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An approach to the intercalibration of benthic ecological status assessment in the North Atlantic ecoregion, according to the European Water Framework Directive

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Abstract

The European Water Framework Directive (WFD) establishes a framework for the protection and improvement of transitional and coastal waters; its final objective is to achieve at least 'good water status' for all waters, by 2015. The WFD requires Member States (MSs) to assess the Ecological Status (ES) of water bodies. This assessment will be based upon the status of the biological, hydromorphological and physico-chemical quality elements, by comparing data obtained from monitoring networks to reference (undisturbed) conditions, and then deriving an Ecological Quality Ratio (EQR). One of the biological quality elements to be considered is the benthic invertebrate component and some structural parameters (composition, diversity and disturbance–sensitive taxa) must be included in the ES assessment. Following these criteria, several approaches to benthic invertebrate assessment have been proposed by MSs. The WFD requires that these approaches are intercalibrated.

This contribution describes the comparison of the different methodologies proposed by United Kingdom, Spain, Denmark and Norway. Results show a high consistency between the approaches, both with regard to determining the EQR and boundary settings for the ES.

Keywords: Intercalibration; Water Framework Directive; Benthic invertebrates; North-East Atlantic; Soft-bottom communities

1. Introduction

The European Water Framework Directive (WFD; 2000/60/EC) establishes a framework for the protection and improvement of all European surface and ground waters (including transitional and coastal waters); its final objective is to achieve at least 'good water status' for all waters bodies, by 2015. The WFD requires Member States (MSs) to assess the Ecological Status (ES) of water bodies. Status will be assigned through the assessment of biological, hydromorphological and physico-chemical quality elements, by comparing data obtained from monitoring networks to reference (undisturbed) conditions, thereby deriving an Ecological Quality Ratio (EQR). This ratio shall be expressed as a numerical value between zero and one, with 'high' status represented by values close to one and 'bad' status by values close to zero. In coastal and transitional waters, one of the biological quality elements to be considered is the benthic invertebrate fauna, an important component of which is the soft-bottom benthos.

The WFD defines the aspects of the biological quality elements that must be included in the ES assessment of a water body (annex V, WFD). Any proposed WFD classification scheme must, therefore, include methodologies that

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address those parameters defined for assessing the benthic quality status: 'the level of diversity and abundance of invertebrate taxa' and the proportion of 'disturbance–sensitive taxa'. Following these criteria, to date several methodologies have been proposed by MSs for the status assessment of the benthic component (Borja et al., 2000, 2003, 2004a,b; Prior et al., 2004; Rosenberg et al., 2004). All of these methodologies have focused upon the proportion of disturbance–sensitive taxa, with the AZTI Marine Biotic Index (AMBI) (Borja et al., 2000) being one of the most widely used in European countries.

Prior to the implementation of WFD assessment, any proposed methodology must be intercalibrated between the MSs within an ecoregion. Each MS shall divide the EQR scale for their monitoring system into five ecological status classes (high, good, moderate, poor, and bad) by assigning a numerical value to each of the class boundaries. The value for the 'high/good' and the 'good/moderate' class boundaries should be established through the intercalibration exercise. This is to ensure that the established class boundaries are consistent with the normative definitions of the WFD and are comparable between MSs.

As part of the official intercalibration exercise, a range of sites in surface water bodies in each ecoregion in the European Union have been identified, in order to establish an intercalibration network of sites (WFD Intercalibration Register). For each MS, for each surface water body type selected, the intercalibration network should consist of at least two sites corresponding to the boundaries between 'high' and 'good' status, and between 'good' and 'moderate' status, with status defined through the normative definitions. The sites were selected by expert judgement based on joint inspections of all available data on the quality elements and any other supporting information.

Within an ecoregion the monitoring system of each MS should be applied to those intercalibration network sites which lie in the surface water body type to which the system will be applied. The results of this application should then be used to set the numerical values for the relevant class boundaries in each MS monitoring system. The intercalibration exercise started in 2005 and is due to complete in June 2006.

This contribution describes a comparison of the initial methodologies proposed by several MSs in the Atlantic ecoregions, to derive the EQR and establish the benthic invertebrate fauna ES. The approach taken may present a useful way forward for other MSs, both for the North Atlantic and other ecoregions, and help develop the way the ES is assessed.

2. Methods

2.1. Data matrix

Although there exists a European intercalibration register, it has been recognised by both the European Commission and MSs that additional data from non-intercalibration sites, may be required to progress the intercalibration exercise. As such the benthic intercalibration group collated benthic invertebrate data from a range of geographical locations within the ecoregion, including intercalibration sites, and incorporating samples from distinct pressure gradients (ranging from 'bad' to 'high' ES) (for pressures and impacts, within the WFD, see Borja et al., 2006).

For this initial exercise, benthic invertebrate abundance samples were collated from the coastal water common European water body types NEA 1 and 26. These types are characterised by an exposed poly- to euhaline (according to the Venice scheme) subtidal habitat, with soft sediment (muds, sandy muds, muddy sands). The samples were standardised for sample type (0.1 m^2, obtained in some cases by pooling data, see Table 1), sieve mesh size (1 mm), and sediment type (muds, muddy sands and sandy muds). By standardising data for this initial comparison, the high level of natural variability found in biological communities from different habitats was minimised, allowing changes in the benthic invertebrate communities to be more clearly associated with anthropogenic pressure.

The resulting data set was comprised of 589 benthic invertebrate abundance samples from different locations along the European Atlantic coasts (Fig. 1): Belgium (132), Denmark (72), Germany (64), Republic of Ireland (RoI, 14), Norway (12), Spain (45), and United Kingdom (UK, 250). As well as the benthic invertebrate abundance data, MSs submitted supporting parameters, such as water depth (m) and sediment size (% <63 μm) (Table 1). The pressure gradient data used relate to a variety of man-induced pressures and impact sources, such as eutrophication and hypoxia (Denmark); hypoxia (Stavanger, Norway); urban and industrial discharges from a submarine outfall (Basque Country, Spain) and sewage sludge disposal at sea (Garroch Head, UK). Other data were selected from well-known undisturbed areas, such as Trondheimsfjord in Norway.

Most of the Belgian data were taken from the west coast of Belgium, within the federal science project 'HABITAT' (Van Hoey et al., 2004). The other samples were taken from the eastern and middle part of the coastline (for details, see Fig. 1 and Table 1).

The Danish data were collected within the National Environmental Monitoring Programme of Denmark (Fig. 1) in order to evaluate the effects of eutrophication on Danish coastal areas. The monitoring has previously been described in annual reports (e.g. Ærtebjerg et al., 2004) and international publications (e.g. biomass–nutrient relationships in Josefson and Rasmussen (2000); programme description and nutrient loads in Conley et al. (2002); species diversity in Josefson and Hansen (2004); and oxygen deficiency in Conley et al. (in press)). Some descriptive data and parameters can be seen in Table 1.

The Norwegian data were taken from an undisturbed site at 50 m depth in Trondheimsfjord (RAH1), from a sandy site at Utnes in southern Norway (U10), and from