



## An approach to intercalibrate ecological classification tools using fish in transitional water of the North East Atlantic



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### ABSTRACT

A simple procedure to harmonise and intercalibrate eight national methods classifying the ecological status using fish in transitional waters of the North East Atlantic is described. These methods were initially intercalibrated and a new method recently developed was added to this exercise. A common human pressure index pre-classified the status of each water body in an independent way. Ecological class boundaries values were established according to the level of anthropogenic pressure using regression analyses. A simulated dataset was used to assess the level of agreement between the fish classification methods. Fleiss' multi-rater kappa analysis indicated that boundary harmonisation was achieved; all classifications fell within one class of each other and class agreement between methods exceeded 70%. The use of a pressure index to establish boundary thresholds provides a practical method of defining and harmonizing the quality classes associated with human pressures, as required by the European Water Framework Directive.

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### 1. Introduction

The European Water Framework Directive (WFD; 2000/60/EC) outlines a framework for the assessment of European surface and ground waters, including transitional waters (estuaries) (Hering et al., 2010). Member States are required to assess the ecological status of water bodies using biological, hydromorphological and physico-chemical quality elements. Biological quality elements are assessed by comparing data obtained from monitoring programmes to some form of reference (natural) condition based on

a network of reference sites, on historical data or on modelling, or a mixture of all of them (Borja et al., 2012). The ecological status of a particular water body is assessed on the basis of an Ecological Quality Ratio (EQR), which ranges from zero to one. The water body is then assigned to one of five status classes (high, good, moderate, poor, bad), where EQR values close to zero representing 'bad' status and EQR values close to one representing 'high' status.

Fish is one of the biological quality elements for transitional waters and numerous fish-based indices have been developed for transitional waters across Europe, as part of the requirements of the WFD (Birk et al., 2012; Pérez-Domínguez et al., 2012a,b). However, since many of these classification methods differ across member states, the results may not necessarily be comparable. To this end, the WFD requires that the various biological

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**Table 1**  
Fish classification methods employed in transitional waters in the North East Atlantic region.

| Method   | Code      | Country                                       | References                    |
|--|-----------|---|-------------------------------|
| AZTI's Fish Index  | AFI       | Spain (Basque Country)                        | Borja et al. (2004)           |
| Estuarine Biotic Index   | EBI       | Belgium                                       | Breine et al. (2007)          |
| Estuarine Fish Classification Index                                  | EFAI      | Portugal                                      | Cabral et al. (2012)          |
| Estuarine and Lagoon Fish Index                                      | ELFI      | France  | Delpech et al. (2010)         |
| Fish-based Classification Tool for Transitional Waters – Germany     | FAT-TW-G  | Germany                                       | Scholle and Schuchardt (2012) |
| Fish-based Classification Tool for Transitional Waters – Netherlands | FAT-TW-NL | The Netherlands                               | Scholle and Schuchardt (2012) |
| Transitional Fish Classification Index – Ireland                     | TFCI-Irl  | Republic of Ireland and Northern Ireland (UK) | Coates et al. (2007)          |
| Transitional Fish Classification Index – Spain                       | TFCI-Sp   | Spain (Asturias and Cantabria)                | Coates et al. (2007)          |
| Estuarine multi-metrics index -Ireland                               | EMFI      | Republic of Ireland and Northern Ireland (UK) | Harrison and Kelly (2013)     |

classification tools are intercalibrated between Member States; this ensures that national classification methods are harmonised and provide consistent and comparable status classifications (Poikane et al., 2014). A key focus of intercalibration for the WFD is to harmonise the 'high-good' and 'good-moderate' boundaries. It is important to note that the aim of intercalibration is to harmonise the results obtained from national classification tools and not the classification tools themselves (Bennett et al., 2011; Buffagni and Furse, 2006; Sandin and Hering, 2004). The most important boundary is that of good-moderate, since water bodies below good status will require management measures to reduce pressures and achieve good status in the future.

As a consequence European member states were obliged to compare the results of classification among countries that share common water body types in similar biogeographic regions. This is one of the main challenges of the WFD implementation, since Member States must demonstrate that different methods provide similar ecological status classification across different countries (Poikane et al., 2014). For this, countries have been organised into Geographic Intercalibration Groups (GIGs). Although the intercalibration results of some biological quality elements (e.g. benthic invertebrates, angiosperms), have been already published (Borja et al., 2009; Lopez y Royo et al., 2011), nothing has been done until now with transitional fish methods. Hence, the objectives of our research are: (i) to provide an intercalibration method for transitional water fish classification tools within the North East Atlantic GIG, where class boundaries are established and harmonised according to the level of anthropogenic impact or pressure; and (ii) to demonstrate if new methods (or updated methods) can be added furtherly to the intercalibration.

## 2. Materials and methods

### 2.1. Fish classification methods in North East Atlantic GIG transitional waters

Eleven member states are included within the North East Atlantic GIG; these include Belgium, Denmark, France, Germany, Ireland, the Netherlands, Norway, Portugal, Spain, Sweden, and the United Kingdom (European Commission, 2011). Apart from Denmark, Norway, and Sweden, the remaining eight countries have all developed WFD fish classification methods for transitional waters (Table 1). While some countries (e.g. Germany, the Netherlands) used similar fish classification methods, these were treated separately to account for regional differences in the application of the methods and reference conditions. In the case of the Republic of Ireland and United Kingdom, a common approach was adopted in the application of the Transitional Fish Classification Index (TFCI) and these data are presented together (TFCI-Irl). Although the TFCI was also applied to Spanish transitional waters

(regions of Asturias and Cantabria), these data were treated separately (TFCI-Sp) to account for some differences in the application of the method (i.e. sampling gears and effort).

### 2.2. Water Framework Directive compliance

Prior to proceeding with the intercalibration process, all fish classification methods were checked for compliance with the WFD requirements. This included the assignment of typologies to transitional waters, the establishment of type-specific reference conditions for biological quality element parameters, as specified within the WFD, monitoring and assessment protocols for the various fish classification methods, ensuring comparability of monitoring results through ecological quality ratios (EQRs), and the categorization of EQR values into five classes (high, good, moderate, poor and bad). All fish classification methods included in this intercalibration exercise were found to comply with the requirements of the WFD.

#### 2.2.1. Typology

The WFD requires that Member States assign a typology to each of their transitional waters based on a number of physico-chemical characteristics as outlined in WFD Annex II. The typology includes factors such as ecoregion (latitude, longitude), salinity, tidal range, depth, current, exposure, temperature, mixing, turbidity, substratum, and shape. All Member States participating in the intercalibration exercise have developed typologies for their transitional waters; however, no common typology was evident among participating countries. Only one broad type was officially designated as an intercalibration common type for transitional waters in North East Atlantic: oligohaline to polyhaline (0–35 mg l<sup>-1</sup>), mesotidal (2–5 m tidal range), shallow (<30 m depth) with medium current velocity (1–3 knots), sheltered or moderately exposed, partially or permanently stratified and with residence time between days and weeks (TW-NEA11). The common intercalibration type TW-NEA11 encompasses all the transitional water bodies used in this study.

#### 2.2.2. Reference conditions

The assignment of typologies to transitional waters allows the characteristics and the biological communities present to be described. For transitional waters, the biological quality elements specified in WFD Annex X includes composition and abundance of fish fauna as well as disturbance-sensitive species. Type-specific reference conditions can be established using spatially based near-natural sites, modelling using historical or available data, expert judgement, or a combination of the above approaches. All Member States have developed type-specific reference conditions for their transitional waters. The national reference conditions take into account monitoring technique and strategy (sampling gear,

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