UK Technical Advisory Group on the Water Framework Directive

Proposed recommendations on biological standards

Consultation

December 2012

Contents

1. INTRODUCTION

The UK Technical Advisory Group ("UKTAG") develops and makes recommendations to the UK government administrations on standards for implementing the Water Framework Directive ("the Directive"). UKTAG is a working group of experts drawn from the environment agencies and conservation agencies[1].

This document sets out our proposed recommendations for new and revised biological standards and associated assessment methods. In developing the recommendations, we were assisted by experts from a number of other public bodies, including the Centre for Environment, Fisheries and Aquaculture Science (CEFAS), the Irish Environmental Protection Agency, Ireland's Marine Institute and Marine Scotland.

Biological standards are values defined for measures of ecological quality, such as the abundance of different species or groups of species of fish or invertebrates. They describe the boundaries between 5 ecological status classes (high, good, moderate, poor and bad) and are used in assessing and classifying the status of rivers, lakes, estuaries and coastal waters. Classification of waters into status classes helps identify where environmental improvements may be needed and where improvement efforts have been successful. You can find out more about classification in our existing recommendations on surface water classification schemes[2].

We first published recommendations on biological standards and associated assessment methods in 2008[3]**.** Those recommendations were adopted by the UK government administrations and used by the environment agencies in preparing the first river basin management plans in 2009. They have assisted in targeting management effort to protect and improve the ecological quality of the water environment. We are proposing to update the recommendations:

(a) to reflect the outcome of a Europe-wide exercise (called the intercalibration exercise) aimed at ensuring our standards for good status are comparable with those of other countries;
(b) to take account of feedback from the use of the standards, including monitoring data; and
(c) because our original recommendations did not include methods for assessing all the relevant measures of ecological quality listed in the Directive or for detecting the impact upon them of all the different pressures that can affect ecological quality.

This report outlines our proposed new recommendations and their expected implications. Details of the proposed standards and the ways they are calculated are provided in accompanying appendices.

The recommendations have been built on the understanding gained from assessing ecological quality across the UK and from working with other countries as part of the Europe-wide

[1] Countryside Council for Wales(CCW), Natural England (NE), Environment Agency (England and Wales),Northern Ireland Environment Agency (NIEA), Joint Nature Conservation Committee (JNCC), Scottish Environment Protection Agency (SEPA), Scottish Natural Heritage (SNH) and the Republic of Ireland's Department of Environment, Community and Local Government (DECLG).
[2] UKTAG (2007) Recommendations on surface water classification schemes for the purposes of the Water Framework Directive. December 2007. http://www.wfduk.org/resources%20/recommendations-surface-water-classification-schemes
[3] http://www.wfduk.org/reference/biological-method-statements.

intercalibration exercise. We believe they provide for a significant step forward in the ability of the environment agencies to assess the ecological quality of rivers, lakes, estuaries and coastal waters and will provide a sound basis for preparing the second river basin management plans in 2015. We would like your views on:

(a) whether or not you agree that our proposals provide for a better understanding of the ecological quality of the water environment; and
(b) how our recommendations might be further improved in the future.

As part of the review of its proposals, the UKTAG welcomes your comments via its website: http://www.wfduk.org/stakeholders/stakeholder-review-phosphorus-and-biological-standards or email your comments to wfduktag@sniffer.org.uk

Once we have taken your comments into account, a final set of recommendations will be made to the UK government administrations. The approach to the adoption and implementation may vary for each country within the UK, depending on the policy in each country. This is for Ministers to decide.

When finalising our recommendations, we will not be able to make revisions to those standards and methods that have been set through the intercalibration exercise. However, we will take account of your comments on these methods in making any recommendations on when and where the methods are used in practice and the weight given to the results obtained in decision-making.

As understanding improves, standards and methods may be further revised. Our role is to look at the evidence and use this information to steer any future changes. We will also try to expand the range of methods to include ones better able to diagnose the impact of certain pressures. One of our priority areas of work is on methods that can detect the ecological effects of abstraction pressures and morphological alterations. We will aim to make future recommendations in time to inform the production of the third river basin management plans, due in 2021.

2. OVERVIEW

An overview of the new and revised assessment methods is provided in the tables below, including information on their implications. There are two principal implications:

(a) Improvements in biological assessment methods enable better, risk-based targeting of improvement action. This is because information from biological classification provides direct evidence of ecological harm. This evidence is used in prioritising efforts to improve the status of the water environment.
(b) The status of water bodies reported by the environment agencies may change. Some may be classed in a better class and some in a worse class.

Taking action to improve the water environment can be expensive. Good evidence that water plants and animals are not in good status is important in helping decide if that investment is proportionate. We think our recommendations provide an improved basis for deciding whether or not ecological quality is good.

It has not yet been possible to quantify the net result of our proposals on the ecological status of water bodies. This would involve running a full classification with all the new standards, including the new biological standards and new standards for water quality and water resources we have recently recommended[4] or on which we are consulting[5]. For some of the new methods, the data needed to do this will only be available once the environment agencies have undertaken the necessary environmental monitoring over the next few years.

Where we have data, we have provided an assessment of the effect of our recommendations on the classification of the particular water plant or animal group, such as invertebrates or fish. These groups are referred to as "quality elements". Many of the pressures to which the new biological methods are expected to respond are also likely to be accounted for, at least in part, by water quality classifications, other biology classifications or assessments of water resources or morphological conditions. We have described where we think this is likely to be the case.

Information about intercalibration
A key aim of intercalibration is to ensure that the biological standards for the boundaries between high status and good status and between good status and moderate status are comparable between countries.

The first round of intercalibration was completed in 2008 and published by the European Commission[6]. The exercise proved complex and remained incomplete, resulting in a second phase. This second phase has been completed for the majority of methods considered. To reflect differences in the level of progress, the European Commission has proposed differentiating methods into those it considers:

- are fully intercalibrated; and
- require further work to be fully intercalibrated but are at a satisfactory interim position.

Our summary tables below indicate which of our recommended UK methods are fully intercalibrated and for which intercalibration is considered interim. There are also a number of quality elements for which too little progress with intercalibration has been possible to place them in either of the above categories or which have not so far been within the scope of the intercalibration exercise.

2.1 Rivers: Overview

We have improved on our existing recommended methods for assessing the status of water plants and invertebrates in rivers. The new methods will assist the environment agencies in better assessing the ecological impact of nutrient enrichment and other forms of pollution, including sewage, toxic pollution and acidification. We have also ensured that our proposed new standards for good status are comparable with those used by other countries across Europe.

We have extended the coverage of our recommended methods for assessing fish status from England and Wales to the whole of the UK and improved our recommended method for assessing the passability to fish of dams and weirs. For the first time, fish assessments in the UK can be based on common principles.

[4] http://www.wfduk.org/stakeholders/stakeholder-review-2012-response-submissions.
[5] http://www.wfduk.org/stakeholders/stakeholder-review-phosphorus-and-biological-standards.
[6] (Decision 2008/918/EC).

None of the methods we recommended prior to the production of the first river basin management plans were specifically designed to detect the effects of water abstraction and engineering works on river ecosystems. We have started to address this important gap by developing a set of ecological indicators designed to help assess the impacts of such hydromorphological alterations. We will be continuing to work to improve assessment capabilities in this area.

Rivers summary

Quality element	Where new/revised method applicable	Principal pressures to which sensitive	Inter-calibration status[1]	Filling gap or revising / replacing existing method	Indicative implications
Macrophytes	UK	Nutrient enrichment	Full	Revising	24% decrease in proportion of water bodies where water plants worse than good status.
Phytobenthos	UK	Nutrient enrichment	Full	Revising	
Phytobenthos – (Bacterial Tufts)	UK	Organic enrichment	None	Filling gap	No significant impact on overall classifications is expected. The impact of the pressure is expected to be taken into account in classifications of benthic invertebrates and water quality. Impact on phytobenthos classifications is not known.
Benthic invertebrates	UK	Organic enrichment; toxic pollutants	Full	Revising	3% increase in proportion of water bodies where invertebrates worse than good status. Pressures also accounted for at least in part by existing water quality classification.
Benthic invertebrates	UK (areas affected by acidification)	Acidification	Full	Revising	1% (1 of the sampled water bodies) increase in the proportion of water bodies in Scotland where invertebrates are worse than good as a result of acidification. Not known for other parts of the UK vulnerable to acidification but pressure also accounted for at least in part by existing water quality classification.
Fish	Northern Ireland & Scotland[2]	Wide range of pressures	Full	Replacing - Northern Ireland & Scotland	17% increase in proportion of water bodies with a fish status worse than good. For Northern Ireland, this assessment is based on very few water bodies. Pressures also accounted for at least in part by existing classifications of other quality elements (water quality; water resources;

Rivers summary					
Quality element	**Where new/revised method applicable**	**Principal pressures to which sensitive**	**Inter-calibration status[1]**	**Filling gap or revising / replacing existing method**	**Indicative implications**
					morphology; barriers to migration). In Scotland, the overall increase in proportion of water bodies worse than good (taking account of existing classifications for other quality elements) is likely to be around 9% (10 water bodies).
Continuity for fish	UK	Barriers to fish passage	None	Revising - Scotland Filling gap Northern Ireland	Likely increase in the number of structures identified as barriers to fish passage (specifically to lampreys or eels). In England & Wales, pressure may be accounted for at least in part by existing fish classifications.
Ecological indicator suites	UK	Hydro-morphological alterations	None	Filling gap	Greater confidence that water bodies are at poor or bad status as a result of hydro-morphological modifications.

Notes
1. "Full" means that the standard is in the Draft Commission Decision Document as accepted as fully Intercalibrated. "Interim" means that the standard is in the Draft Commission Decision Document as accepted for use as a national method but requires more work to be fully intercalibrated.
2. A separate but analogous method is already used in England and Wales

2.2 Lakes: Overview

We are proposing improvements to our previously recommended assessment methods for phytoplankton, phytobenthos, macrophytes and invertebrates in lakes. For Northern Ireland, we have added an assessment method for fish. The standards for all of these methods have been aligned with those of other countries across Europe. The methods detect the different effects of nutrient enrichment on lake ecosystems. Together, the methods will enable the environment agencies to produce more reliable assessments of the ecological impact of this pressure than ever before.

None of the methods we recommended prior to the production of the first river basin management plans methods were specifically designed to detect the effects of water abstraction and engineering works on lakes ecosystems. We have started to address this important gap by developing a set of ecological indicators designed to help assess the impacts of such hydromorphological alterations. We will be continuing to work to improve assessment capabilities in this area.

Lakes Summary

Quality element	Where new/revised method applicable	Principal pressures to which sensitive	Inter-calibration status[1]	Filling gap or revising / replacing existing method	Indicative implications
Phytoplankton	UK	Nutrient enrichment	Full	Revising	1% increase in proportion of water bodies where water plants worse than good status.
Macrophytes	England, Scotland & Wales[2]	Nutrient enrichment	Full	Revising	
Phytobenthos	UK	Nutrient enrichment	Full	Revising	
Benthic invertebrates	UK	Nutrient enrichment	Full	Revising	No change in proportion of water bodies where invertebrates worse than good status. Not expected to be worse than good status unless water plants are also worse than good status.
Fish	Northern Ireland	Nutrient enrichment Wide range of pressures	Full for Northern Ireland	Filling gap	Not known as not yet applied. At least some of pressures likely to be accounted for at least in part by existing classifications of other quality elements.
Ecological indicators	UK	Hydro-morphological alterations	None	Filling gap	Greater confidence that water bodies are at poor or bad status as a result of hydro-morphological modifications.

Notes
1. "Full" means that the standard is in the Draft Commission Decision Document as accepted as fully Intercalibrated. "Interim" means that the standard is in the Draft Commission Decision Document as accepted for use as a national method but requires more work to be fully intercalibrated.
2. A separate macrophyte assessment method is used in Northern Ireland. This is not proposed for revision and its intercalibration status is "full".

2.3 Coastal waters: Overview

Our proposals for coastal waters reflect efforts to align standards across Europe as far as possible. We have also enhanced the environment agencies' abilities to assess the impact on coastal waters of nutrient enrichment. We have done this by improving existing methods and by adding a new one for seagrasses. We have also developed our first method specifically designed to assess ecological impacts of hydromorphological alterations on coastal water shores, our salt marsh method.

Coastal waters summary

Quality element	Where new/revised method applicable	Principal pressures to which sensitive	Inter-calibration status[1]	Filling gap or revising / replacing existing method	Indicative implications
Phytoplankton	UK	Nutrient enrichment	Interim (chlorophyll component only)	Revising for England, Scotland & Wales Filling gap for Northern Ireland	Only minor changes in phytoplankton classification expected. Pressure may also be accounted for in existing opportunistic macroalgae classifications
Macroalgae - opportunistic	UK	Nutrient enrichment	Interim	Revising	Only minor changes in classification expected.
Angiosperms - seagrasses	Scotland, Northern Ireland[2]	Nutrient enrichment Physical disturbance	Interim	Filling gap for Scotland & Northern Ireland	Not known but nutrient enrichment also taken into account in existing opportunistic macroalgae & phytoplankton classifications.
Angiosperms - salt marsh	England & Wales	Morphological alterations	None	Filling gap	Not known but initial assessments shows good correlation with heavily modified water body identifications
Benthic invertebrates	UK	Organic pollution; toxic pollutants; Smothering - physical disturbance	Interim	Revising	Only minor changes in invertebrate classification expected. Organic pollution & toxic pollutants also accounted for at least in part by existing water quality classification.

Notes
1. "Full" means that the standard is in the Draft Commission Decision Document as accepted as fully Intercalibrated. "Interim" means that the standard is in the Draft Commission Decision Document as accepted for use as a national method but requires more work to be fully intercalibrated.
2. The method for sea grasses is the same as that already used in England and Wales

2.4 Estuaries: Overview

Estuaries, sometimes referred to as transitional waters, are highly dynamic environments with environmental conditions varying as the balance between seawater and freshwater flows changes along the estuary and with the tidal cycle. Developing robust ecological assessment methods for use in such environments is particularly challenging. We believe we have made a considerable step forward since 2008/9 and our latest recommendations for estuaries start to fill significant gaps in the existing range of assessment methods available to the environment agencies. In particular, we are now able to recommend methods for assessing the status of phytoplankton and benthic invertebrates in estuaries. We have also extended the application of our existing method for assessing the condition of seagrasses to Scotland and developed a method for assessing the condition of salt marshes in England and Wales.

Estuaries summary

Quality element	Where applicable	Principal pressures to which sensitive	Inter-calibration status[1]	Filling gap or revising / replacing existing method	Indicative implications
Phytoplankton	UK	Nutrient enrichment	None	Filling gap	Not known but pressure may also be accounted for in existing opportunistic macroalgae classifications.
Macroalgae - opportunistic	UK	Nutrient enrichment	Interim	Revising	Only minor changes in classification expected
Macroalgae - fucoid extent	UK	Toxic substances	None	Revising	Not known but change to existing method is minor and the pressure will also be accounted for, at least in part, in existing water quality classifications
Angiosperms - seagrasses	Scotland[2]	Nutrient enrichment Physical disturbance	Interim	Filling gap for Scotland	Not known but nutrient enrichment also taken into account in existing opportunistic macroalgae & phytoplankton classifications.
Angiosperms - saltmarsh	England & Wales	Morphological alterations	None	Filling gap	Not known but initial assessments shows good correlation with heavily modified water body identifications
Benthic invertebrates	UK	Organic pollution; toxic pollutants; Smothering - physical disturbance	None	Filling gap	Not known but organic pollution & toxic pollutants also accounted for at least in part by existing water quality classification.
Fish	UK	Wide range of pressures	Full - Northern Ireland only	Revising	Only minor changes in fish classification expected. At least some of pressures also likely to be accounted for at least in part by existing classifications of other quality elements.

Notes
1. "Full" means that the standard is in the Draft Commission Decision Document as accepted as fully Intercalibrated. "Interim" means that the standard is in the Draft Commission Decision Document as accepted for use as a national method but requires more work to be fully intercalibrated.
2. The method for sea grasses is the same as that already used in England and Wales.

The following sections provide a summary overview of our proposed recommendations for rivers, lakes, coastal waters and estuaries.

How biological standards are expressed
Most of the biological standards in this report are expressed as ecological quality ratios ("EQRs") on a scale of 0 to 1, with the standards for the boundary between high and good status being closest to 1 and the values for the boundary between poor and bad status being closest to 0.

The EQR represents the relationship between the values observed for the biological quality element and the values expected for it under near natural conditions ("reference conditions").

The appendices to this report describe how the EQR is calculated for each of the recommended assessment methods.

3. SUMMARY FOR RIVERS

3.1 Rivers: Macrophytes and phytobenthos

Macrophytes and phytobenthos are algae and higher plants that are either rooted in river sediments or attached to stones and other submerged surfaces. They range from submerged and emergent flowering plants (e.g. water crowfoot: *Ranunculus* spp; reeds: *Phragmites australis*) and aquatic mosses (e.g. *Fontinalis antipyretica*) to algae, most of which are not visible to the naked eye. In their natural state, they are an important source of food and shelter for aquatic invertebrates and fish. However, many types of pollution can lead to alterations in the composition and abundance of macrophytes and phytobenthos. These changes can have a number of consequences, including unsightly growth of filamentous algae and, in some circumstances, night-time de-oxygenation of rivers, leading to the death of fish. The Directive's descriptions of the condition of macrophytes and phytobenthos in rivers at high, good and moderate status are shown in Table 1.

In common with most other European countries, we have developed separate methods for assessing macrophytes (those photosynthetic organisms visible to the naked eye, including the larger algae) and phytobenthos.

Table 1: Description of high, good and moderate status for river macrophytes and phytobenthos

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The taxonomic composition corresponds totally or nearly totally to undisturbed conditions. There are no detectable changes in the average macrophytic and the average phytobenthic abundance.	There are slight changes in the composition and abundance of macrophytic and phytobenthic taxa compared to the type-specific communities. Such changes do not indicate any accelerated growth of phytobenthos or higher forms of plant life resulting in undesirable disturbances to the balance of organisms present in the water body or to the physico-chemical quality of the water or sediment. The phytobenthic community is not adversely affected by bacterial tufts and coats present due to anthropogenic activity.	The composition of macrophytic and phytobenthic taxa differs moderately from the type-specific community and is significantly more distorted than at good status. Moderate changes in the average macrophytic and the average phytobenthic abundance are evident. The phytobenthic community may be interfered with and, in some areas, displaced by bacterial tufts and coats present as a result of anthropogenic activities.

Macrophytes

Macrophytes are an important part of the ecology of rivers, as they are primary producers that may also influence the hydromorphological regime. The river macrophytes considered in the method are plants found in those parts of the river which are often under water. They include plants that are normally submerged, such as water crowfoot (*Ranunculus* spp.), and plants, such as the common reed (*Phragmites australis*), that can grow in waterlogged soil. River macrophyte species vary in the way that they respond to pressures. These responses also change with a number of environmental variables such as alkalinity; height of the river's source and distance from the source; the slope of the river; and the latitude at which the plants are growing. When nutrient concentrations are high, larger and more tolerant species flourish and filamentous algal cover is likely to increase. The assessment method is based on these responses and incorporates site specific reference conditions in order to address the varied response of macrophytes within a range of environmental variables.

During the intercalibration exercise, several small revisions were made to the existing method[7] in terms of the metrics included and the weight assigned to them in deriving the overall ecological quality ratio ("EQR") for a site:

(a) The River Macrophyte Hydraulic Index (RMHI), which is based on substrate, depth and stream energy, was dropped from the suite of metrics used. This improved the relationship with diatom classifications by focussing the macrophyte method on eutrophication.
(b) The weight given to two measures of diversity (N_TAXA and N_FG) that consider the number of scoring aquatic plant species and functional groups, respectively, was reduced, making them less sensitive to survey effort, and the criteria under which these metrics will contribute to the final EQR was adjusted.

Following these revisions, the method[8] was intercalibrated successfully. The revised method results in only slight changes to classification. Of 1287 water bodies in UK that we have assessed, 81% (1040) will stay in the same class and the net change in class is only 3%. The change in water body class is largely between high and good status. Only three more water bodies are classed as worse than good status using the revised method compared with the existing method. Figure 1 provides a summary of the implications for the classification of the status of macrophytes in each part of the UK.

Technical details on the recommended revised method are provided in Annex 1.

[7] http://www.wfduk.org/resources%20/river-macrophytes
[8] The method is referred to as LEAFPACS v 2.0

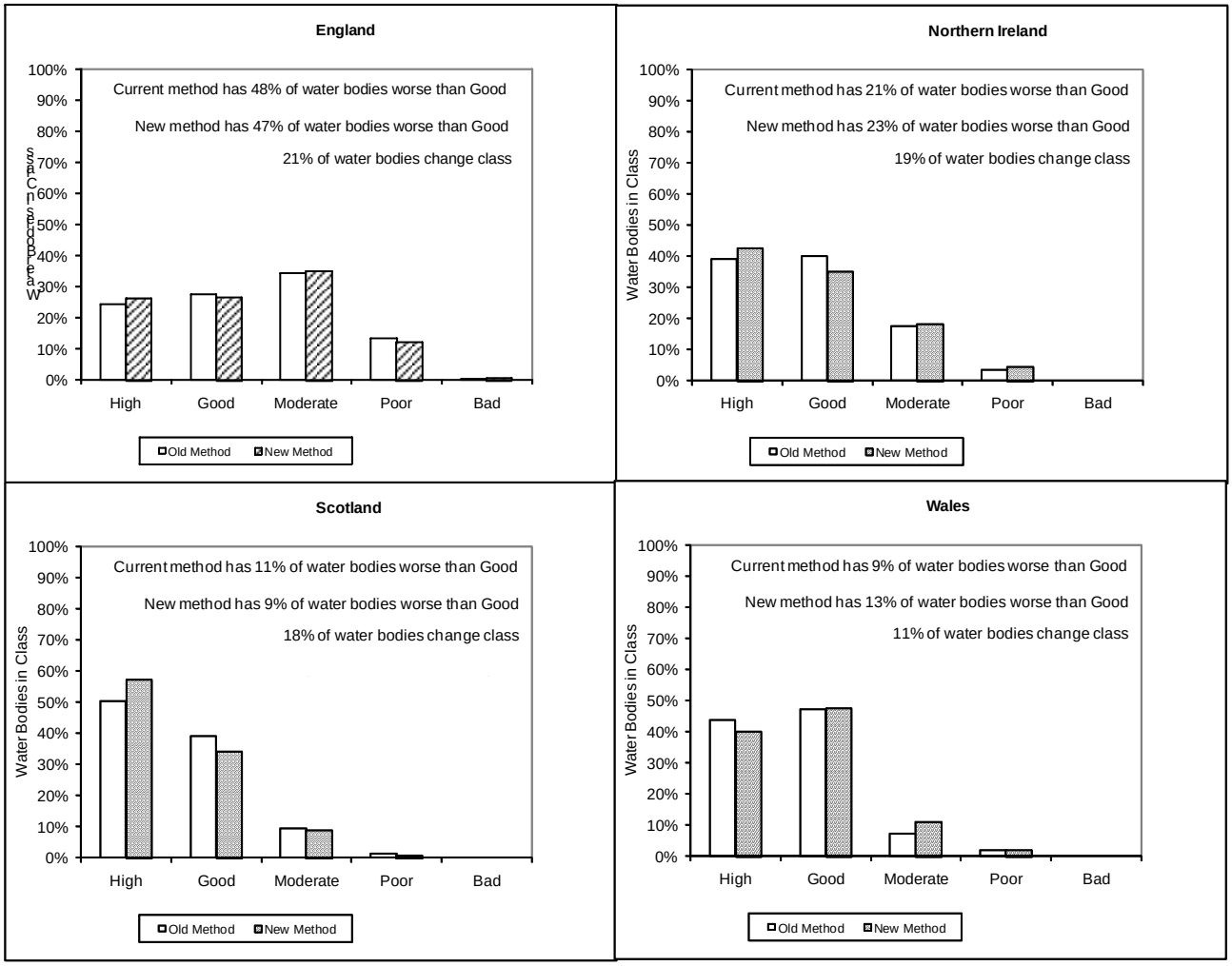

Figure 1: Summary of the implications expected from adopting the revised river macrophyte standards and associated assessment method.

Phytobenthos

The term “phytobenthos” refers to a mostly microscopic group of organisms, called algae, that are found attached to submerged surfaces, such as stones and plant stems. Both the existing[9] and the revised assessment method for assessing the impact of nutrient enrichment on phytobenthos focus on the diatoms, a large and diverse group of algae. The existing method has been used throughout the UK. We have also recommending a method for assessing the impact of inputs of waste organic matter (e.g. in sewage effluents) on phytobenthos.

Phytobenthos - impact of nutrient enrichment

The most important change we are recommending to the existing method for assessing the impact of nutrient enrichment is based on a reappraisal of the way in which it calculated the reference values. This change has a particularly pronounced effect in high alkalinity rivers, with some water bodies that were previously reported as being at less than good status now being considered to be good status. In addition, the taxa list was revised and shortened, in order to simplify analysis. The

[9] http://www.wfduk.org/resources%20/river-phytobenthos

standards were also adjusted to ensure that they are comparable with those applied elsewhere in Europe.

The implications of these changes on classification are summarised in Figure 2. Based on an assessment of 4,016 water bodies, significantly fewer water bodies are classed as worse than good status for phytobenthos using the revised method than using the existing method. This effect is particularly noticeable in high alkalinity rivers. This is a very common type of river in England and Northern Ireland.

Technical details of the recommended revised method are provided in Annex 2.

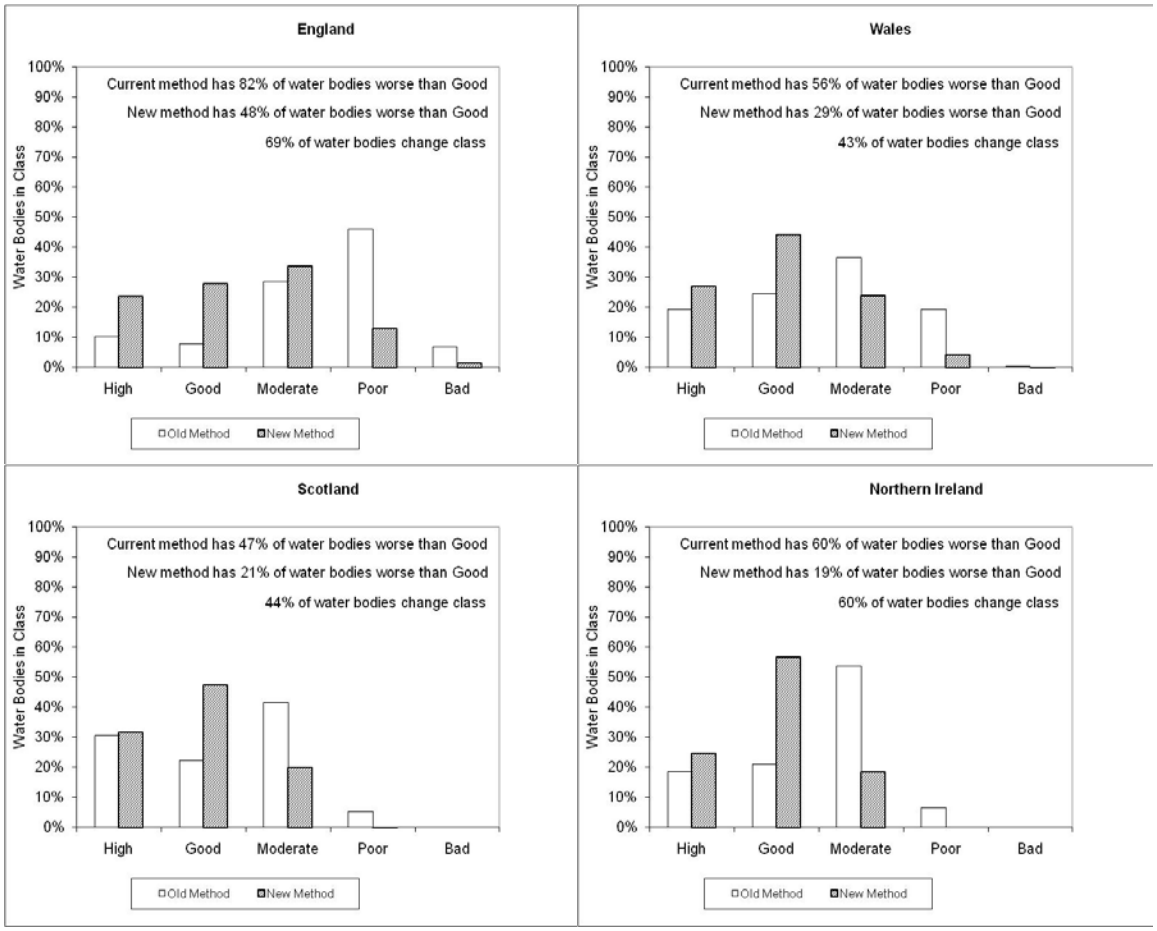

Figure 2: Summary of the implications expected from adopting the revised river phytobenthos standards and associated assessment method.

Assessing the impact of nutrient enrichment on river plants

The macrophyte and phytobenthos assessment methods both respond to nutrient enrichment and so help identify where eutrophication is a problem. Under some circumstances, a reliable assessment of the impact of nutrient enrichment on river plants can be obtained using either the macrophyte or phytobenthos assessment method. However, we recommended that both assessment methods are used wherever possible, as they each give insights into separate aspects of ecosystem functioning. The diatom assessment method can be used on its own if mean alkalinity is < 75 mg l^{-1} $CaCO_3$ and the macrophyte method can be used on its own if mean alkalinity is >200 mg l^{-1} $CaCO_3$. Further details are provided in Annex 3.

The implications of the revised methods for the classification of water plants as a whole are summarised in Figure 3. Based on an assessment of 1204 water bodies, fewer water bodies would be classed as worse than good status using the revised assessment methods than using the existing assessment methods.

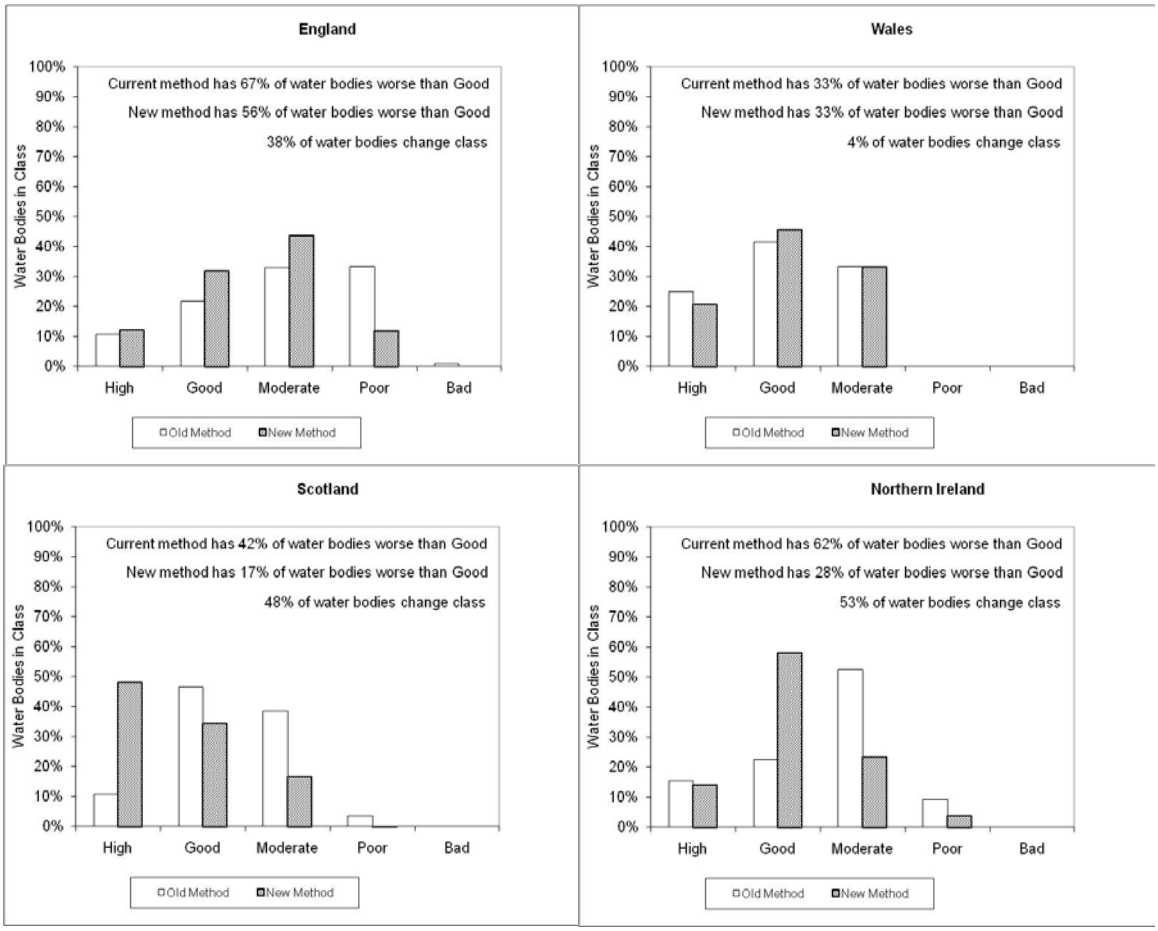

Figure 3: Summary of the combined effect of the revised phytobenthos and macrophyte assessment methods on the classification of water plants

Phytobenthos - impact of organic enrichment

As inputs of organic matter increase, the phytobenthos community can be progressively replaced by bacterial tufts, commonly known as sewage fungus. Our recommended method considers the extent to which phytobenthos has been displaced by sewage fungus.

We do not expect the method to have a significant impact on the overall number of water bodies classed as worse than good status. This is because the impact of organic enrichment on river ecosystems is also reflected in classifications using our recommended method for assessing the status of benthic invertebrates (see Section 3.2) and in water quality classifications based on our recommended environmental standards for dissolved oxygen and for other pollutants associated with inputs of organic matter, such as ammonia[10]. At this time, we are unable to quantify the effect

[10] http://www.wfduk.org/resources%20/uk-environmental-standards-and-conditions-report-phase-1

of the recommended method on classifications of phytobenthos. Such an assessment can only be made once the environment agencies have collected suitable monitoring data. However, severe impacts on river water bodies form organic enrichment are rare thanks largely to considerable investment by water utilities over several decades in the collection and treatment of sewage.

Technical details of the recommended new method are provided in Annex 3.

3.2 Rivers: Benthic invertebrates

Benthic invertebrates include insects, crustaceans, worms and other animals lacking backbones that live on submerged surfaces. These include the sediments forming the river channel bed, which range from bedrock and boulders to fine sands and silts. They also include submerged and emergent water plants.

Benthic invertebrate communities play important roles in freshwater ecosystems, grazing on aquatic algae and plants, processing fallen leaves and other detritus and serving as a food source for fish and other animals. The Directive's descriptions of the condition of invertebrates in rivers at high, good and moderate status are shown in Table 2.

Table 2: Description of high, good and moderate status for river invertebrates

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The taxonomic composition and abundance correspond totally or nearly totally to undisturbed conditions. The ratio of disturbance sensitive taxa to insensitive taxa shows no signs of alteration from undisturbed levels. The level of diversity of invertebrate taxa shows no sign of alteration from undisturbed levels.	There are slight changes in the composition and abundance of invertebrate taxa from the type-specific communities. The ratio of disturbance-sensitive taxa to insensitive taxa shows slight alteration from type-specific levels. The level of diversity of invertebrate taxa shows slight signs of alteration from type-specific levels.	The composition and abundance of invertebrate taxa differ moderately from the type-specific communities. Major taxonomic groups of the type-specific community are absent. The ratio of disturbance-sensitive taxa to insensitive taxa, and the level of diversity, are substantially lower than the type-specific level and significantly lower than for good status.

We recommended two methods for assessing the status of invertebrates for use in developing the first river basin management plans. The first was a development of a long-established UK method for assessing the effect of pollution from sewage discharges[11]. The second was specifically developed to assess the affect of acid rain on rivers[12]. The latter was used in Scotland in areas vulnerable to acidification.

Principal invertebrate assessment method

Under the existing method, each invertebrate taxon (species or group of species) present in a sample is assigned a score based on its relative tolerance to pollution. The results for all the taxa are summed to give an overall score.

[11] http://www.wfduk.org/resources%20/river-invertebrates
[12] http://www.wfduk.org/resources%20/river-invertebrates-acidification-scotland

The new method[13] takes account of the abundance of each taxon as well as their relative tolerance to pollution. The scores for each taxon were derived using a large dataset of invertebrate samples and matched water quality data collected by the environment agencies since our original method was developed.

The additional information provided by measuring the abundance of taxa in the samples makes the new method more discriminatory than the original. This helps distinguish between sites that are adversely impacted by poor water quality and sites that are unaffected or only slightly affected. This means that the new method will help the environment agencies and other bodies better target their efforts to improve the water environment.

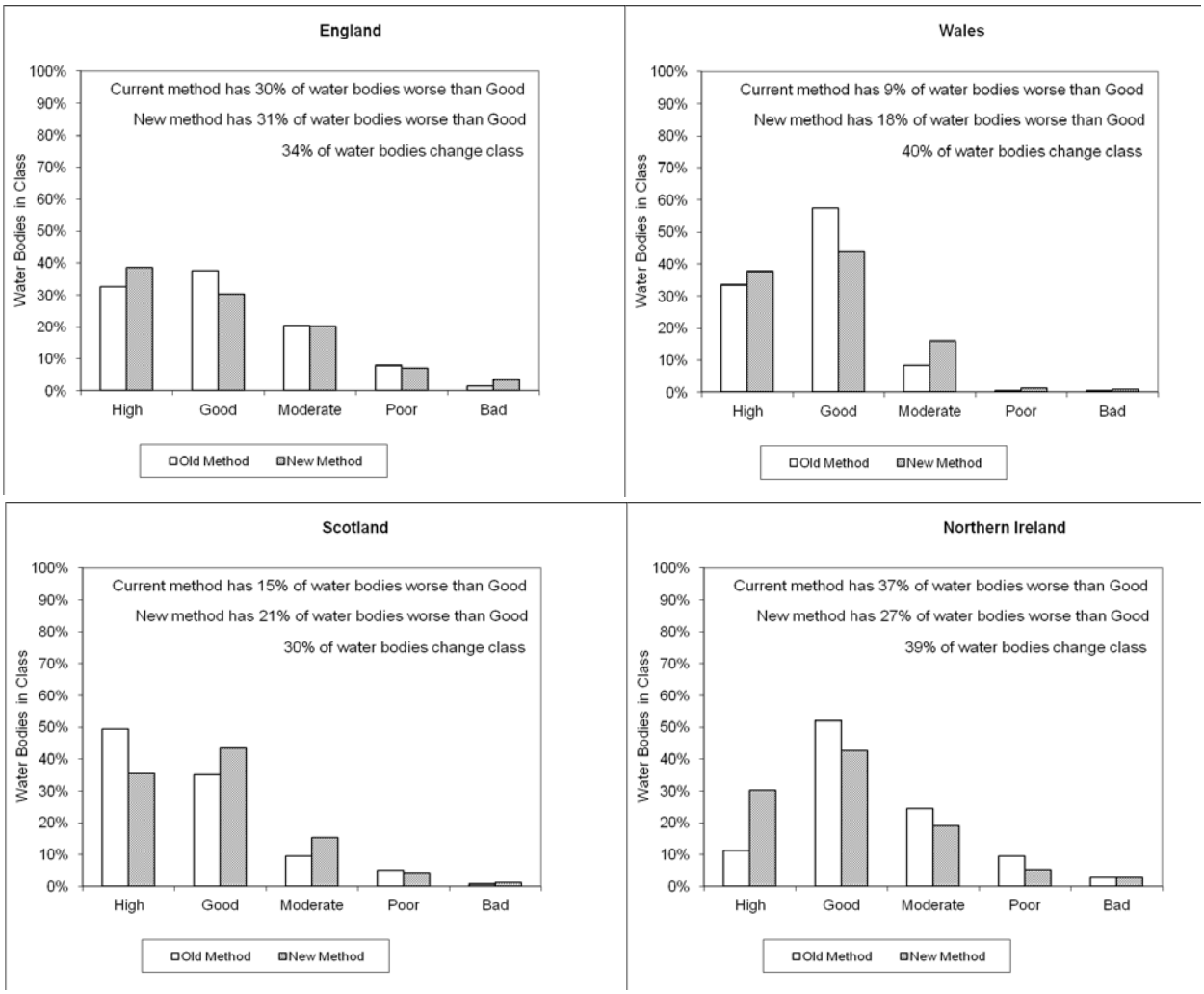

Figure 4: Summary of the implications expected from adopting the revised river invertebrate standards and associated assessment method.

Technical details of the recommended revised method are provided in Annex 4.

Acidification assessment method

[13] The Whalley Hawkes Paisley Trigg (WHPT) method

Elevated acidity can have a direct toxic affect on water plants and animals. It can also alter the toxicity of metals that may be present. The main cause of acidification of rivers is acid deposition. This results from the burning of fossil fuels that emit acid-forming gases (sulphur and nitrogen compounds) into the atmosphere. The gases can react with moisture in the atmosphere to form sulphuric and nitric acid. These acids can then reach water bodies following rainfall. The main sources of the acid-forming gases are emissions from industries burning coal and oil, and vehicle emissions. The vulnerability of waters to acidification varies across the UK, depending on the characteristics of the catchment's geology and soils and factors such as coniferous tree cover. Acidification can also result from discharges from some industrial processes and from seepage of contaminated groundwater from old mine workings.

We have improved our existing method by:

(a) focusing in on a shorter list of invertebrate comprising taxa that show a clear response to the effect of acidification;
(b) updating the sensitivity scores assigned to the different taxa and their relative abundances;
(c) differentiating the response to acidification in clear water river types in Scotland, England and Wales; and in humic water river types, to account for the mitigating effects of humic substances; and
(d) revising the standards to ensure comparability with those of other countries and to differentiate 5 status classes. Our existing method only differentiated "good or better", moderate and "poor or worse".

The implications of these changes on classification in Scotland are summarised in Figure 5. The monitoring data necessary to apply the existing method and the proposed new method in other parts of the UK vulnerable to acidification has not yet been collected. Consequently, it is not possible to provide a similar assessment of the implications for invertebrate classifications. However, acidification effects are expected to be accounted for at least in part by existing water quality classifications based on pH.

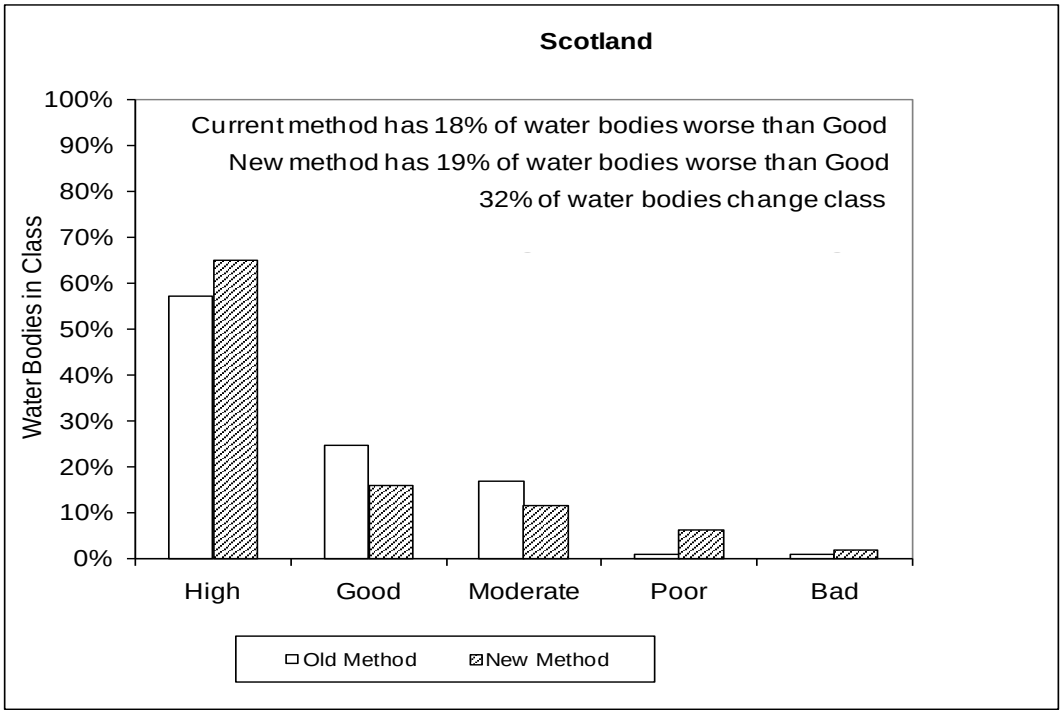

Figure 5: Summary of the implications expected from adopting the revised invertebrate standards and associated method for assessing the impact of acidification.

Technical details of the recommended revised method are provided in Annex 5.

3.3 Rivers: Fish

Most fish species occupy a position high up the food chain in river ecosystems. Consequently, the status of fish populations can be affected by a wide range of direct and indirect impacts. For example, fish typically respond to reduced oxygen levels, acidification, physical modifications to spawning and nursery habitat, alterations to river flows and pollution by toxic pollutants, such as pesticides. Man-made barriers to fish movements also have a significant role in shaping the composition of fish communities. Because of this, assessments of fish populations have the potential to provide a valuable indication of the effect of pressures on river ecosystems. However, confounding factors can complicate the interpretation of assessment results.

The Directive's requirements for the assessment of descriptions of the condition of fish in rivers at high, good and moderate status are shown in Table 3.

Table 3: Description of high, good and moderate status for river fish

HIGH STATUS	GOOD STATUS	MODERATE STATUS
Species composition and abundance correspond totally or nearly totally to undisturbed conditions. All the type-specific disturbance-sensitive species are present. The age structures of the fish communities show little sign of anthropogenic disturbance and are not indicative of a failure in the reproduction or development of any particular species.	There are slight changes in species composition and abundance from the type-specific communities attributable to anthropogenic impacts on physico-chemical and hydromorphological quality elements. The age structures of the fish communities show signs of disturbance attributable to anthropogenic impacts on physico-chemical or hydromorphological quality elements, and, in a few instances, are indicative of a failure in the reproduction or development of a particular species, to the extent that some age classes may be missing.	The composition and abundance of fish species differ moderately from the type-specific communities attributable to anthropogenic impacts on physico-chemical or hydromorphological quality elements. The age structure of the fish communities shows major signs of anthropogenic disturbance, to the extent that a moderate proportion of the type specific species are absent or of very low abundance.

In 2008, we recommended a method for assessing fish status in England and Wales[14]. Separate methods were used in Scotland and Northern Ireland. We are now recommending new methods for application in Northern Ireland and Scotland. These methods are based on the same principles as our existing method for England and Wales but have been adapted to take account of the different natural characteristics of fish populations across the UK.

[14] http://www.wfduk.org/resources%20/river-fish

The assessment methods compare the observed abundance of fish of each species with a site specific prediction of the expected fish community under near undisturbed ("reference conditions") conditions. The predicted reference conditions are estimated using models created for each part of the UK.

The recommended methods respond to a range of pressures but their response has been optimised to detect the effects of artificial impassable barriers, salmon stocking and pollution by ammonium, phosphorus and acidification.

The implications of the replacement methods on classification in Northern Ireland and Scotland are summarised in Figure 6. The comparison of the results for the current and proposed methods in Scotland is complicated because the current approach does not differentiate between high and good status. Our assessment suggests that fish status in the majority (65%) of waters in Scotland would be the same using the existing and the new assessment method. The new method would produce a 17% increase in the number of water bodies classed as worse than good status for fish. An initial evaluation of these water bodies suggests that around half of these are classed as worse than good status for other quality elements. The increase in the number of water classed as worse than good reflects the improved ability of the new method to detect impacts on fish populations compared with that of the existing method.

Our assessment for Northern Ireland was based on 15 water bodies in Northern Ireland. Around 53% of these are placed in the same class under our proposed new method and the existing method. An additional 13% (2 water bodies) of the water bodies are classed as worse than good.

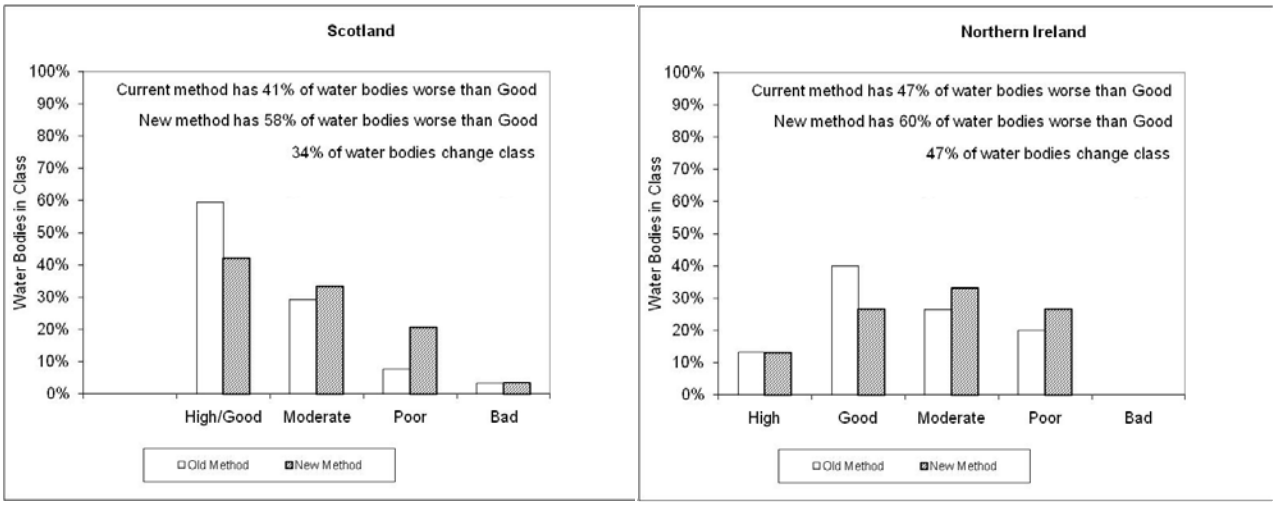

Figure 6: Summary of the implications expected from adopting the revised fish standards and associated assessment methods.

Technical details of the recommended revised method are provided in Annex 6.

3.4 Rivers: Barriers to fish migration

We are also proposing a revised method for assessing the likely impact on fish status of man-made barriers to fish migration, such as dams and weirs. Compared with the existing method[15], the revised assessment method allows for a more reliable identification of partially passable barriers and facilitates consideration of a wider range of fish species. Knowledge of the swimming ability of these non-salmonid species is limited and we recommend that assessments suggesting a structure are acting as a barrier is corroborated with monitoring data on fish population distribution before using the results in classification decisions or in deciding whether or not action should be sought.

It has not yet been possible to quantitatively assess the implications of the new method. In Scotland, the existing method is used to make classification decisions. The new method is expected to improve the reliability of such classifications. Improving data availability is likely to have a much bigger effect on assessments and classification than the changes to the method.

Technical details of the recommended revised method are provided in Annex 6.

3.5 Rivers: Ecological indicators of hydromorphological alterations

Biological assessment methods for use in classifying the ecological status of rivers are intended to indicate the effect on the status of aquatic ecosystems of human activities. A wide range of activities have the potential to impact on ecological quality. These include the discharge of pollutants, modifications to water flows or levels and alterations to the structure or condition of the beds, banks or shores of rivers, lakes, estuaries or coastal waters. The way these different pressures affect water plant and animal communities differs. For example, modifications to river flows as a result of abstraction or impoundment can alter:

(a) the size of the habitat (area/volume of aquatic habitat space);
(b) connectivity and juxtaposition of different habitats; and
(c) character and diversity of the habitat (ecological 'quality' of the habitat)[16].

The biological assessment methods recommended to date, including most of those described earlier in this Chapter, have principally been designed to assess the effects of activities that alter water quality by increasing the concentration of various pollutants. They have not been specifically designed to assess the ecological effects of modifications to river flows or morphological characteristics. This picture is similar in most other Member States.

Because of the lack of suitable assessment methods, for the first river basin management plans in 2009 we recommended[17] that the environment agencies base their status classifications on all reasonably available information. It advised that this should include the results of risk assessments and any relevant biological data that may be available. The risk assessments were recommended to be informed by assessments using the standards we recommended for water flows, water levels and

[15] http://www.wfduk.org/resources%20/recommendations-surface-water-classification-schemes
[16] APEM (2012); Ecological indicators of the effects of abstraction and flow regulation; and optimisation of flow releases from water storage reservoirs; SNIFFER; August 2012 http://www.wfduk.org/search/content/apem
[17] UKTAG (2007); Recommendations on Surface Water Classification Schemes for the purposes of the Water Framework Directive; December 2007 http://www.wfduk.org/resources%20/recommendations-surface-water-classification-schemes

morphological conditions. The available biological data in the different parts of the UK varied. For example, SEPA had to rely exclusively on application of river flow standards and morphological condition limits to ensure its status classifications for rivers provided as good an estimate of ecosystem health as possible.

The development of methods for assessing the ecological effects of modifications to water flows, water levels and morphological conditions continues to be a priority work area for UKTAG. The ecological indicators recommended in this section are a first output of this work. Details of the proposed indicators can be found in Annex 7.

Whilst the indicators cannot be used to differentiate waters into high, good or moderate status, they are designed to add to the weight of evidence needed to be confident that a water body is at poor or bad ecological status.

To help ensure classifications for the second river basin management plans reflect the best understanding of status, we continue to recommend that:

(a) the environment agencies base their status classifications of water bodies subject to hydromorphological alterations on all reasonably available information; and

(b) this information includes the results of risk assessments and any relevant ecological data that may be available.

The ecological indicators are recommended for use in informing ecological data collection and interpretation for this purpose.

The indicators offer a means by which ecological information can be used to better inform classifications of poor and bad status or better understand the impacts on river water bodies of modifications to flows or morphological conditions. For example, the ecological indicators would allow SEPA to base classifications of poor and bad status on information provided by the ecological indicators rather than, as at present, on the application of environmental standards for river flows and morphological conditions. This would be done by directly taking into account the results from surveys using the indicators when deciding on status classifications. Where other information is used as the basis for classification decisions, we recommend that the results from surveys using the indicators can be used to increase confidence in the classifications and so help in prioritising where action to improve status is sought.

We are currently undertaking further work to identify the most appropriate sub-sets of the ecological indicators for use in different circumstances (e.g. depending on the characteristics of the pressure, river type, etc.). This work is due to report in March 2013 and will help each of the UK environment agencies decide when and where to apply the indicators in place of, or in addition to, their existing approaches.

4. SUMMARY FOR LAKES

4.1 Lakes: Phytoplankton

Phytoplankton is the term for algae that live suspended in the water column. Mostly, these algae are individually invisible to the naked eye. When present in large numbers, they can reduce the transparency of the water and even give the water a green tinge.

The composition and abundance of phytoplankton are sensitive to increases in the concentrations of inorganic nutrients, particularly phosphorus and nitrogen. Under some conditions, nutrient enrichment can produce potentially-toxic blue-green algal (cyanobacteria) blooms. The Directive's descriptions of the condition of phytoplankton in lakes at high, good and moderate status are shown in Table 4.

Table 4: Description of high, good and moderate status for lake phytoplankton

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The taxonomic composition and abundance of phytoplankton correspond totally or nearly totally to undisturbed conditions. The average phytoplankton biomass is consistent with the type-specific physico-chemical conditions and is not such as to significantly alter the type-specific transparency conditions. Planktonic blooms occur at a frequency and intensity which is consistent with the type specific physico-chemical conditions.	There are slight changes in the composition and abundance of planktonic taxa compared to the type-specific communities. Such changes do not indicate any accelerated growth of algae resulting in undesirable disturbance to the balance of organisms present in the water body or to the physico-chemical quality of the water or sediment. A slight increase in the frequency and intensity of the type-specific planktonic blooms may occur.	The composition and abundance of planktonic taxa differ moderately from the type-specific communities. Biomass is moderately disturbed and may be such as to produce a significant undesirable disturbance in the condition of other biological quality elements and the physico-chemical quality of the water or sediment. A moderate increase in the frequency and intensity of planktonic blooms may occur. Persistent blooms may occur during summer months.

In the method we recommended in 2008[18], impacts on phytoplankton abundance were assessed on the basis of chlorophyll a concentrations and impacts on the natural composition of phytoplankton species were assessed using the percentage of eutrophic cyanobacteria. We are recommending revisions to the method to:

(a) reflect the outcome of European efforts to ensure that our standards for good status are comparable with those used by other countries across Europe; and
(b) improve the response of the method to the effects of nutrient enrichment on phytoplankton.

Our proposed new method uses a new indicator of impacts on composition, known as Plankton Trophic Index (PTI) and assesses impacts on phytoplankton blooms by considering the abundance by biovolume of cyanobacteria. The new method continues to assess impacts on phytoplankton abundance using chlorophyll a concentrations. The standards for this indicator remain very similar to those recommended previously but the reference values are predicted from alkalinity and depth rather than from total phosphorus.

The implications of the revised method are summarised in Figure 7. The assessment is based on a data from 539 lakes across the UK. Of these, 39% would be classed as moderate or worse for phytoplankton using the revised method compared with 42% using the existing method. The smallest change is in Northern Ireland, where slightly more lakes would be classed as worse than

[18] http://www.wfduk.org/resources%20/lake-%E2%80%93-phytoplankton

good. The greatest change is in Scotland, where the revised method places more lakes at high status. The principal reason for this latter change is the replacement of assessments based on percentage of eutrophic cyanobacteria with assessments based on PTI. The former had placed many lakes with a very low abundance of cyanobacteria at good status for phytoplankton rather than at high status.

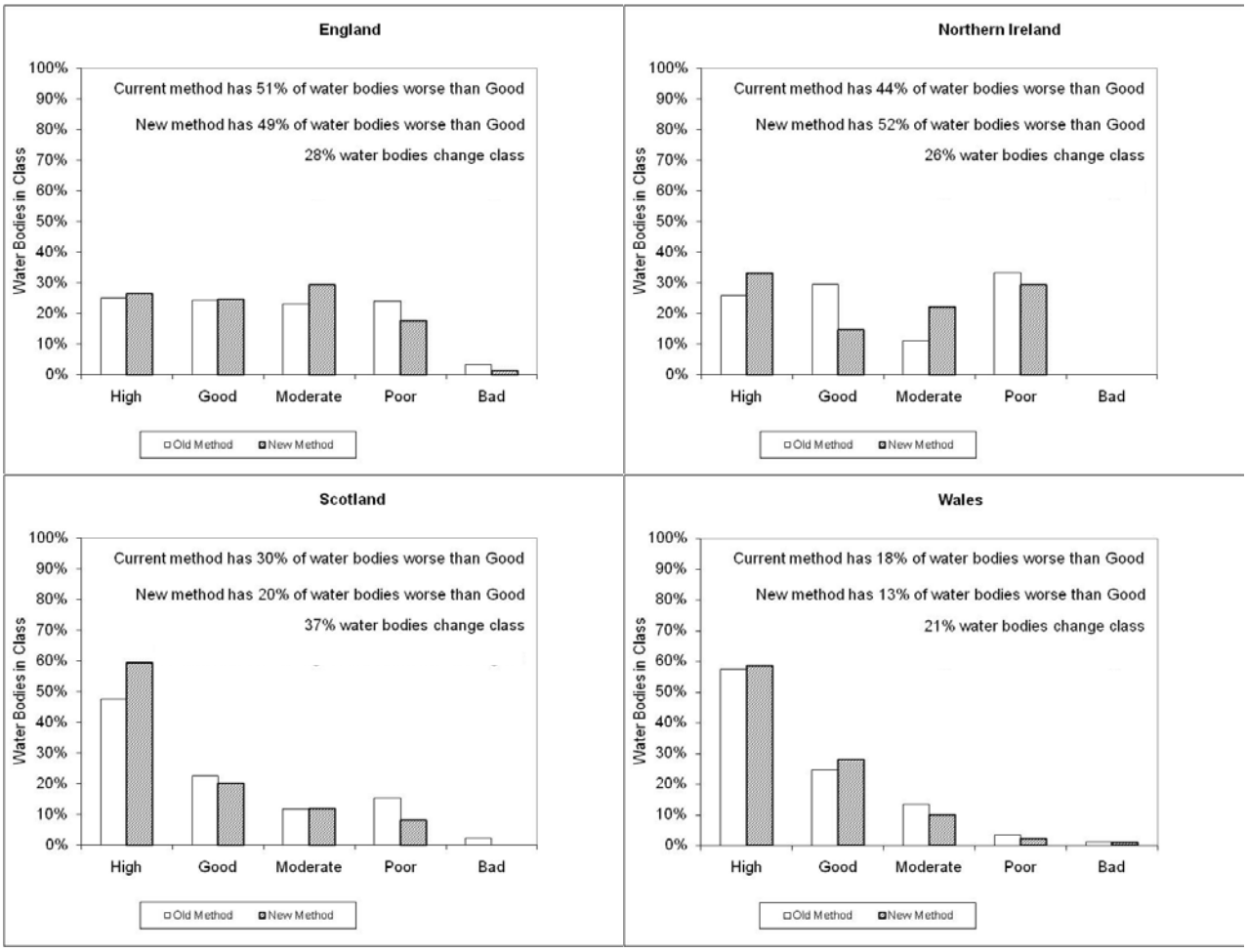

Figure 7: Summary of the implications expected from adopting the revised phytoplankton standards and associated assessment methods

Full technical details of the recommended revised method are provided in Annex 8.

4.2 Lakes: Macrophytes and phytobenthos

Macrophytes and phytobenthos encompass submerged and floating-leaved plants (e.g. water milfoil: *Myriophyllum spicatum*; water lily: *Nuphar lutea*), aquatic mosses (e.g. *Fontinalis antipyretica*) and algae (e.g. diatoms). Theses water plants are an important source of food and shelter for aquatic invertebrates and fish. Although many types of pollution can lead to alterations in the composition of macrophytes and phytobenthos, eutrophication is the most widespread problem in UK lakes. This has a number of consequences including unsightly growth of filamentous algae and, in some circumstances, night-time deoxygenation, leading to the death of fish. The Directive's descriptions of the condition of macrophytes and phytobenthos in lakes at high, good and moderate status are shown in Table 5.

Table 5: Description of high, good and moderate status for lake macrophytes and phytobenthos

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The taxonomic composition corresponds totally or nearly totally to undisturbed conditions. There are no detectable changes in the average macrophytic and the average phytobenthic abundance.	There are slight changes in the composition and abundance of macrophytic and phytobenthic taxa compared to the type-specific communities. Such changes do not indicate any accelerated growth of phytobenthos or higher forms of plant life resulting in undesirable disturbance to the balance of organisms present in the water body or to the physico-chemical quality of the water. The phytobenthic community is not adversely affected by bacterial tufts and coats present due to anthropogenic activity.	The composition of macrophytic and phytobenthic taxa differ moderately from the type-specific communities and are significantly more distorted than those observed at good quality. Moderate changes in the average macrophytic and the average phytobenthic abundance are evident. The phytobenthic community may be interfered with, and, in some areas, displaced by bacterial tufts and coats present as a result of anthropogenic activities.

Macrophytes

Lake macrophytes are plants which normally grow below the water surface or have floating leaves. Macrophytes are integral to the natural functioning of lakes, acting as both habitat and food source as well as stabilising sediments. The macrophyte species found in a lake depend on a number of environmental factors such as alkalinity, altitude and lake depth as well as the magnitude of pressures, such as eutrophication (nutrient enrichment). When nutrient concentrations increase, larger and more tolerant species flourish and filamentous algal cover is likely to increase. However when nutrient levels become very high phytoplankton will become dominant and even nutrient tolerant macrophytes will tend to disappear.

Due to Northern Ireland's naturally species-poor flora relative to the rest of the UK, the Northern Ireland Environment Agency uses a separate method to assess the status of water plants in Irish lakes. We are not recommending changes to our existing recommendations on this method[19].

We are recommending changes to the existing macrophyte method[20] for the rest of the UK:

(a) to reflect the outcome of European efforts to ensure that our standards for good status are comparable with those used by other countries across Europe; and

(b) because we found that it was not properly indicating the effects on macrophytes of nutrient enrichment in high alkalinity lakes.

The changes involve revising the indicator of nutrient enrichment used by the method (the lake nutrient macrophyte index); improving the model used to predict the values of the indicators under near natural conditions (reference conditions); and minor adjustments to the standards corresponding to the status class boundaries.

The implications of the revised method for the classification of macrophytes are summarised in Figure 8. Comparison of the macrophyte classification in lakes in England and Wales using combined data from 2009 to 2011 (180 water bodies) shows that the new method would place 71%

[19] http://www.wfduk.org/resources%20/lake-macrophytes-free-index
[20] http://www.wfduk.org/resources%20/lake-macrophytes-leafpacs

of sites at moderate status or worse for macrophytes compared with 52% using the existing method. The most significant change is for high alkalinity lakes.

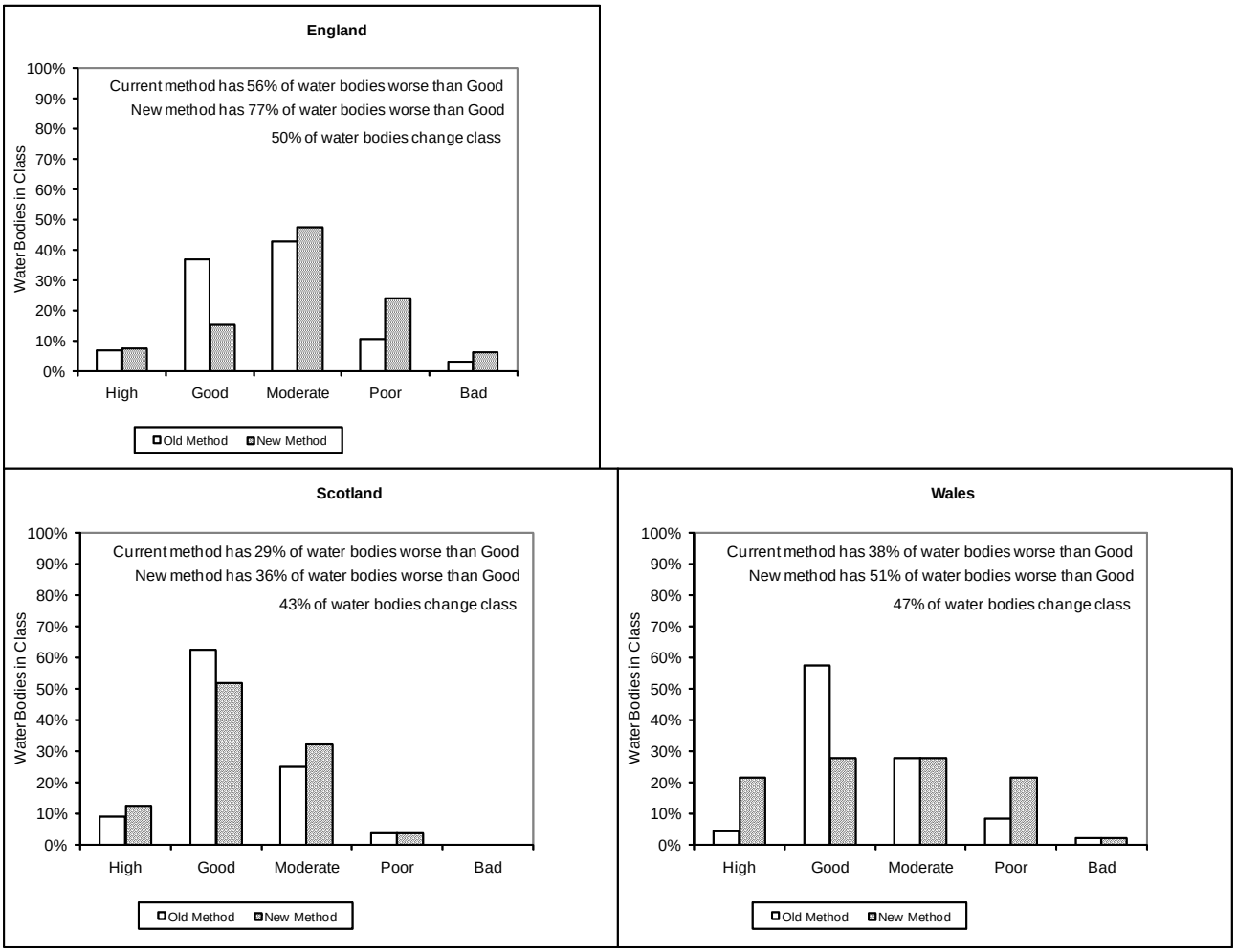

Figure 8: Summary of the implications expected from adopting the revised macrophyte standards and associated assessment methods

Full technical details of the recommended revised method are provided in Annex 9.

Phytobenthos

Phytobenthos encompasses a diverse community of phototrophic algae and cyanobacteria. These are an important source of food for aquatic invertebrates in the littoral zone of lakes. Our methods consider group of algae, the diatoms. These are found attached to submerged surfaces such as boulders, cobbles, stones and plant stems are used to indicate the condition of the phytobenthos more broadly. Diatoms and other algae are affected by nutrient enrichment and other forms of pollution.

We are recommending revisions to our previously recommended method[21] to:

(c) to reflect the outcome of European efforts to ensure that our standards for good status are comparable with those used by other countries across Europe; and

(d) take account of improved understanding of the impact of nutrient enrichment on

[21] http://www.wfduk.org/resources%20/lake-%E2%80%93-phytobenthos

phytobenthos.

The main changes to the existing method are revisions of the standards for the status class boundaries. These ensure that the standards for good status are comparable with those used by other countries across Europe. In addition, we have updated to the list of species or groups of species used to indicate impacts and improved the method for predicting the values for these indicators under near natural conditions (reference conditions).

The implications for the classification of phytobenthos of the revised method are summarised in Figure 9. Suitable data to apply the method is only available for a small numbers of lakes across the UK (143). The analysis indicates that the largest changes in classifications would be likely in Scotland whereas changes in England, Northern Ireland and Wales would be minimal.

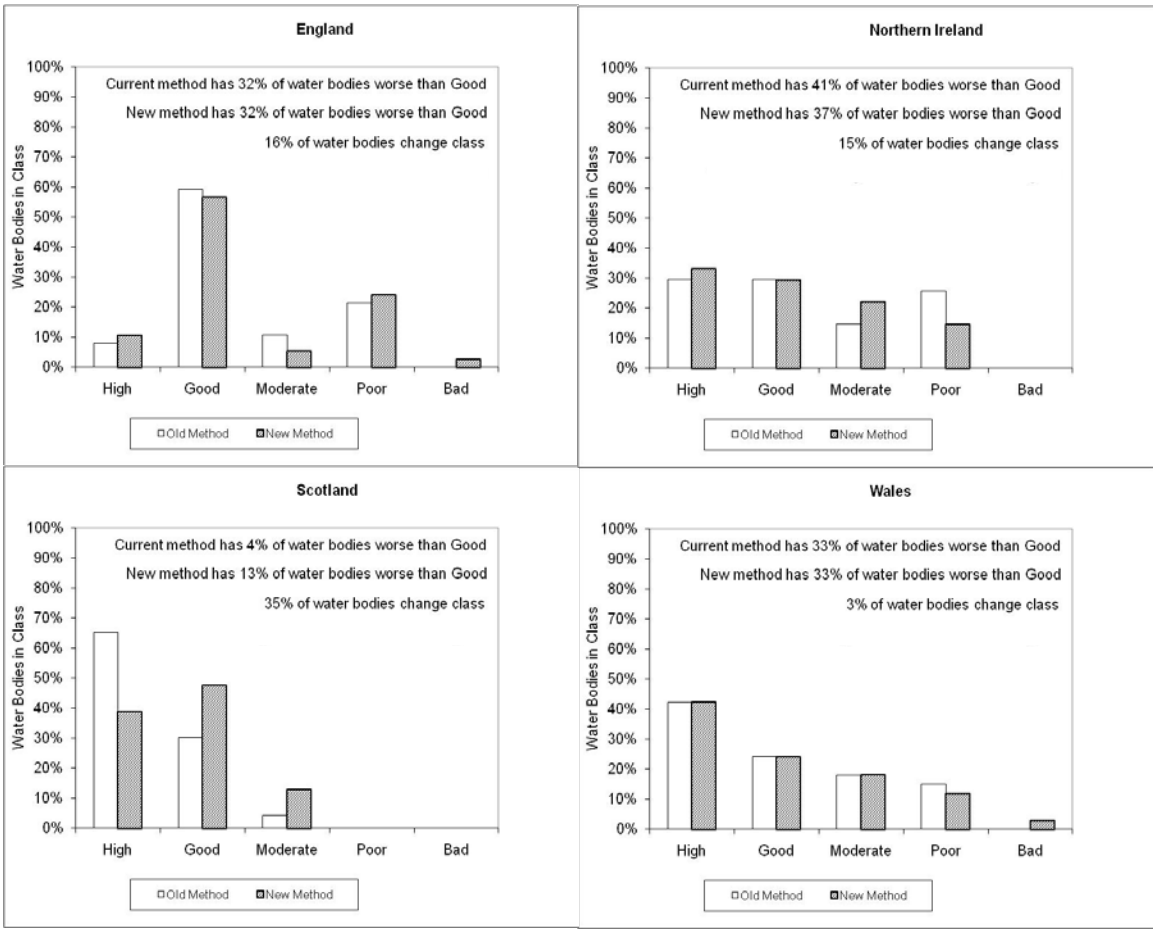

Figure 9: Summary of the implications expected from adopting the revised phytobenthos standards and associated assessment methods

Full technical details of the recommended revised method are provided in Annex 10.

Assessing the impact of nutrient enrichment on water plants

The macrophyte and phytobenthos assessment methods both respond to nutrient enrichment and so help identify where eutrophication is a problem. The implications of both revised methods for the classification of phytobenthos and macrophytes as a whole are summarised in Figure 10.

The proposed revised phytoplankton assessment method discussed above has also been designed to respond to the effects of nutrient enrichment. Taking results for this method into

account as well, our initial assessment is that the number of lakes classed as worse than good status for water plants would increase by around 1%.

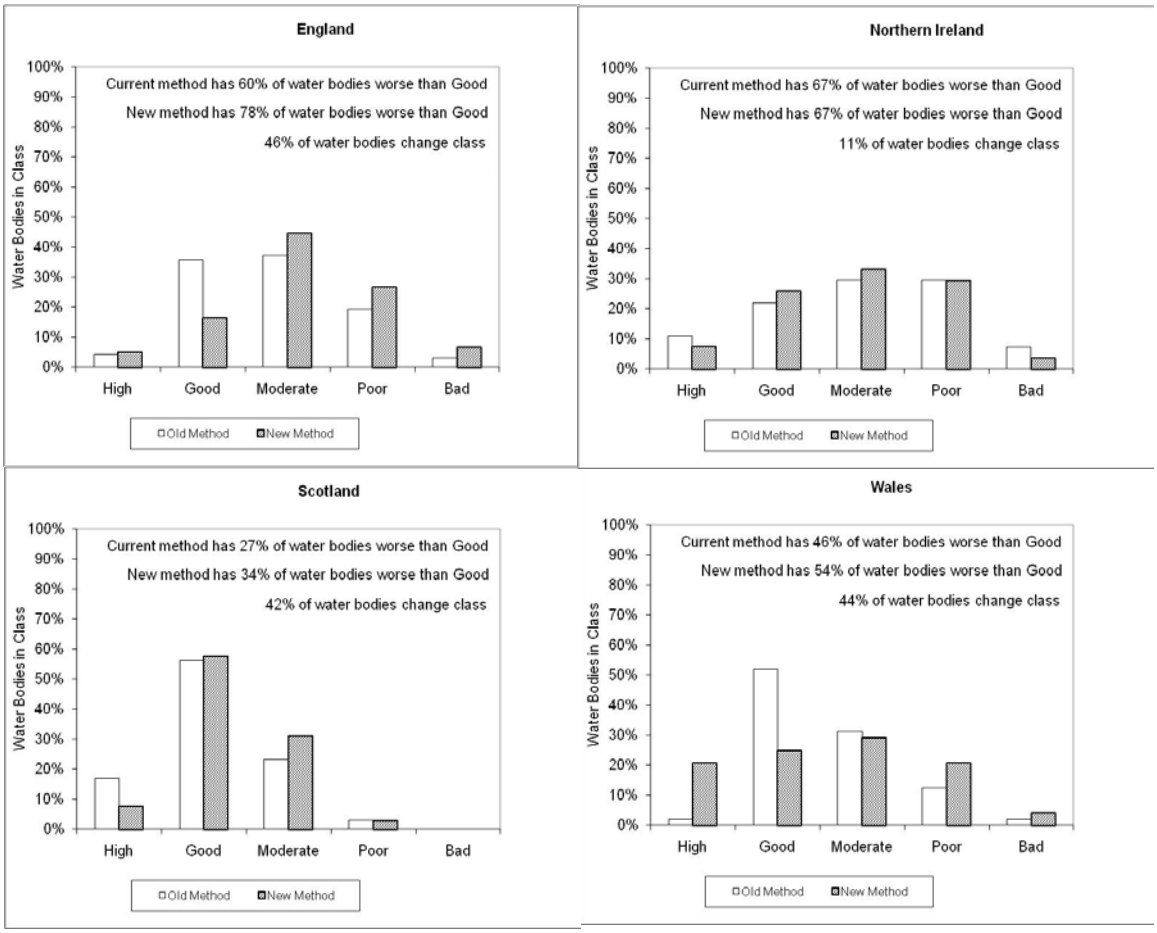

Figure 10: Summary of the implications expected from adopting the revised phytobenthos and macrophyte standards and associated assessment methods. For Northern Ireland, the assessment is based on the existing macrophytes assessment method.

Full technical details are provided in Annex 11.

4.3 Lakes: Invertebrates

Benthic invertebrates include insects, crustaceans, worms and other animals lacking backbones that live on submerged surfaces. These invertebrate communities play important roles in freshwater ecosystems, grazing on aquatic algae and plants, processing fallen leaves and other detritus and serving as a food source for fish and other animals. The Directive's descriptions of the condition of invertebrates in lakes at high, good and moderate status are shown in Table 6.

Table 6: Description of high, good and moderate status for lake invertebrates		
HIGH STATUS	GOOD STATUS	MODERATE STATUS
The taxonomic composition and abundance correspond totally or nearly totally to the undisturbed conditions. The ratio of disturbance sensitive	There are slight changes in the composition and abundance of invertebrate taxa compared to the type-specific communities. The ratio of disturbance-sensitive	The composition and abundance of invertebrate taxa differ moderately from the type-specific conditions. Major taxonomic groups of the

taxa to insensitive taxa shows no signs of alteration from undisturbed levels. The level of diversity of invertebrate taxa shows no sign of alteration from undisturbed levels.	taxa to insensitive taxa shows slight signs of alteration from type-specific levels. The level of diversity of invertebrate taxa shows slight signs of alteration from type-specific levels.	type-specific community are absent. The ratio of disturbance sensitive to insensitive taxa, and the level of diversity, are substantially lower than the type-specific level and significantly lower than for good status.

It is difficult to take representative samples of benthic invertebrates from lakes due the size, depth and complexity of the lake bed, plus the often inaccessible nature of the lake shores. For this reason, we recommended a method in 2008 that employs the high diversity of chironomidae (non-biting midge) larvae[22]. Members of this group of invertebrates shed their pupal exuviae (the cases within which the larvae metamorphose into flying adults). These exuviae float on the surface and collect on leeward lake shores where they can be sampled and the different species or groups of species present identified with a high degree of accuracy.

Different species and groups of species of the non-biting midges respond differently to nutrient enrichment. By assessing the composition of the taxa present, the method indicates whether invertebrates are impacted as a secondary effect of nutrient enrichment. This complements assessments of the effects of nutrient enrichment on primary production made using the phytoplankton, phytobenthos and macrophyte methods outlined above.

We are proposing minor changes to the method. These were identified as necessary during work to ensure the standards corresponding to the boundaries for good status are comparable with those of other countries across Europe.

The changes principally involved minor alterations to the scoring system (i.e. the weighting given to different taxa based on sensitivity to nutrient enrichment). They do not have any noticeable affect on classification.

Full technical details of the recommended revised method are provided in Annex 12.

In 2008, we also recommended a separate method for assessing the impact of acidification on lake invertebrates. We are not proposing any changes to this method. The standards for good status applicable to this method have been checked for comparability with those of other counties across Europe as part of the Europe-wide intercalibration exercise.

4.4 Lakes: Fish

Fish are an ecologically and often economically important component of lake ecosystems. Lake fish communities across the UK vary considerably. Scientific understanding of the natural composition and abundance of fish in lakes is incomplete and sampling of fish in lakes can be difficult. For these reasons, it has not yet been possible to develop methods for assessing fish status in lakes in England, Scotland and Wales. However, we are now able to recommend a method for assessing fish status in lakes in Northern Ireland. The method has been designed to

[22] http://www.wfduk.org/resources%20/lake-cpet

detect the impact of eutrophication and non-native invasive species on fish status but may also detect the effects of other pressures. The Directive's descriptions of the condition of fish in lakes at high, good and moderate status are shown in Table 7.

Table 7: Description of high, good and moderate status for lake fish

HIGH STATUS	GOOD STATUS	MODERATE STATUS
Species composition and abundance correspond totally or nearly totally to undisturbed conditions. All the type-specific sensitive species are present. The age structures of the fish communities show little sign of anthropogenic disturbance and are not indicative of a failure in the reproduction or development of a particular species.	There are slight changes in species composition and abundance from the type-specific communities attributable to anthropogenic impacts on physico-chemical or hydromorphological quality elements. The age structures of the fish communities show signs of disturbance attributable to anthropogenic impacts on physico-chemical or hydromorphological quality elements, and, in a few instances, are indicative of a failure in the reproduction or development of a particular species, to the extent that some age classes may be missing.	The composition and abundance of fish species differ moderately from the type-specific communities attributable to anthropogenic impacts on physico-chemical or hydromorphological quality elements. The age structure of the fish communities shows major signs of disturbance, attributable to anthropogenic impacts on physico-chemical or hydromorphological quality elements, to the extent that a moderate proportion of the type specific species are absent or of very low abundance.

The proposed method has built on a method originally developed in 2005 through a joint project with the Republic of Ireland[23]. The original method has been used widely in the Republic of Ireland but mainly in cross-border lakes in Northern Ireland.

The earlier method has been revised and improved and its standards for good status have been compared and aligned with those of other countries across Europe. The method assesses status using two independent modules. The first estimates fish status using simple, rules based on qualitative information. The second quantitative approach is based on a general linear model relating fish status to the magnitude of pressures on the lakes, such as nutrient enrichment.

We recommend that the results of assessments for each of the components of the method together with information on nutrient concentrations and the status of water plants are taken into account in decision-making.

The method has been tested on 4 lakes in Northern Ireland. It classifies the Upper Lough Macnean and Lough Melvin as good status for fish and the Upper Lough Erne and the Lower Lough Macnean as poor status for fish.

In the two poor status lakes, there is a high biomass of species that feed on zooplankton, such as the non-native species, roach and a low biomass of species, such as trout.

Technical details of the recommended revised method are provided in Annex 13.

[23] North South Shared Aquatic Resource – an Interreg sponsored project that ran from 2004-2008

4.5 Lakes: Ecological indicators of hydromorphological alterations

As in the case of rivers, the biological assessment methods we have recommended to date, including most of those described earlier in this Chapter, have principally been designed to assess the effects of activities that alter water quality. They have not been specifically designed to assess the ecological effects of modifications to lake water levels or morphological characteristics. This picture is similar in most other Member States.

As a first step towards filling this gap, we have developed a series of ecological indicators that can be used to help identify where hydromorphological alterations are causing major or severe ecological damage. This work has been undertaken alongside the parallel work for rivers already described in Section 3.4 and the recommended approach and implications outlined for rivers are the same for lakes.

Technical details are provided in Annex 7.

SUMMARY FOR COASTAL WATERS

5.1 Coastal waters: Phytoplankton

Phytoplankton are microscopic plants that float passively in coastal currents although they often have some ability to change the depth at which they are suspended. Species are short lived and utilise the nutrients in the water and the suns energy to grow and reproduce forming the basic food source in the world's oceans. The Directive's descriptions of the condition of phytoplankton in coastal waters at high, good and moderate status are shown in Table 8.

Table 8: Description of high, good and moderate status for coastal water phytoplankton

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The composition and abundance of phytoplanktonic taxa are consistent with undisturbed conditions. The average phytoplankton biomass is consistent with the type-specific physico-chemical conditions and is not such as to significantly alter the type-specific transparency conditions. Planktonic blooms occur at a frequency and intensity which is consistent with the type specific physico-chemical conditions.	The composition and abundance of phytoplanktonic taxa show slight signs of disturbance. There are slight changes in biomass compared to type-specific conditions. Such changes do not indicate any accelerated growth of algae resulting in undesirable disturbance to the balance of organisms present in the water body or to the quality of the water. A slight increase in the frequency and intensity of the type-specific planktonic blooms may occur.	The composition and abundance of planktonic taxa show signs of moderate disturbance. Algal biomass is substantially outside the range associated with type-specific conditions, and is such as to impact upon other biological quality elements. A moderate increase in the frequency and intensity of planktonic blooms may occur. Persistent blooms may occur during summer months.

We first made recommendations on a method for assessing the status of phytoplankton in coastal waters in 2008[24]. The method is designed to assess the effect on phytoplankton of nutrient enrichment. In waters with near natural nutrient concentrations, a high diversity of phytoplankton species with a high growth rate would be expected in the spring and autumn periods. A natural depression of their numbers during the summer would normally occur, typically caused by grazing of animals and the depletion of available nutrients. In situations where nutrients are not limiting, the rapid growth of opportunistic fast growing species changes the population balance with diatoms being replaced by dinoflagellates and this may lead to high overall biomass throughout the growing season. The method considers a number of indicators of phytoplankton status:

(a) Phytoplankton biomass as indicated by the concentration of chlorophyll a;
(b) elevated cell counts of algal species; and
(c) the seasonal succession of groups of species with different ecosystem functions (diatoms, dinoflagellates).

The observed (measured) values for each of the above indicators are compared to those expected under near undisturbed (reference) conditions. The reference conditions were derived using historical records, expert judgement and data from sites at high and low risk of eutrophication.

Our recommended improvements to the method include:
(a) modifying the elevated cell count indicator by removing consideration of blooms of *Phaeocystis.* Such blooms have only rarely been observed in the UK.
(b) changes in thresholds for some of the indicators to better reflect geographical differences in phytoplankton communities; and
(c) updating and better focusing of the taxa list used in assessing elevated cell counts.

We are not expecting these changes to have more than a minor affect on phytoplankton status classifications compared with classifications made using the existing method.

Full technical details of the recommended revised method are provided in Annex 14.

5.2 Coastal waters: Macroalgae and angiosperms

Macroalgae are more generally known as seaweeds. They are common in the intertidal zone, especially attached to rocky substrates and are easy to see with the naked eye. Under particular conditions, some may grow on sedimentary shores.

Angiosperms include seagrasses and the flowering plants of salt marshes. In the UK, the seagrasses are a small group of 5 species of marine flowering plants. They grow on sedimentary shores both in the intertidal and subtidally, where there is sufficient light. All of the seagrasses are nationally scarce and disturbance sensitive. The ideal conditions needed for seagrasses to flourish are not entirely understood and the absence of seagrasses from an area may be natural.

Salt marshes are complex communities of flowering plants and algae formed in low lying sedimentary land at the top of the shore and subject to regular or occasional inundation by the sea.

[24] http://www.wfduk.org/resources%20/coastal-%E2%80%93-phytoplankton

The Directive's descriptions of the condition of macroalgae and angiosperms in coastal waters at high, good and moderate status are shown in Table 9.

Table 9: Description of high, good and moderate status for coastal water macroalgae and angiosperms

HIGH STATUS	GOOD STATUS	MODERATE STATUS
All disturbance-sensitive macroalgal and angiosperm taxa associated with undisturbed conditions are present. The levels of macroalgal cover and angiosperm abundance are consistent with undisturbed conditions.	Most disturbance-sensitive macroalgal and angiosperm taxa associated with undisturbed conditions are present. The level of macroalgal cover and angiosperm abundance show slight signs of disturbance.	A moderate number of the disturbance-sensitive macroalgal and angiosperm taxa associated with undisturbed conditions are absent. Macroalgal cover and angiosperm abundance is moderately disturbed and may be such as to result in an undesirable disturbance to the balance of organisms present in the water body.

We first made recommendations on methods for assessing the impact of nutrient enrichment on the status of seaweeds in coastal waters in 2008. These included the method[25] discussed in this section, which is based on opportunistic species of seaweed found on soft, sedimentary, intertidal shores. The second method[26] is based on seaweed found on rocky shores and is designed to detect the impact of a wide range of pressures in addition to nutrient enrichment. We are not proposing any changes to the rocky shore method. However, we have re-drafted the technical description of the method with the aim of making it easier to understand how the method is applied in practice. We would be interested in your views on this new format. A copy can be found in Annex 22.

Macroalgae - opportunistic species assessment

Some seaweeds, particularly a few intertidal green seaweeds, grow very rapidly when nutrient levels are high. Other seaweeds can be out-competed and invertebrate animals in the underlying sediment may become smothered. Assessments based on such seaweeds can be used to detect the effects of nutrient enrichment. Our previously recommended method considers:

(a) the areal extent of algal mats (areas within which algal cover > 5%);
(b) the proportion of the available intertidal habitat covered by mats;
(c) the biomass of algae in algal mats;
(d) the biomass of algae over the available intertidal habitat (i.e. the habitat suitable for algal growth); and
(e) the proportion of algae growing 3 cm or more into (i.e. entrained in) the underlying sediment.

The observed (measured) values for each of the above indicators are compared to those expected under near undisturbed (reference) conditions. The reference conditions were derived using historical information contained in the scientific literature and expert judgement.

[25] http://www.wfduk.org/resources%20/transitional-and-coastal-opportunistic
[26] http://www.wfduk.org/resources%20/coastal-%E2%80%93-macroalgae

Our recommended improvements to the method include the option to take account of the worse of the alteration to the areal extent of algal mats or to the proportion of available intertidal habitat covered by algal mats. Experience of applying the existing method has shown that the impact of nutrient enrichment on some water bodies with extensive mats of opportunistic seaweed could be estimated incorrectly using the existing approach. Only minor changes in classification results compared with those of the existing method are expected.

Full technical details of the recommended revised method are provided in Annex 15.

Seagrasses

Seagrasses are particularly disturbance-sensitive and can be adversely affected by nutrient enrichment and by physical disturbances, including boat moorings. We published a draft method for assessing the condition of seagrasses in 2009[27]. The method has been applied in England and Wales, although there were insufficient data to produce classifications of seagrass status in the river basin management plans published in 2009. The method was not applied in Scotland and Northern Ireland. The method is applied in intertidal areas and considers:

(a) the number of seagrass species;
(b) the density of seagrass shoots; and
(c) the areal extent of the seagrass bed.

Where the waters are under stress, seagrass species diversity drops; shoot density decreases; the areal extent of seagrass beds may reduce; and opportunistic seaweeds are likely to become established where the seagrasses have declined.

We have reviewed the draft method and consider it suitable for use across the UK without any substantive revisions, including in Northern Ireland and Scotland. We do not yet have the data necessary to indicate the status of seagrasses in Northern Ireland and Scotland. This will only be possible once the environment agencies have collected the necessary monitoring data. However, the effects of nutrient enrichment are also taken into account in the existing classifications of opportunistic macroalgae and phytoplankton. In Scotland, at least some of the morphological alterations that might affect seagrasses are already directly reflected in classification results.

Full technical details of the recommended revised method are provided in Annex 16.

Salt marshes

The status of salt marshes can be affected by alterations to the extent or frequency of inundation of the land by the sea. We began development of a method for assessing the status of salt marshes in 2005. We subsequently obtained the data necessary to test and refine the approach and are now in a position to recommend an assessment method for salt marshes in England and Wales. The method considers:

- the areal extent of salt marsh as a whole;
- the areal extent of each of the different natural salt marsh vegetation communities that are associated with different frequencies and durations of inundation; and
- the species or groups of species of salt marsh plants present.

[27] http://www.wfduk.org/resources%20/transitional-and-coastal-angiosperms

We recommend using aerial imagery to help obtain the data needed to apply the method. The observed (measured) values for each of the above indicators are compared to those expected under near undisturbed (reference) conditions. The reference conditions are derived using historical information, including Ordnance Survey maps dating from 1860 and estimates based on up-to-date surveys of the area of land likely to be salt marsh in the absence of existing engineering structures.

In response to pressures, the diversity of plant species in salt marshes can reduce, different salt marsh vegetation zones may start to shrink or expand and the areal extent of salt marsh as a whole may reduce.

We expect that the status of salt marsh will be worse than good in a significant proportion of water bodies. This cannot be quantified until the agencies have collected sufficient monitoring data. So far testing in England and Wales has shown a strong correlation between water bodies designated as heavily modified and those assessed as worse than good status for salt marshes using our proposed method.

Salt marshes vary in the species and groups of species present. Factoring in these differences is necessary before the method can be used to produce reliable classifications in Scotland and Northern Ireland. We will make recommendations on how this should be done in due course.

Full technical details of the recommended revised method are provided in Annex 17.

5.3 Coastal waters: Benthic invertebrates

Assessments of the condition of benthic invertebrates provide a good indication of the status of coastal water ecosystems. Benthic invertebrates are largely sedentary and relatively long lived so respond to the integrated effect of pressures over time. The Directive's descriptions of the condition of invertebrates in coastal waters at high, good and moderate status are shown in Table 10.

Table 10: Description of high, good and moderate status for coastal water invertebrates

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The level of diversity and abundance of invertebrate taxa is within the range normally associated with undisturbed conditions. All the disturbance sensitive taxa associated with undisturbed conditions are present.	The level of diversity and abundance of invertebrate taxa is slightly outside the range associated with the type-specific conditions. Most of the sensitive taxa of the type-specific communities are present	The level of diversity and abundance of invertebrate taxa is moderately outside the range associated with the type-specific conditions. Taxa indicative of pollution are present. Many of the sensitive taxa of the type-specific communities are absent

We first made recommendations in 2008 on a method[28] for assessing the impact of a range of pressures on the status of invertebrates in coastal waters, including inputs of organic wastes (e.g.

[28] http://www.wfduk.org/resources%20/coastal-benthic-invertebrate-fauna

in sewage), toxic pollution and smothering of habitats with sediments. At the same time we also recommended a method specifically for use in assessing the impact of tributyl tin (TBT), which is found in some antifouling paints[29]. This section describes changes we are recommending to the first of these methods, the principal method used to assess the status of invertebrates in coastal waters.

We are not proposing any changes to our method for assessing the impact of TBT. However, we have re-drafted the method with the aim of making it easier to understand how to apply the method in practice. We would be interested in your views on this new format. A copy can be found in Annex 23.

The principal method for assessing the status of invertebrates considers three indicators of the health of invertebrate assemblages[30]:

(a) the number of different taxa present;
(b) the sensitivity of various taxa to pressures; and
(c) whether the water body is dominated by a few taxa or the relative proportions of different taxa are more evenly balanced.

Where a few taxa dominate, this indicates that the invertebrate community has been disturbed.

The method compares the observed (measured) values for each of the indicators with those expected under near undisturbed (reference) conditions. The reference conditions are derived for each monitored habitat using historical records, expert judgement and models.

For the existing method, we were only able to identify reference conditions for a very limited number of the many different habitat types found in coastal waters, specifically sand/mud sub tidal areas. Our recommended updated method includes reference conditions for a wider range of habitats. This will expand the number of sites within water bodies at which the method can be used so enabling the environment agencies to ensure monitoring results are representative of the impact of pressures on water bodies. To take account of developments in scientific knowledge, we have also made minor alterations to the weightings given to different taxa to reflect their relative sensitivity to pressures.

We do not expect either of the above changes to affect the results obtained for sites previously assessed using the existing method. The main implication stems from the ability to apply the method to a wider range of habitats. This may identify significant ecological impacts on the status of invertebrates that are not represented in assessments of the limited number of habitats that can be assessed using the existing method. The classifications of other quality elements (such as water quality) are already likely to account for these impacts, at least in part.

Full technical details of the recommended revised method are provided in Annex 18.

[29] http://www.wfduk.org/resources%20/coastal-benthic-invertebrate-fauna-dog-whelks
[30] Invertebrates are identified from a standard taxonomic list, the World Register of Marine Species.

5. SUMMARY FOR ESTUARIES

6.1 Estuaries - phytoplankton

Phytoplankton are microscopic plants that drift passively within estuaries and the adjacent coastal waters, although they often have some ability to change the depth at which they are suspended. Phytoplankton species are short lived and utilise the nutrients in the water and the suns energy to grow and reproduce.

The Directive's descriptions of the condition of phytoplankton in estuaries at high, good and moderate status are shown in Table 11.

Table 11: Description of high, good and moderate status for phytoplankton in estuaries

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The composition and abundance of the phytoplanktonic taxa are consistent with undisturbed conditions. The average phytoplankton biomass is consistent with the type-specific physico-chemical conditions and is not such as to significantly alter the type-specific transparency conditions. Planktonic blooms occur at a frequency and intensity which is consistent with the type specific physico-chemical conditions	There are slight changes in the composition and abundance of phytoplanktonic taxa. There are slight changes in biomass compared to the type-specific conditions. Such changes do not indicate any accelerated growth of algae resulting in undesirable disturbance to the balance of organisms present in the water body or to the physico-chemical quality of the water. A slight increase in the frequency and intensity of the type specific planktonic blooms may occur.	The composition and abundance of phytoplanktonic taxa differ moderately from type-specific conditions. Biomass is moderately disturbed and may be such as to produce a significant undesirable disturbance in the condition of other biological quality elements. A moderate increase in the frequency and intensity of planktonic blooms may occur. Persistent blooms may occur during summer months.

The species composition and biomass of phytoplankton is affected by elevated nutrient concentrations in the water column. As a result, assessments of the status of phytoplankton have the potential to indicate whether or not estuarine ecosystems are subject to eutrophication. However, estuaries are highly dynamic environments. This makes the identification of reliable reference conditions against which to compare the observed condition of phytoplankton particularly challenging. For this reason, we were not able to develop a method for use in assessing the status of phytoplankton in estuaries prior to the publication of the first river basin management plans in 2009.

The method we are proposing now considers:

(a) the biomass of phytoplankton (as indicated by chlorophyll a concentrations) in both the inner part of the estuary and the outer part as defined in terms of salinities; and
(b) the number of cells of different phytoplankton species or groups of species.

The method will fill an important gap in the ability of the environment agencies to assess the ecological impact of nutrient enrichment on estuarine ecosystems. This is in part because the parallel method for assessing the impact of nutrient enrichment on macroalgae in estuaries (See

Section 6.2) cannot be applied in all estuaries. This is because not all estuaries have the habitats that are needed by the opportunistic macroalgae considered by that method.

We expect that the new method will show the status of phytoplankton to be worse than good in a significant proportion of estuaries. This is because a significant proportion of estuaries have elevated nutrient levels. We cannot yet quantify how many estuaries will be classified as worse than good status for phytoplankton until the agencies have collected sufficient monitoring data. However, we expect that in many of the estuaries, the impact of nutrients is already likely to be accounted for, at least in part, by existing water quality classifications and, where applicable, classifications of macroalgae.

Full technical details of the recommended revised method are provided in Annex 19.

6.2 Estuaries - macroalgae

Macroalgae are more generally known as seaweeds. They are common in the intertidal zone, especially attached to rocky substrates and are easy to see with the naked eye. Under particular conditions, some may grow on sedimentary shores.

The Directive's descriptions of the condition of macroalgae in estuaries at high, good and moderate status are shown in Table 12.

Table 12: Description of high, good and moderate status for macroalgae in estuaries

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The composition of macroalgal taxa is consistent with undisturbed conditions. There are no detectable changes in macroalgal cover due to anthropogenic activities.	There are slight changes in the composition and abundance of macroalgal taxa compared to the type-specific communities. Such changes do not indicate any accelerated growth of phytobenthos or higher forms of plant life resulting in undesirable disturbance to the balance of organisms present in the water body or to the physico-chemical quality of the water.	The composition of macroalgal taxa differs moderately from type-specific conditions and is significantly more distorted than at good quality. Moderate changes in the average macroalgal abundance are evident and may be such as to result in an undesirable disturbance to the balance of organisms present in the water body.

We first made recommendations on methods for assessing the status of seaweed in estuaries in 2008. These included a method for assessing the impact of nutrient enrichment on the status of seaweed[31] that looks at opportunistic seaweeds and a separate method designed primarily to assess the impact on the status of seaweed of toxic pollutants[32]. This looks at the extent of colonisation of estuaries by fucoid seaweed species.

Macroalgae - opportunistic species assessment

Some seaweed species, particularly a few intertidal green seaweeds, grow very rapidly when nutrient levels are high. Other seaweeds can be out-competed and invertebrate animals in the underlying sediments can become smothered.

[31] http://www.wfduk.org/resources%20/transitional-and-coastal-opportunistic
[32] http://www.wfduk.org/resources%20/transitional-macroalgae-extent

Our previously recommended method and our proposed revised method for assessing the impact of nutrient enrichment on seaweeds in estuaries are the same as those applicable to coastal waters. The existing method and proposed updates are summarised in Section 5.2.

Only minor changes in classification results are expected under the revised method compared with those produced by the existing method.

Full technical details of the recommended revised method are provided in Annex 15.

Macroalgae - Fucoid Extent

Fucoid seaweeds are commonly known as the wracks and include species such as bladderwrack. They are amongst the most common brown seaweeds and are widely distributed in coastal waters, estuaries and brackish lagoons. Our existing method is designed to detect the impact of toxic pollutants. In unpolluted conditions, wracks can occur almost to the freshwater limit of estuaries. However, pollution can limit how far up an estuary wracks extend.

The assessment method can be used in estuaries with substrates suitable for the growth of wracks and where turbidity is sufficiently low to allow colonisation. The existing method considers:

(a) the extent of upstream limit of colonisation by three fucoid species (horned wrack, spiral wrack and bladderwrack); and
(b) where the fucoid species are absent, whether or not non-fucoid species are present.

The extent of upstream penetration is currently defined in terms of the mean annual salinity at the most upstream site at which wracks are found. However, we are recommending that this measure of upstream penetration used is changed to the median annual salinity. There is a stronger relationship between upstream penetration into an estuary of wracks and median salinity than there is for mean salinity. This is likely to be because the mean is skewed by extremes that do not have a significant effect on the seaweeds.

It has not yet been possible to quantify the effect of the proposed revision to the method on seaweed status classifications compared with classifications made using the existing method. This is primarily due to the relatively limited use of the existing method to date. However, whilst helping improve on the existing method's ecological robustness, the proposed changes are fairly minor nature. The toxic pollution to which the method is expected to respond may also be accounted for, at least in part, in existing water quality classifications.

Full technical details of the recommended revised method are provided in Annex 20.

6.3 Estuaries - angiosperms

Angiosperms include seagrasses and the flowering plants of salt marshes. In the UK, the seagrasses are a small group of 5 species of marine flowering plants. They grow on sedimentary shores both in the intertidal and subtidally, where there is sufficient light. All of the seagrasses are nationally scarce and disturbance sensitive. The ideal conditions needed for seagrasses to flourish are not entirely understood and the absence of seagrasses from an area may be natural.

Salt marshes are complex communities of flowering plants and algae formed in low lying sedimentary land at the top of the shore and subject to regular or occasional inundation by the sea.

The Directive's descriptions of the condition of angiosperms in estuaries at high, good and moderate status are shown in Table 13.

Table 13: Description of high, good and moderate status for angiosperms in estuaries

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The taxonomic composition corresponds totally or nearly totally to undisturbed conditions. There are no detectable changes in angiosperm abundance due to anthropogenic activities.	There are slight changes in the composition of angiosperm taxa compared to the type-specific communities. Angiosperm abundance shows slight signs of disturbance.	The composition of the angiosperm taxa differs moderately from the type-specific communities and is significantly more distorted than at good quality. There are moderate distortions in the abundance of angiosperm taxa.

Seagrasses

As for coastal waters, we published a draft method for assessing the condition of seagrasses in 2009[33]. The method has been applied in England and Wales, although there were insufficient data to produce classifications of seagrass status in the river basin management plans published in 2009. The method was not applied in Scotland. In Northern Ireland, there are no estuarine seagrass beds.

We are now in a position to recommend the use of the existing method for assessing the status of seagrasses in Scottish estuaries as well as those in England and Wales. The method we are recommending for assessing the status of seagrass in estuaries in Scotland is the same as the method we are recommending for assessing the status of seagrasses in coastal waters (see Section 5.2).

We do not yet have the data necessary to indicate the status of seagrasses in Scotland as classified using the recommended method. This will only be possible once SEPA has collected the necessary monitoring data. The impacts of the pressures to which the seagrasses are particularly responsive (i.e. nutrient enrichment and morphological alterations) are already likely to be reflected to a significant extent in existing classifications of opportunistic macroalgae, phytoplankton and morphological conditions.

Full technical details of the recommended revised method are provided in Annex 16.

Salt marsh

The status of salt marshes can be affected by alterations to the extent or frequency of inundation of the land by the sea. Our recommended method for assessing the status of salt marshes in estuaries is the same as the method we are proposed for assessing salt marshes in coastal waters (See Section 5.2). Salt marshes vary in the species and groups of species present. Our recommended method is suitable for use in assessing estuarine salt marshes in England, Wales

[33] http://www.wfduk.org/resources%20/transitional-and-coastal-angiosperms

and Northern Ireland. There is still work to do to take account of the different salt marshes in Scotland before we can make recommendations on a method applicable to estuaries in Scotland.

We expect that the method will show that the status of salt marshes in estuaries in England and Wales will be worse than good in a significant proportion of water bodies. We cannot quantify the number of water bodies until the agencies have collected sufficient monitoring data. However, initial testing in England and Wales has shown a strong correlation between water bodies designated as heavily modified and those whose salt marshes have been assessed as worse than good status using our proposed method.

Full technical details of the recommended revised method are provided in Annex 17.

6.4 Estuaries - benthic invertebrates

Assessments of the condition of benthic invertebrates in estuaries have the potential to provide a good indication of the status of estuarine ecosystems. However, the challenge in estuaries is to define reliable reference conditions against which to compare measured characteristics of the invertebrate communities present. Estuaries are highly dynamic environments with environmental conditions, such as salinity, changing not only spatially but also with the tidal cycle and river flow.

The Directive's descriptions of the condition of invertebrates in estuaries at high, good and moderate status are shown in Table 14.

Table 14: Description of high, good and moderate status for estuarine invertebrates

HIGH STATUS	GOOD STATUS	MODERATE STATUS
The level of diversity and abundance of invertebrate taxa is within the range normally associated with undisturbed conditions. All the disturbance-sensitive taxa associated with undisturbed conditions are present.	The level of diversity and abundance of invertebrate taxa is slightly outside the range associated with the type-specific conditions. Most of the sensitive taxa of the type-specific communities are present.	The level of diversity and abundance of invertebrate taxa is moderately outside the range associated with the type-specific conditions. Taxa indicative of pollution are present. Many of the sensitive taxa of the type-specific communities are absent.

The method we are recommending for assessing the status of invertebrates in estuaries is the same as the method we are recommending for assessing the status of invertebrates in coastal waters (See section 5.3) and builds on the method we recommended for assessing the status of invertebrates in coastal waters in 2008[34].

The method considers three indicators of the health of invertebrate assemblages: the number of different taxa present; the sensitivity of various taxa to pressures; and whether the water body is dominated by a few taxa or the relative proportions of different taxa are more evenly balanced.

[34] http://www.wfduk.org/resources%20/coastal-benthic-invertebrate-fauna

Where a few taxa dominate, this indicates that the invertebrate community has been disturbed. The method detects the effect of enrichment with organic matter (e.g. sewage), toxic pollution and smothering of habitats with sediments. It may also detect the effect of other pressures.

Reliable reference conditions are more difficult to identify for estuaries because of the high level of natural variability in environmental conditions within estuaries, especially in salinity. To address this, we have improved the models used to estimate reference conditions and the range of different habitat types to which they can be applied. As a consequence, we are now in a position to recommend a method that can be used to assess the status of invertebrates in any estuary.

We expect that the status of invertebrates will be worse than good in a significant proportion of estuaries. This cannot be quantified until the agencies have collected sufficient monitoring data. However, the impact of the principal pressures to which the method responds (i.e. pollution by organic matter or toxic pollutants) is expected to be accounted for, at least in part, by existing water quality classifications. Other impacts, such as from smothering with sediments disturbed by dredging, may also correlate with designations of water bodies as heavily modified or with other indications of hydromorphological alterations already accounted for in classifications.

Full technical details of the recommended new method are provided in Annex 18.

6.4 Estuaries - fish

Estuarine fish communities are good indicators of a range of human pressures and the majority of fish species can be readily caught for assessment purposes. They include a range of migratory species and permanent residents. Being close to the top of the food chain, fish can be adversely impacted by pollutants that have accumulated in their food and by pressures that affect the plants and animals that serve as those food sources.

The Directive's descriptions of the condition of fish in estuaries at high, good and moderate status are shown in Table 15.

Table 15: Description of high, good and moderate status for estuarine fish

HIGH STATUS	GOOD STATUS	MODERATE STATUS
Species composition and abundance is consistent with undisturbed conditions.	The abundance of the disturbance-sensitive species shows slight signs of distortion from type-specific conditions attributable to anthropogenic impacts on physico-chemical or hydromorphological quality elements.	A moderate proportion of the type-specific disturbance-sensitive species are absent as a result of anthropogenic impacts on physicochemical or hydromorphological quality elements.

We first made recommendations on an assessment method for estuarine fish in 2009[35]. To build up as comprehensive a picture as possible of the status of fish, the method considers a wide range of fish community characteristics, including

(a) the species that are present, including whether they are resident species or migratory species;
(b) the relative abundance of the species;

[35] http://www.wfduk.org/resources%20/transitional-fish

(c) the feeding characteristics of the species or groups of species (e.g. whether they feed on other fish, benthic invertebrates, zooplankton, etc.)

The observed (measured) values for the method's different indicators of fish status are compared to the values for those indicators expected under near undisturbed conditions. Our proposed revisions to the method have focused on improving estimations of these reference conditions and on extending information on reference conditions to allow the method to be used in a wider range of estuary types.

We have also revised the standards for high status and good status for application in Northern Ireland to ensure comparability with the standards used by other countries across Europe. For the estuaries in the rest of the UK, we have not yet been able to make ecologically-relevant comparisons with the methods used by other countries.

We are not expecting our proposed changes to have more than a minor effect on fish status classifications compared with those produced by the existing method. At least some of pressures to which fish respond are also likely to be accounted for, at least in part, by existing classifications of other quality elements.

Full technical details of the recommended new method are provided in Annex 21.

Annexes

The two annexes below have not changed since 2008.