be a length of approximately 40 times the stream wetted width. Ideally the habitat assessment is performed on the same reach length for which the biological sampling is conducted. Some parameters may require an observation of a broader section of the catchment than just the sampled reach.
3. Before the field survey, a desk study is required. The reach identification and physical characterisation sections for each field site are recorded on Sheet 1 (see Appendix E) with all information available from GIS and aerial photographs, including:
    a. expected stream type and the description of various stream types (NS Share report provides guidance);
    b. catchment and reach-scale pressures (these may help to identify, confirm or explain field observations);
    c. expected riparian vegetation types (for high quality status);
    d. any other notable issues (e.g. from previous surveys).
4. Initial assessment of some attributes may be possible from map data and aerial photographs, particularly alterations to the channel, planform (Spatial pattern and location of a channel, as viewed from above) or pattern and riparian vegetation. These may be recorded on the assessment sheets, however it is recommended that the desk-based score be verified by a confirmatory assessment of these attributes in the field. If the physical and water quality characterisation and habitat assessment are done before the biological sampling, care must be taken to avoid disturbing the sampling habitat.
5. Attach a map of the sampling reach and aerial photograph to the assessment sheets, as well as details of any previous survey. These may be useful to the field surveyor, for instance for confirming the extent of riparian vegetation or, where monitoring surveillance is being undertaken, how the channel has changed over time.

6. Complete the Habitat Assessment Field Data Sheets, in a team of 2 or more, if possible, to come to a consensus on determination of quality. On Sheet 1 (see Appendix E), which should have included details noted during the desk study note:
    a. the weather conditions on the day of the survey, and those immediately preceding the day of the survey. This information is important to interpret the effects of storm events on the survey results;
    b. the estimated stream width and the reach length to be assessed (~ 40 x width).
7. Allocate a score to each relevant attribute (the number of attributes to be assessed will depend on the stream type). Where the condition departs from the reference condition, note should be made if this condition results from a particular identifiable pressure.
8. Where possible and where relevant, all attributes should be included in the assessment, using the assessment sheet (Sheet 2, see Appendix E). If an attribute is not assessed, the score-summary table should be amended (cells shaded) and a note made as to why the assessment was not carried out. The WFD status can still be calculated on the basis of other attributes, but with a note that a particular attribute was omitted.
9. Take at least 2 photographs that are representative of the reach condition. Where unusual features exist, or a particular condition or feature has significant influence on the quality of one or more attributes, further photographs should be taken and notes made. These will help to monitor future changes in the channel and can also be used in a quality control.
10. Transfer scores for individual attributes to the summary table on the survey Sheet 2.
11. Calculate overall WFD category:

> 0.8	= high
0.6 – 0.8	= good
0.4 – 0.6	= moderate
0.2 – 0.4	= poor
< 0.2	= bad

For the purposes of the assessment as part of the NS2 project, a high status for morphology is desirable for pearl mussel habitats. Through work carried out by the Shannon IRBD project on the Freshwater Morphology Programme of Measures Study, it was found that an observed relationship exists between biological data and a RHAT score. The study confirmed that morphological pressure can impact biology and therefore ecological status. In general, sites with RHAT scores less than 0.6 also have less than good Q scores. Similarly high levels of siltation affecting macrophyte populations are reflected by less than good RHAT scores. The NS Share RHAT tool can therefore be used in the field to verify the desktop information which was assessed and incorporated into the Phase 1 draft plans. The survey stretches can be focussed using this information and the results of the tool will allow for the validation of the pressure information and therefore the identification of remediation and mitigation measures.

2.7 PHYSICO-CHEMICAL

Local Authorities have been charged under the WFD Monitoring Programme (http://www.epa.ie/whatwedo/wfd/monitoring/programme/) with the sampling and analysis of physico-chemical data from rivers. The current survey programme (2007-2009) involves the collation of physico-chemical data from 1400 sites nationally. Table 2.4 outlines the main parameters that are monitored as part of the surveillance and operation programmes under the WFD (note additional parameters such as total phosphorus, copper and zinc are also monitored at certain sites for other regulatory requirements – see web link above).
Each draft sub-basin plan for pearl mussel catchments outlines the number and location of WFD physico-chemical sites within each catchment, and also the latest available results from these sites for Molybdate Reactive Phosphorus (MRP), which is the key nutrient of interest in pearl mussel catchments due to its link with eutrophication pressures (see section 3.3 of sub-basin plans).

Appendix F summarises the MRP levels (mg P/l) at sites in pearl mussel catchments between 2005 and 2007. These data were compiled by the EPA for the determination of WFD river status. The Environmental Quality Standards for MRP are stated in the Consultation Paper 'Draft European Communities Environmental Objectives (Surface Waters) Regulations 2008', and are;

For	High status	$\leq$0.025 (mean) or $\leq$0.045 (95%ile)
	Good Status	$\leq$0.035 (mean) or $\leq$0.075 (95%ile)

The supporting physico-chemical quality elements define three status levels – High, Good, or less than Good. In the interim status assessments produced to date, only two levels have been defined Good or Better and Less than Good.

In summary, the results show the following:

1. A number of catchments have no physico-chemical monitoring sites i.e. the Aughavaud, Ballymurphy and Cloon (Shannon Estuary) catchments. These catchments should be considered by the Local Authorities for inclusion in their monitoring programmes;
2. A number of catchments have exceeded the EQS for MRP, and require pressures assessment in order to link elevated nutrient levels with the source(s) of these nutrients i.e. Mountain, Dawros, Eske, Leannan, Allow, Munster Blackwater, Nore, Owenea, Derreen and Clodiagh catchments;
3. A number of catchments may not have sufficient monitoring sites in order to assess whether nutrient enrichment is a significant contributor to the pearl mussel decline, and therefore may need to be considered by Local Authorities for future additional monitoring. These are; Caragh, Clady, Corrib, Currane, Kerry Blackwater, Gearhameen, Glaskeelan, Allow, Licky, Newport, Owenea, Owenmore and Ownagappul. In most cases the existing monitoring sites are too low down in the pearl mussel catchment to provide an adequate picture of the nutrients higher up in the catchment where pearl mussels are known to exist.

These results should be discussed at RBD sub-basin committee level.

Table 2.3 Physico-chemical parameters monitored as part of the WFD surveillance and operational monitoring programmes

Physico-chemical parameter	Units
Temperature	^{o}C
Dissolved Oxygen	mgO_2/l
pH	pH units
Electrical Conductivity	µS/cm
Hardness	mg/l $CaCO_3$
Colour	Hazen
Alkalinity	mg/l $CaCO_3$
o-Phosphate (Unfiltered Molybdate Reactive Phosphate)	mg P/l
Total Oxidised Nitrogen	mg N/l
Nitrate	mg N/l
Nitrite	mg N/l
Ammonium	mg N/l
Chloride	mg/l
Biochemical oxygen demand (BOD)	mgO_2/l

2.8 DANGEROUS SUBSTANCES

It is important that dangerous substances are monitored within pearl mussel catchments and an assessment made in relation to their impact on the populations.
Under the Water Framework Directive a dangerous substance surveillance monitoring programme was established in 2007 and will run to the end of 2009. The results from this monitoring programme will be assessed and incorporated in the final sub-basin management plans for December 2009.

Table 2.4 provides a list of the 28 substances which are included on the WFD Surveillance Monitoring Programme together with the reason for inclusion following the findings of the National Dangerous Substance Screening Programme.

Table 2.4 List of specific pollutants included in the WFD Dangerous Substance surveillance monitoring programmes (*The selection of substances for inclusion on the list took a precautionary approach)

No.	Monitoring List	Reason for inclusion	CAS Number
1	Antimony	Presence in significant quantities*	744-36-0
2	Arsenic	Dangerous Substances Regulations and presence in significant quantities*	7440-38-2
3	Barium	Presence in significant quantities*	7440-39-3
4	Boron	Presence in significant quantities*	7440-42-8
5	Chromium	Dangerous Substances Regulations and presence in significant quantities*	7440-47-3
6	Cobalt	Presence in significant quantities*	7440-48-4
7	Copper	Dangerous Substances Regulations and presence in significant quantities*	7440-50-8
8	Cyanide	Dangerous Substances Regulations*	57-12-5
9	Epichlorohydrin	Presence in significant quantities*	106-89-8
10	Epoxiconazole	Presence in significant quantities*	135319-73-2
11	Fernitrothion	Presence in significant quantities*	122-14-5
12	Fluoride	Dangerous Substances Regulations and presence in significant quantities*	16984-48-8
13	Glyphosate	Presence in significant quantities*	1071-83-6
14	Malathion	Presence in significant quantities*	121-75-5
15-18	Maneb/zineb/thiram/ mancozeb	Presence in significant quantities*	n/a
19	Mecoprop	Presence in significant quantities*	96-65-2
20	Molybdenum	Presence in significant quantities*	7439-98-7
21	Nonylphenol ethoxylates	Presence in significant quantities*	37340-60-6
22	Pirimiphos-methyl	Presence in significant quantities*	29232-93-7
23	Selenium	Presence in significant quantities*	7782-49-2
24	Tin	Presence in significant quantities*	7440-31-5
25	Toluene	Dangerous Substances Regulations*	108-88-3
26	Vanadium	Presence in significant quantities*	7440-62-2
27	Xylene-o	Dangerous Substances Regulations and presence in significant quantities*	1330-20-7
	Xylene-p,m		1330-20-7
28	Zinc	Dangerous Substances Regulations and presence in significant quantities*	7440-66-6

Further information has also been obtained and included in the "*Pre Consultation Draft Freshwater Pearl Mussel Sub-Basin Management Plans"* from the following screening programmes.

1. Dangerous Substances Screening Monitoring Programme (2005-2006)
2. LA Dangerous Substances Monitoring Programme (2002-2005)
3. EPA Monitoring Data 1999-2000
4. EPA Monitoring Data 2002-2003

2.9 SILTATION

The Draft EC Environmental Objectives (Freshwater Pearl Mussel) Regulations 2008 require that there is no artificially elevated levels of siltation present at the pearl mussel habitat. This is evidenced by the absence of plumes of silt when the substratum is disturbed. For siltation, a survey site condition assessment form has been generated specifically for the purposes of this project (Appendix D). The form requires the surveyor to perform a substrate kick in order to ascertain whether a plume of silt is generated or not. The surveyor must then note one of the following three observations;

1. no visible silt plume
2. some visible silt
3. a lot of visible silt

Plate 2.2 No visible silt plume

Plate 2.3 Some visible silt

Plate 2.4 A lot of visible silt

2.10 PRESSURES ASSESSMENT – CATCHMENT WALKOVERS

Where nutrient enrichment and siltation have been identified as likely causes of the decline and recruitment failure of the pearl mussel population, investigation must be undertaken to identify the significant sources of these pollutants within the catchment. Throughout the development of the Phase 1 plans, pressures and their sources were identified through the use of national datasets and extensive detailed aerial imagery. This information allows us to focus the catchment walkovers to fully investigate the actual sources on the ground.
Where it is not possible to walk an entire catchment, car surveys will be carried out to pick up as much of the pressures as possible.

During the catchment walkovers, the potential sources to be investigated will include: drains (erosion of, enrichment of, siltation in/at mouth); areas of exposed, bare soil in the catchment; overly-enriched land; river bank erosion/ collapse; patterns of sediment deposition in the river; etc.
Further details in relation to the catchments selected for walkover surveys are listed in section 4.6.

Quality control

These catchment walkovers will be carried out by members of the team who have obtained full River Habitat Survey (RHS) accreditation through the Environment Agency accreditation scheme. This technique requires the surveyor to have a full and in depth understanding of the physical river structure together with an appreciation for the pressures acting on it from the surrounding landscape.

3 PHASE I MONITORING

The NS2 pearl mussl team's knowledge suggested that gaps in monitoring information existed in the following catchments and these were prioritised for Phase I monitoring: Leannan (Donegal), Aughavaud (Carlow), Allow (Cork, subcatchment of the Munster Blackwater), Owenmore (Kerry), and the Ownagappul (Cork). These catchments currently have insufficient pearl mussel assessments. Monitoring of these catchments was attempted in October 2008 for pearl mussels and macroinvertebrates, however it was not possible to survey some of the catchments due to the high flows which were experienced in late 2008. Due to the late start of the NS2 project, it was not possible to survey other elements such as phytobenthos, macrophytes or fish as the sampling season had passed.

3.1 FRESHWATER PEARL MUSSEL MONITORING

The field work conducted in October 2008 was a targeted initial survey of the Aughavaud River, and a Stage 2 survey of the area of prior record. In addition, a survey of the Allow River (Stage 2 survey one section), and some survey work up high in the catchment was done, as the lower catchment was in flood at the time of survey.

3.2 MACROINVERTEBRATE MONITORING

Four catchments were surveyed for macroinvertebrates: the Allow, Ownagappul, Aughavaud and Owenmore.

Aughavaud River, Co Carlow

No EPA Q value monitoring data is available for the Aughavaud pearl mussel catchment. The table below summarises the water quality information (Q-values) from the Aughavaud system recorded during October 2008 surveyed through the NS2 Project.

Table 3.1 Q-values at NS2 monitoring sites in the Aughavaud catchment October 2008

RIVER	Site name	Easting	Northing	Q value
Aughavaud	AV Lower	274504	139398	Q3-4
Aughavaud	AV d/s first trib	275263	140103	Q3-4
Aughavaud	AV u/s first trib	275371	140115	Q3-4
Aughavaud	AV first major trib	275381	140032	Q3-4
Aughavaud	Upper AV Nth trib	276764	141852	Q3-4
Aughavaud	Upper AV Sth trib	277244	141326	Q3-4
Aughavaud	West trib. AV lower	274360	139857	Q4
Aughavaud	West trib AV upper	273796	141925	Q3-4

Owenmore, Co. Kerry

An NS2 Q rating survey was carried out in October 2008. Results are detailed below in Table 3.2. All results place the sites sampled on the Owenmore at good or high status. Further fieldwork will be undertaken in 2009 and will confirm these results in the final plan for the Owenmore catchment.

Table 3.2 NS2 survey results for Q ratings on the Owenmore river

River	Site	Easting	Northing	Q value
Owenmore	An Chonair Tribtary	50544	108734	Q4
Owenmore	Owenmore U/ An Chonair Trib	50544	108761	Q4
Owenmore	Owenmore U/S Loch Cruite Trib	49555	108246	Q4
Owenmore	Owenmore D/S Loch Cruite Trib	49690	108450	Q4-5
Owenmore	Owenmore Boherboy Bridge	51330	110642	Q4-5

Allow, Co. Cork

Fieldwork conducted by the NS2 project in October 2008 found that sites in the Allow catchment varied in status and covered the range of status classes from high to poor (Table 3.3 below). The assessment determined that;
All sites assessed on the main channel of the Allow merited a Q-rating of Q4, with the exception of the most upstream site at Rowls Aldworth Bridge where a Q4-5 was recorded.

Of the twenty three tributaries assessed, twelve were Q4, six were Q3-4, three were Q4-5, one was Q3, and a single small watercourse was Q2-3/0.

Notably the largest tributary of the Allow, the Glashawee River, merited a Q-rating of Q4.

This catchment will be surveyed again in 2009, and will confirm whether those RWBs not containing mussels should have high or good status and this will be confirmed in the final plan for the Allow catchment.

Table 3.3 Results of NS2 Q value surveys of the Allow in October 2008

LOCATION NAME	Survey Date	Easting	Northing	Location notes	Q-rating
AL A	20/11/08	13131	11640	Site 20m d/s bridge 10m long 5m u/s/ & d/s ash on RHS	4-5
AL B	10/10/08	13653	11561	From br. To 15.d/s	4
AL C	10/10/08	13930	11370	From 50m d/s of br. To 15m farther d/s	4
AL D	10/10/08	13948	10983	From 10m d/s of br. To 20m farther d/s	4
AL E	10/10/08	13815	10372	From field boundary on LHS to 20m u/s	4
AL 1	20/11/08	13148	11776	u/s of bridge for c.10m d/s of hawthorn on LH bank	4
AL 2	20/11/08	13263	11605		4
AL 3	20/11/08	13348	11612	From ash tree on LHS for 10m d/s	4-5
AL 4	20/11/08	13400	11609	For 10m d/s two small willows on RHS.	3-4
AL 5	20/11/08	13432	11557	u/s gorse clump for 5m	3-4
AL 6	20/11/08	13430	11572	Small mal-odourous drain	2-3/0
AL 7	20/11/08	13442	11551	For 10m just u/s yellow plastic field drain pipe	4
AL 8	20/11/08	13580	11542	u/s confluence for 5m	3-4
AL 9	20/11/08	13604	11558	For 10m just d/s of pool on bend	4
AL 10	4/10/08	13755	11580	From point where fence angles into field to 10m d/s	4
AL 11	4/10/08	13825	11555	From 40m u/s of Allow confluence to 10m farther u/s	3-4
AL 12	4/10/08	13939	11403	From 5m u/s of Allow confluence to 15m farther u/s	4
AL 13	4/10/08	13958	11311	From 5m u/s of Allow confluence to 15m farther u/s	3-4
AL 14	4/10/08	13947	11302	From 1st sharp bend u/s of Allow confluence to 15m farther u/s	4-5
AL 15	4/10/08	13939	11229	From Allow confluence to 10m u/s	4-5
AL 16	10/10/08	13987	11119	From gap between fields where stream disappears into dense scrub to 5m u/s	4
AL 17	10/10/08	13960	11121	From 15m d/s of cattle drinking point to 5m farther d/s	4
AL 18	4/10/08	13971	10944	From 35m u/s of culvert at confluence to 10m farther u/s	3-4

LOCATION NAME	Survey Date	Easting	Northing	Location notes	Q-rating
AL 19	10/10/08	13993	10838	From 40m u/s of Allow confluence to 10m farther u/s	4
AL 20	4/10/08	13938	10693	Riffle in section with no bushes on either side. From top of riffle to 15m d/s	4
AL 21	10/10/08	13862	10637	Entire 10m of riffle d/s of lone willow d/s of br.	4
AL 22	10/10/08	13861	10571	From 10m u/s of Allow confluence to 10m farther u/s	3
AL 23	20/11/08	13863	10512	for 20m from alder on LHS	4

Ownagappul, Co. Kerry

Pilot Q rating survey work conducted by the NS 2 project during November 2008 found the following, which is summarised in Table 3.4, in relation to Q assessments:

The main channel of the Ownagappul merits a Q-rating of Q3-4 at its upstream extremity immediately downstream of Glenbeg Lough, and at its lower extremity c.250m upstream of the estuary at Cappul Bridge. The river merits a Q-rating of Q4 immediately downstream of Slieve Bridge at Ardgroom. This site has merited a Q-rating of Q4 at all EPA monitoring rounds since monitoring began in 1994, except for 2003 when a Q4-5 rating was recorded.

Apart from the main Barrees River tributary, all tributaries of the Ownagappul River assessed in the present survey merited Q-ratings of Q3-4.

The main channel of the Barrees River merits a Q-rating of Q4-5 at Barrees Bridge. All tributaries of the river downstream of Barrees Bridge merit Q-ratings of Q3-4 (albeit tentative due to the suboptimal conditions for Q-rating assessment), except for the tributary flowing from Lough Fadda which merits a Q-rating of Q4.

Further survey work to be conducted in 2009 and will be detailed in the final plan for the Ownagappul catchment.

Table 3.4 Results of NS2 Q value surveys of the Ownagappul catchment in November 2008 (Note: Unless otherwise stated, Q-ratings with the suffix (t) can be confidently assigned to the water quality bracket within a ½ Q-rating point margin of error. For instance where a Q3-4(t) rating is given, the operator is stating with a high level of confidence that the rating is no lower than Q3 and no higher than Q4.)

LOCATION NAME	Date	GPS Easting	GPS Northing	Location notes	Q-rating
Owgpl 1	21/11/08	70070	53830	For 10m d/s of lowest step of fish weir immediately downstream of lake exit.	3-4
Owgpl 2	7/11/08	70060	54250	Between two holly bushes c.10m u/s confluence	3-4(t)
Owgpl 3	7/11/08	70030	54330	For 20m u/s from where stream flows under fence just u/s of confluence	3-4(t)
Owgpl 4	21/11/08	69190	54870	From 5 fence posts u//s of where fence crosses stream to 12 fence posts up.	3-4
Owgpl 5	21/11/08	68940	55180	From 5ft wide boulder on RHS for 10m d/s	4
Owgpl 6	7/11/08	68590	55180	At fenced crossing and for 10m u/s and d/s	3-4
Owgpl 7	21/11/08	68610	55600	Riffle area just upstream of pool	3-4
Owgpl 8	21/11/08	67750	54100	For 10m u/s from culvert	3-4(t)
Owgpl 9	21/11/08	67410	53710	From large alder tree c.16m downstream of bridge on RHS to alder 20m further downstream	4-5
Owgpl 10	21/11/08	66950	53730	Just d/s culvert for 5m	3-4(t)
Owgpl 11	7/11/08	67360	54490	c.18m u/s confluence, 4th fence post up to 7th post. Site 10m long	3-4(t)
Owgpl 12	21/11/08	67400	54890	From 10m d/s small cascade for 20m d/s	4

4 PHASE II MONITORING

Phase II monitoring of pearl mussel catchments will be conducted in 2009. Methodologies for these surveys have been outlined in Chapter 2, and the details and extent of the surveys is covered in this section.

4.1 FRESHWATER PEARL MUSSEL SURVEY

Pearl mussels surveys will be carried out in, 14 catchments and will be surveyed by Evelyn Moorkens, Ian Killeen and Eugene Ross. They are:

Bandon

Aughavaud

Ballymurphy

Currane

Gerarhameen

Munster Blackwater

Owenmore

Cloon (Shannon Estuary)

Owencarrow

Leannan

Glaskeelan

Allow

Nore

Derreen (Slaney)

4.2 MACROINVERTEBRATE SURVEYS

Conservation Services (Bill Quirke, Pascal Sweeney) will survey the following catchments for macroinvertebrates:

Kerry Blackwater (43 sites)

Caragh (39 sites)

Currane (11 sites)

Munster Blackwater (23 sites)

Bandon/Caha (32 sites)

Derreen (Slaney) (32 sites)

Mountain/Ballymurphy (25)

Lauren Williams will survey the following catchments for macroinvertebrates:

Bundorragha (6 sites)

Clady (TBC)

Owenriff (Corrib) (c. 12 sites)

Dawros (13 sites)

Eske (c.6-7 sites)

Glaskeelan (c.4 sites)

Newport (c. 10-11 sites)

Owencarrow (6 sites)

Owenea (c. 12 sites)

Owenmore (c. 2 sites)

Leannan (c. 10-12 sites)

4.3 MACROPHYTE SURVEYS

All those surveying at the pearl mussel habitat will complete the site condition assessment form in Appendix D, which requires the input of abundance information of macrophytes and macroalgae. The surveyors in question are Evelyn Moorkens, Ian Killeen, Eugene Ross (pearl mussel), Bernie Ní Chatháin (filamentous algae and diatoms) and Sheila Downes (RAT).

4.4 PHYTOBENTHOS SURVEYS

Filamentous algae will be assessed by a number of surveyors as outlined above, at each site they visit in the course of their fieldwork, including at pearl mussel habitat locations. All 27 catchments will also be surveyed for filamentous algae and diatoms by Bernie Ní Chatháin, assisted by Danielle Aherne. The number of sites per catchment are detailed below, and site numbers within catchments reflect the importance of the catchments in terms of the pearl mussel. A note is placed beside those catchments where diatoms will be surveyed from the pearl mussel shells/habitat as well as from cobble substrata..

Bandon & Caha (4 sites)

Aughavaud (1 site)

Ballymurphy (2 sites)

Mountain/Aughnabrisky (3 sites) (pearl mussel shell ad habitat samples also)

Bundorragha (3 sites)

Caragh (7 sites) (pearl mussel shell and habitat samples also)

Clady (4 sites)

Owenriff (Corrib) (TBC but circa 3-4 sites)

Currane (4 sites)

Dawros (3 sites)

Eske (3 sites) (pearl mussel shell and habitat samples also)

Kerry Blackwater (5 sites) (pearl mussel shell and habitat samples also)

Gearhameen (2 sites)

Glaskeelan (1-2 sites)

Leannan (5 sites)

Allow (1 site)

Licky (3 sites) (pearl mussel shell and habitat samples also)

Munster Blackwater (4 sites)

Newport (4 sites) (pearl mussel shell habitat samples also)

Nore (3 sites)

Owencarrow (2 sites)

Owenea (4 sites)

Owenmore (2 sites)

Ownagappul (3 sites) (pearl mussel shell and habitat samples also)

Cloon (Shannon estuary) (2 sites)

Derreen (Slaney) (3 sites)

Clodiagh (Suir) (3 sites) (pearl mussel shell and habitat samples also)

4.5 FISH SURVEYS

The 27 sub-basin catchments designated as SACs for pearl mussel have been reviewed. These catchments have been prioritised according to the requirement for fish data, and fall into 3 distinct groups:

- Data required - Priority catchments (3)
- Data required - Non-priority catchments (15)
- Probably enough data / some data available (9)

The 18 catchments detailed above as requiring data will be surveyed this year by Paul Johnston Associates (Fisheries Consultant). Data will be collated and interpreted for those catchments for which data is more than likely already available, by the Shannon Regional Fisheries Board working in close consultation with the other Regional Fisheries Boards and the Central Fisheries Board.
The catchments to be surveyed are:

Data required - Priority catchments

13 Gearhameen (Laune)
24 Ownagappul
26 Derreen (Slaney)

Data required - Non-priority catchments

1 Bandon
2 Aughavaud (Barrow)
3 Ballymurphy (Barrow)
4 Mountain (Barrow)
6 Caragh
9 Currane
12 Kerry Blackwater
14 Glaskeelan (Leannan)
15 Leannan
16 Allow (Munster Blackwater)
17 Licky
21 Owencarrow
23 Owenmore
25 Shannon Estuary
27 Clodiagh (Suir)

The catchments for which data is already available are;

5 Bundorragha
7 Clady
8 Owenriff (Corrib)
10 Dawros
11 Eske

18 Munster Blackwater
19 Newport
20 Nore
22 Owenea

4.6 HYDROMORPHOLOGY – RAT/CATCHMENT WALKOVERS

The catchments which will be surveyed using RAT and those which will be the focus for catchment pressure assessments are currently being discussed and selected by the NS2 project and NPWS. Once finalised, this section of the monitoring report will be updated and reloaded to www.wfdireland.ie. The catchment assessments will be undertaken at the same time as the RAT surveys, and they will ground truth pressures as identified in the draft sub-basin pearl mussel plans in December 2008, and identify any further pressures present in the catchments. Sheila Downes will carry out both the RAT assessments and the catchment walkovers with assistance from Gary O'Connell, Francis Mackin and Lorraine Houston for the catchments located in the West & North West and Danielle Aherne for catchments located in the South East and South West.

4.7 PHYSICO-CHEMICAL SURVEYS

Data for 2005-2007 has been collated and reported on in Appendix F. Data for 2008 should be collated from Local Authorities to ascertain whether any improvements in problem catchments have occurred. In addition, those catchments where data is lacking will be brought to the attention of the WFD Monitoring Working Group.

4.8 SILTATION

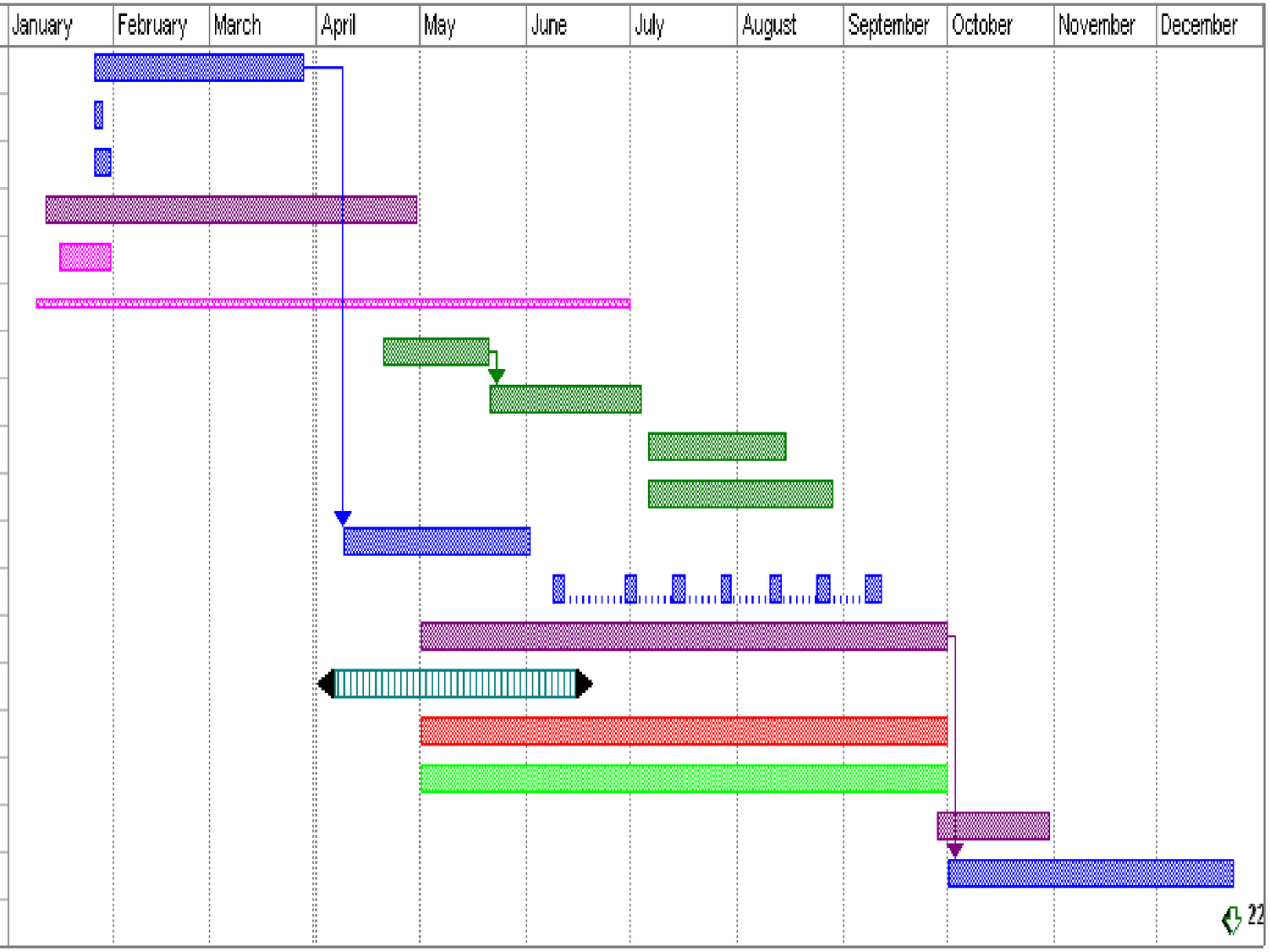
All those surveying will complete and record the results of a substrate kick at each site which they visit. In addition, data from the UCC project where turbidity meters have been deployed on Licky, Caha and Kerry Blackwater, will also be obtained. The remaining 3 turbidity meters owned by NPWS will be deployed in the near future, possibly in the Leannan catchment, and data from this will also be collated for use as part of the NS2 project.

4.9 SUMMARY

A summary of the fieldwork is outline below in Figure 4.1 as a gantt chart.

Figure 4.1 Field work schedule for 2009

ID	Task Name
1	Analysis of FPM Plans to focus field survey walk overs
2	Finalise FPM GIS layers/Issues surrounding catchment boundaries
3	Complete 27 catchment maps as per Conservation Services Field Reports
4	Editing draft FPM Plans/Legislative Review
5	Monitoring Methods Report
6	Consultations
7	Fieldwork - Diatoms
8	Lab - Data Analysis
9	Fieldwork - Macroalgae
10	Lab- Data Analysis
11	Fieldwork - Morphology
12	Fieldwork - Pressure verification
13	Fieldwork - Freshwater Pearl Mussel
14	Fieldwork - Fisheries
15	Fieldwork - Macroinvertebrates
16	Fieldwork - Macrophytes & Macroalgae
17	Analysis/Interpretation of Field Data in relation to FPM
18	Completion of final FPM Plans (Moorkens Ass./RPS)
19	Publication of final FPM Plans



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APPENDIX A

Comhshaol, Oidhreacht agus Rialtas Áitiúil
Environment, Heritage and Local Government

7th April 2009

To whom it may concern

The Freshwater Pearl Mussel is a globally threatened species which Ireland is legally bound to protect. All Irish populations of the species are in decline. To meet its obligations under the Water Framework and Habitats Directives Ireland is required to draw up and implement catchment plans which will ensure that the water needs of the Freshwater Pearl Mussel in the catchments of SACs designated for the species are met. Part of this process involves surveys to assess river condition and pressure sources and establish monitoring stations. This work will contribute to the development of the catchment plans aimed at the restoration of the habitat of the Freshwater Pearl Mussel so that it can again support fully functioning, recruiting mussel populations.

The draft plans produced by this project to date will form part of the draft River Basin Management Plans and are available for consultation until 22nd June 2009 on www.npws.ie and www.wfdireland.ie/docs/5_FreshwaterPearlMusselPlans/ . The plans are scheduled to be complete by December 2009. During 2009 further surveys will need to be undertaken to refine and revise the plans both to incorporate new data and stakeholder suggestions arising from the consultation process.

The company RPS Consulting Engineers, Mulkear House, Newtown Centre, Annacotty, Co. Limerick and their sub-contractors have been contracted to develop the Freshwater Pearl Mussel catchment plans. We would be grateful if you would allow the bearer of this letter to gain access to your land to carry out the survey. RPS may be contacted at 061-337914.The NPWS contact person for this project is Jim Ryan, 018883291 and 087 2713801.

Yours sincerely,

Dr. Ciaran O'Keeffe,

Director

National Parks & Wildlife Service

7 Ely Place

Dublin 2

APPENDIX B

Sample forms from pearl mussel Survey: Quadrat Survey form

Margaritifera quadrat data sheet

River		**Quadrat #**	
Date		**Time**	
Photo #'s		**Weather**	
Surveyors			

Quadrat (50x50cm) mussel search data			
Location of quadrat in relation to transect:			
Number of mussels visible on surface in quadrat =		Total number of mussels counted in quadrat =	
Number of juvenile mussels (i.e. ≤ 30mm) recorded in quadrat =			
Quadrat Habitat Data	**Vegetation:**		
	Substrate:		
Velocity	**Position**	**Depth**	**%Shade**

Photo 1.	Photo 2

APPENDIX C

Standard Transect Survey Form

River						**Transect #**													
Date						**Time**													
Photo #'s						**Weather**													
Surveyors																			
Type of Bankside Vegetation																			
% Shading of Channel																			
Average water depth																			
Velocity (**X**)	Torrential		Fast			Moderate			Slow			Very Slow							
Transect (**X**)	Riffle					Pool						Glide							
Upstream (**X**)	Riffle					Pool						Glide							
Downstream (X)	Riffle					Pool						Glide							
QUADRATS (Numbered from North to South, 19.3m wide)																			
Quadrat #	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Substrate (% Cover																				
Mussels																				
Silt																				
Sand																				
Gravel																				
Pebble																				
Cobble																				
Boulders																				
Bedrock																				
Aquatic Vegetation (% Cover)																				
Algae																				
Submerged macrophytes																				
Emergent macrophytes																				
Bryophytes																				
Live mussels (dead shells)																				
Total no. of mussels in transect	N=																			
Insert graph																				
Were juveniles present at site?																				
Other Observations																				

APPENDIX D

Survey site Condition Assessment Form

River		**GPS location**	
Date		**Location name**	
Photo #'s		**Weather**	
Surveyors		**Main Purpose of visit**	

Type of Bankside Vegetation					
% Shading of Channel		**Bank width (m)**		**Wet width (m)**	
Average water depth		**Average length survey area**			

Velocity (**X**)	Torrential	Fast	Moderate	Slow	Very Slow

Area of survey (**X**)	Riffle	Pool	Glide
Upstream (**X**)	Riffle	Pool	Glide
Downstream (X)	Riffle	Pool	Glide

%	**0**	**<5**	**<10**	**<25**	**<50**	**<75**	**75-100**	**Comments**
Substrate (% Cover)								
Silt								
Sand								
Gravel								
Pebble								
Cobble								
Boulders								
Bedrock								
Aquatic Vegetation (% Cover)								
TOTAL Macrophyte cover								
Fil Algae								
Ranunculus								
Myriophyllum								
Potamogeton								
Callitriche								
Fontinalis								
Others								
Substrate kick – is there a plume of silt?								

Other Observations – particularly pressures that may not have come to the notice of the group… outfalls, poaching etc A photograph and GPS of location would be very useful

N.B. Percentages should be estimated only for the immediate area being examined, there is no need to survey the section upstream and downstream.

APPENDIX E

RHAT survey sheets

Sheet 1: RHAT
Field Health and Safety sheet

River Name _____ Site Code Date_____

1 - Low risk **5** - High risk
Please circle applicable number

PARKING	1	2	3	4	5
FENCES / BARRIERS	1	2	3	4	5
GROUND STABILITY	1	2	3	4	5
DENSE VEGETATION	1	2	3	4	5
BANK STEEPNESS OR STABILITY	1	2	3	4	5
RISK FROM ANIMALS	1	2	3	4	5
PHONE COVERAGE	1	2	3	4	5

PREVIOUS RHS / RHAT SURVEYS

DETAILS OF ACCESS

Sheet 2: RHAT **Version 2.**
28/01/09

TRIBUTARY / MAIN CHANNEL *

Site Identification

River Name	Site Code Nearest WFD site F10
Water Body ID	Start U/S or D/S *
First site IGR	Last site IGR **Bank surveyed from L / R / Both / In-Channel***

Desk-study notes	Field Notes
ACTION TO TAKE PRIOR TO FIELDWORK	
General overall shape of river	**River Type**
Check weirs, impoundments etc on catchment	
Floodplain connectivity and land use	Date
Expected river type	Time
Rain in last week	Surveyors
Estimated River Width	Weather Conditions Now
Estimated Survey Length	Est. river **width** (m) (ave. 3 readings)
Riparian land use	
Rivers Agency Designated?	Est. survey **length** (m) (40 times wetted width)
Other comments inc. Geology:- Limestone / Siliceous / Peat *	Est. river **depth** (m)
RESULTS	Channel Characteristics (e.g. different stream types on the reach)
Hydromorph Score	Pressures
WFD Class	

* Circle as appropriate

Photograph details include IGR or approximate location.
NB. The survey length should be 40x the wetted width with a minimal stretch of 160m but not exceeding 1km.

Sheet 3: RHAT

ANTHROPOGENIC IMPACTS

Feature	Tick if present, record as E if >30%
Resectioning	None ☐ Left Bank ☐ Right Bank ☐
Reinforcement	None ☐ Left Bank ☐ Right Bank ☐
Embankments NO*	LB ☐ RB ☐ Set back LB ☐ RB ☐
Culverts**	Y / N / Unknown *
Over deepened	Y / N / Unknown *
Over widened	Y / N / Unknown *
Narrowed	Y / N / Unknown *
Fords**	Y / N *
Poaching	None Left Bank ___ (m) Right Bank ___(m)

	Major	Intermediate	Minor
Bridges** NO*			
Weirs ** NO*			
Fish Pass** NO*			

Physical features or resource use if applicable. *

Deflectors / Jetties / Arterial drainage / Side channels / Mid channel bar / Field Drains / Mill Race

Navigation / Fishing / Recreation / Forestry / Urban / Industry / HEP

Trashline present (height __ m) above water / Buffer zone (**LB**___m / **RB**___m back from water edge)

Other observations - Invasives - Trees - Birds - Pollution indicators - Invertebrates*

Rhododendron / Himalayan Balsam / Japanese Knotweed / Giant hogweed / Snowberry / Cherry-Laurel / Gunnera

Sycamore / Beech / Conifers / Oak / Ash / Alder / Willow / Birch / Hazel / Hawthorn / Blackthorn / Holly

Heron / Sand martin / Grey wagtail / Dippers / Kingfishers /

Sewage fungus / Diatomaceous algae / Oil / Cladophora / Vaucheria / Dumping / Silt on Substrate

Other comments:-
*** Circle** as appropriate **E** - extensive. ** **Tally** as appropriate. **LB** - left bank / **RB** - right bank

Sheet 4 **RHAT River Hydromorphology Assessment Technique**
Field Assessment of Morphological Condition

River Name:

Site Code: **Date:**

If river in spate ignore 3 and 4 but deduct individual scores from overall if either feature not visible. Greyed boxes may be scored but note why in Comments/Notes.

	Bedrock	Step-pool / cascade	Pool-riffle-glide	Lowland meandering
1.Channel form and flow types	4	4	4	4
2. Channel vegetation	4	4	4	4
3. Substrate condition	4	4	4	4
4. Barriers to continuity	4	4	4	4
5. Bank structure & stability L+R	4	4	4	4
6. Bank vegetation L+R	4	4	4	4
7. Riparian land cover L+R	4	4	4	4
8. Floodplain connectivity L+R	4	4	4	4
Total	32	32	32	32
Hydromorph Score*				
WFD class **				

	Hydromorph score = $\frac{\Sigma \text{ Assessment score}}{\text{Maximum score}}$	
*		
**	WFD Class	> 0.8 = high >0.6 – 0.8 = good >0.4 – 0.6 = moderate >0.2 - 0.4 = poor < 0.2 = bad.

Sheet 5:

Notes:-

APPENDIX F

Summary of physico-chemical data available for sites located within pearl mussel catchments.

(Catchment names highlighted in red should be considered for additional monitoring in 2009 in order to fill data gaps)

	Pearl Mussel population	Rivers and lakes containing pearl mussels (list not exhaustive)	Site names	No of samples	Mean PO4-P	StdDev PO4-P	Max PO4-P	Min PO4-P	95%ile	EQS (Good or better/less than good)	WFD MRP standard exceedance noted	Comments/ Additional sites required in the catchment?
1	**Bandon**	Bandon & Caha	Bandon river, Bealboy Br	16	0.015	0.007	0.038	0.003	0.026	Good or better	No	The site is located at the lowest point in the catchment below the pearl mussel known locations
2	**Aughavaud (Barrow)**	Aughavaud										There is no supporting physico-chemical quality elements data for this catchment.
3	**Ballymurphy (Barrow)**	Ballymurphy										No EPA Q value monitoring data, or physico-chemical parameters, are available for this pearl mussel catchment
4	**Mountain (Barrow)**	Mountain, Aughnabrisky	Black (Borris), 1.2km u/s Br in Borris	6	0.047	0.026	0.078	0.013	0.078	Less than good	**Yes**	The Black river flows in to the Mountain river, and d/s of the confluence a monitoring site shows an MRP level which under WFD is 'good or better'. Known locations of pearl mussels are all on the Mountain river. Investigation is recommended during the pressures assessment.
			Mountain, Ballycoppigan Br	16	0.030	0.032	0.097	0.003	0.084	Good or better	No	
			Mountain, Just u/s Barrow river	10	0.015	0.010	0.031	0.003	0.029	Good or better	No	

	Pearl Mussel population	Rivers and lakes containing pearl mussels (list not exhaustive)	Site names	No of samples	Mean PO4-P	StdDev PO4-P	Max PO4-P	Min PO4-P	95%ile	EQS (Good or better/less than good)	WFD MRP standard exceedance noted	Comments/ Additional sites required in the catchment?
			confl									
5	**Bundorragha**	Bundorragha	Bundorragha, Bridge just u/s Doo lough	9	0.008	0.004	0.018	0.006	0.016	Good or better	No	Located above pearl mussel known locations
			Bundorragha, 100m u/s Fin lough	13	0.006	0.0001	0.006	0.006	0.006	Good or better	No	Located above pearl mussel known locations
			Bundorragha, Bridge d/s Fin lough	9	0.006	0.0001	0.006	0.006	0.006	Good or better	No	Located above pearl mussel known locations
			Bundorragha, Bridge East of Bundorragha	20	0.006	0.0001	0.006	0.006	0.006	Good or better	No	Located below pearl mussel know locations
6	**Caragh**	Caragh, Owenroe, Meelagh, Caraghbeg, Glashawee, Lough Beg stream, Lough Acoose, Cloon lough	Owenroe, 1.1km u/s Caragh R confl	9	0.004	0.002	0.011	0.002	0.009	Good or better	No	Sites are located in the middle and lower end of the catchment. Some sites in the upper catchment may be required to confirm any elevated nutrients if present.
			Caragh, Blackstones Br	13	0.003	0.001	0.007	0.002	0.006	Good or better	No	
7	**Clady**	Clady	Clady, Br d/s Bunbeg	16	0.005	0.005	0.020	0	0.012	Good or better	No	Site below the pearl mussel known locations. May require sites at pearl mussel locations.
			Cronaniv Burn, Br u/s Dunlewy	16	0.014	0.030	0.125	0	0.054	Good or better	No	Site located in the upper catchment where no known pearl mussel habitats have been identified.
8	**Corrib**	Owenriff, Glengawbeg	Owenriff, 1km u/s Oughterard Bridge	26	0.010	0.005	0.025	0.006	0.018	Good or better	No	Sites are all located in the lower part of the catchment. Sites may be required to confirm water quality in the upper catchment.
			Owenriff, Bridge u/s Lough Corrib	4	0.009	0.003	0.012	0.006	0.012	Good or better	No	
			Owenriff, d/s STW Oughterard	22	0.020	0.015	0.067	0.006	0.042	Good or better	No	

	Pearl Mussel population	Rivers and lakes containing pearl mussels (list not exhaustive)	Site names	No of samples	Mean PO4-P	StdDev PO4-P	Max PO4-P	Min PO4-P	95%ile	EQS (Good or better/less than good)	WFD MRP standard exceedance noted	Comments/ Additional sites required in the catchment?
9	**Currane**	Capall, Cummeragh	Currane, Dromkeare Bridge	116	0.020	0.023	0.137	0.002	0.064	Good or better	No	Site is located in the lower part of the catchment, therefore sites may be required in the upper catchment to confirm quality.
10	**Dawros**	Dawros	Dawros, Tullywee bridge	21	0.034	0.008	0.046	0.017	0.046	Good or Better	No	Both sites monitored are at lower end of the catchment, and one pearl mussel location is located above them. May require further site to investigate quality in this upper pearl mussel location.
			Dawros, Dawros Bridge	21	0.063	0.024	0.108	0.029	0.102	Less than Good	**Yes**	The causes of this elevated result needs to be investigated through the pressures assessment
11	**Eske**	Eske	Eske, Thrushbank Br	7	0.002	0.003	0.009	0	0.008	Good or better	No	All sites are located in the lower catchment area. Pearl mussel locations have been identified above these locations and therefore may require water quality monitoring sites.
			Eske, New Br (1km u/s East Br Donegal)(LHS)	4	0.402	0.764	1.550	0.015	1.321	Less than good	**Yes**	The causes of the elevated MRP needs to be investigated through the pressures assessment
			Drummeny , Br u/s Eske R confl	4	0.003	0.005	0.011	0	0.009	Good or better	No	
12	**Kerry**	Blackwater,	Blackwater,	8	0.008	0.008	0.026	0.002	0.021	Good or	No	Both sites are low in

	Pearl Mussel population	Rivers and lakes containing pearl mussels (list not exhaustive)	Site names	No of samples	Mean PO4-P	StdDev PO4-P	Max PO4-P	Min PO4-P	95%ile	EQS (Good or better/less than good)	WFD MRP standard exceedance noted	Comments/ Additional sites required in the catchment?
	Blackwater	Kealduff, Derreendarragh	Gearha Br							better		the catchment and therefore data may be required in the upper catchment where pearl mussel locations are known.
			Blackwater, SW of old Dromore	11	0.005	0.003	0.012	0.002	0.011	Good or better	No	
13	**Gearhameen (Laune)**	Gearhameen & Owenreagh	Owenreagh, Br u/s Upper lake	7	0.005	0.004	0.016	0.002	0.013	Good or better	No	The site is located below the majority of the known pearl mussel locations, and at the location of a pearl mussel habitat. Further monitoring may be required above this point.
14	**Glaskeelan (Leannan)**	Glaskeelan	Glaskeelan, Glaskeelan Br	18	0.003	0.005	0.020	0	0.012	Good or better	No	Site located below some pearl mussel locations. May require further sites in the upper catchment.
15	**Leannan**	Leannan	Leannan, Gartan Bridge	23	0.018	0.037	0.157	0.000	0.079	Good or better	No	
			Leannan, Barrack Bridge	19	0.012	0.030	0.122	0.000	0.071	Good or better	No	
			Leannan, Dromore Bridge	3	0.004	0.008	0.013	0.000	0.012	Good or better	No	
			Leannan, Ballydone Br (u/s L Fern)	21	0.008	0.014	0.054	0.000	0.037	Good or better	No	
			Leannan, 0.8 km d/s L Fern	15	0.096	0.358	1.390	0.000	0.437	Less than good	**Yes**	Site is located in the lower end of the catchment and requires pressure assessment
			Leannan, Drumman Br (d/s L Fern)	3	0.002	0.003	0.006	0.000	0.005	Good or better	No	
			Leannan, Bridge	18	0.288	1.190	5.055	0.000	0.791	Less than	**Yes**	Site is located in the

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			at Claragh							good		lower end of the catchment and requires pressures assessment
			Leannan, Drumonaghan	19	0.104	0.431	1.881	0.000	0.225	Less than good	Yes	Site is located in the lower end of the catchment and requires pressures assessment
			Owenbeg, Bridge at Glendowan	5	0.002	0.002	0.005	0.000	0.005	Good or better	No	
			Owenwee, Owenwee bridge	9	0.0001	0.0002	0.0005	0.0000	0.0003	Good or better	No	
16	**Allow (Munster Blackwater)**	Allow	Allow, Ballynaguilla Br	4	0.011	0.005	0.016	0.003	0.015	Good or better	No	Above the known location of the pearl mussel
			Allow, Allow Br Freemount	4	0.005	0.004	0.011	0.003	0.009	Good or better	No	Above the known location of the pearl mussel
			Allow, 1.3km d/s Kanturk Br	12	0.062	0.080	0.308	0.003	0.178	Less than Good	Yes	This site is below the known location for the pearl mussel.
			Dalua, 0.3km d/s Anne's Br (RHS)	9	0.027	0.010	0.039	0.008	0.038	Good or better	No	This site is located in the lower part of the catchment, however there are known pearl mussel locations below this site which require investigation.
17	**Licky**	Licky	Licky, Br NE of Glenlicky	15	0.010	0.014	0.046	0.003	0.041	Good or better	No	Sites are located in the middle and lower end of the catchment, and may not convey the water quality in the upper catchment where numerous pearl mussel locations have been identified.
			Licky, Licky Br	8	0.014	0.021	0.056	0.003	0.050	Good or better	No	
18	**Munster**	Munster	New Quarter Br	39	0.014	0.008	0.037	0.003	0.029	Good or	No	

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	Blackwater	Blackwater (main channel)								better		
			Nohaval Br	36	0.020	0.011	0.056	0.003	0.039	Good or better	No	
			Duncannon Br	36	0.022	0.009	0.055	0.003	0.039	Good or better	No	
			Ford SSE of Dromiscane Castle	36	0.031	0.015	0.076	0.003	0.060	Good or better	No	
			Colthurst Br	36	0.028	0.014	0.083	0.003	0.051	Good or better	No	
			Ballymaquirk Br	35	0.026	0.012	0.059	0.003	0.053	Good or better	No	
			Roskeen Br	4	0.024	0.014	0.034	0.003	0.033	Good or better	No	
			Lombardstown Br	36	0.028	0.019	0.114	0.003	0.054	Good or better	No	
			Rly Br Mallow (LHS)	1	0.043		0.043	0.043	0.043	Good or better	No	
			Rly Br Mallow (RHS)	34	0.026	0.013	0.060	0.003	0.050	Good or better	No	
			1.2km d/s Mallow Br (u/s STW)	34	0.029	0.015	0.060	0.003	0.054	Good or better	No	
			Ballymagooly	5	0.025	0.015	0.045	0.003	0.042	Good or better	No	
			Killavullen Br	55	0.032	0.026	0.190	0.003	0.059	Good or better	No	
			Ballyhooley Br	36	0.029	0.015	0.074	0.003	0.058	Good or better	No	
			Cregg Castle	36	0.029	0.016	0.078	0.003	0.058	Good or better	No	
				1	0.047		0.047	0.047	0.047	Good or better	No	
			Illleclash 2.1km d/s Fermoy	35	0.032	0.016	0.084	0.003	0.057	Good or better	No	
			W of Kilmurry House	36	0.039	0.021	0.108	0.003	0.084	Less than good	**Yes**	Site is located in the lower end of the catchment and requires pressures assessment

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			Ballyduff Br	25	0.049	0.051	0.260	0.003	0.097	Less than good	Yes	Site is located in the lower end of the catchment and requires pressures assessment
			Lismore Br	24	0.045	0.045	0.220	0.007	0.107	Less than good	Yes	Site is located in the lower end of the catchment and requires pressures assessment
19	**Newport**	Newport	Newport, Br 1.23km d/s L Beltra	4	0.006	0.0001	0.006	0.006	0.006	Good or better	No	All sites are located at the lower end of the catchment, and a pearl mussel location is located above these sites. May require further investigation at this pearl mussel location in terms of water quality.
			Newport, New Bridge	9	0.012	0.006	0.021	0.006	0.019	Good or better	No	
			Newport, 400m u/s Newport Bridge	4	0.007	0.003	0.013	0.006	0.011	Good or better	No	
20	**Nore**	Nore	Nore Bridge	5	0.036	0.022	0.067	0.019	0.062	Good or Better	No	
			Curragunneen Bridge	24	0.103	0.269	1.360	0.008	0.156	Less than good	Yes	The site is located in the upper Nore, and some distance from the location of known pearl mussel habitat. Unlikely to be exerting an influence on the population as monitoring sites closer to the population are good or better.
			Nore Bridge SE of Roscrea	25	0.027	0.014	0.058	0.003	0.047	Good or Better	No	
			Quakers Bridge	32	0.024	0.026	0.130	0.003	0.072	Good or Better	No	
			New Bridge WNW of	25	0.024	0.025	0.110	0.003	0.068	Good or Better	No	

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			Borris-in-Ossory									
			B south of Coorain Kildrigh	60	0.032	0.028	0.169	0.003	0.086	Good or Better	No	
			Castletown New Road Bridge	25	0.012	0.011	0.045	0.003	0.037	Good or Better	No	
			Kilbrickin Bridge	26	0.018	0.022	0.110	0.003	0.048	Good or Better	No	
			New Bridge Cloncough	24	0.021	0.022	0.110	0.003	0.048	Good or Better	No	
			Poormans Bridge	26	0.017	0.011	0.046	0.003	0.041	Good or Better	No	
			Waterloo Bridge	25	0.028	0.027	0.130	0.003	0.072	Good or Better	No	
			Watercastle Bridge	26	0.028	0.026	0.110	0.003	0.091	Good or Better	No	
			New Bridge u/s Durrow	25	0.024	0.015	0.071	0.003	0.046	Good or Better	No	
			Tallyho Bridge	27	0.027	0.014	0.053	0.003	0.047	Good or Better	No	
			0.5km u/s Ballyragget	27	0.032	0.019	0.071	0.003	0.060	Good or Better	No	
21	**Owencarrow**	Owencarrow	Glenveagh Bridge	9	0.002	0.005	0.016	0	0.011	Good or better	No	Sites are just below known pearl mussel habitat and potentially provide an adequate picture of MRP.
			New Bridge	6	0.0006	0.001	0.003	0	0.002	Good or better	No	
22	**Owenea**	Owenea	Br S of Mullanmore	5	0.301	0.664	1.489	0.0000	1.194	Less than good	**Yes**	Both sites require further investigation. More sites may also be required as pearl mussel locations are above and below these two sites. This may be required to ascertain water quality elsewhere in the catchment.
			Footbridge 2km d/s Stracashel R	6	0.067	0.079	0.182	0.0000	0.171	Less than good	**Yes**	
23	**Owenmore**	Owenmore	Br d/s L. Cruite	5	0.005	0.004	0.009	0.003	0.009	Good or better	No	Pearl mussel habitat is located higher up

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			Br at Boherboy	9	0.006	0.005	0.016	0.003	0.014	Good or better	No	in the catchment than the physico-chemical sites and therefore may require water quality investigation to ascertain nutrient conditions in the upper catchment.
24	**Ownagappul**	Ownagappul & Barees	Slieve Bridge	5	0.003	0.001	0.006	0.003	0.005	Good or better	No	The site location is in the middle of the river stretch where of pearl mussel habitat has been identified. Some further sites may be required to investigate the water quality further up in the catchment.
25	**Shannon Estuary**	Cloon										There are currently no physico-chemical monitoring sites in the catchment
26	**Slaney**	Derreen	Douglas (Kiltegan), Highpark Br	25	0.034	0.033	0.136	0.005	0.112	Good or better	No	
			Douglas (Kiltegan), Lucas Br	9	0.030	0.012	0.052	0.013	0.048	Good or better	No	
			Clonmore stream, Aghinree Breidge	15	0.047	0.070	0.290	0.003	0.157	Less than good	**Yes**	Site requires pressures assessment
			Dereen, Br SW of Toorboy	29	0.007	0.007	0.034	0.0005	0.025	Good or better	No	
			Dereen, Rathcoyle Br	25	0.012	0.014	0.070	0.002	0.033	Good or better	No	
			Dereen, Br NE of Ballykilmurray Lr	28	0.014	0.018	0.089	0.0005	0.044	Good or better	No	
			Dereen, 2nd Ford u/s	15	0.034	0.088	0.350	0.003	0.133	Good or better	No	

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			Hacketstown br									
			Dereen, Hacketstown Br	15	0.036	0.042	0.180	0.003	0.094	Less than good	Yes	Site requires pressures assessment
			Dereen, Saulsford Br	15	0.046	0.062	0.230	0.003	0.167	Less than good	Yes	Site requires pressures assessment
			Dereen, Acaun Br	11	0.039	0.039	0.140	0.003	0.108	Less than good	Yes	Site requires pressures assessment
			Dereen, Knockeen Br	31	0.032	0.026	0.120	0.0005	0.083	Good or better	No	
			Deree, Knockloe Br	36	0.035	0.022	0.110	0.003	0.086	Less than good	Yes	Site requires pressures assessment
			Mullanacrana stream, Intake at Cornan East	4	0.002	0.001	0.005	0.0005	0.004	Good or better	No	
27	**Suir**	Clodiagh	Drummond stream, Br S of Drummond Crossroads	34	0.030	0.027	0.104	0.001	0.089	Good or better	No	
			Clodiagh, Br E of Shanakill House	13	0.016	0.013	0.054	0.003	0.038	Good or better	No	
			Clodiagh,Clonea Br	13	0.060	0.174	0.640	0.003	0.2704	Less than good	Yes	This site is located directly u/s of the first known pearl mussel location. Site requires pressures assessment
			Clodiagh,Lowry Br	13	0.013	0.007	0.023	0.003	0.0230	Good or better	No	
			Clodiagh,2.5km u/s Portlaw	12	0.016	0.011	0.038	0.003	0.0358	Good or better	No	
			Clodiagh,Portlaw Br (LHS)	13	0.016	0.009	0.034	0.003	0.0298	Good or better	No	
			Clodiagh,Portlaw Br (RHS)	13	0.012	0.008	0.029	0.003	0.0260	Good or better	No	