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Transitional and freshwater bioassessments: One site, two perspectives?

J.M. Neto [a,*], M.J. Feio [a], H. Teixeira [a], J. Patrício [a], S.R.Q. Serra [a], J.N. Franco [b], A.R. Calapez [a], E. Constantino [a]

[a] IMAR – Institute of Marine Research, Marine and Environmental Research Centre, Faculty of Sciences and Technology, University of Coimbra, 3004-517 Coimbra, Portugal
[b] CIIMAR, Rua dos Bragas 269, 4450-123 Porto, Portugal

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ABSTRACT

The freshwater–saltwater-transition-zone was analysed using two different sampling protocols and assessment methodologies, developed for freshwater and estuaries, to compare their agreement level in terms of community composition and quality assessments. The use of different protocols resulted in significant differences in macroinvertebrate communities, in index scores and initially in quality classes. After modifications in the sensitivity scores of the IBMWP and AMBI indices (average scores or the use of a score of the other index when both were present), the differences were largely reduced and quality classes became coincident for the assessments provided by IPtIs and BAT tools. Such harmonisation of quality assessments for adjacent water categories (e.g., large rivers vs. transitional waters), exemplified here as an harmonisation in one of the metrics comprised in the assessment tools, is essential as it has direct implications on the expansion and accomplishment of River Basin Management Plans committed by the Water Framework Directive.

1. Introduction

In Europe, the assessment of the ecological integrity of aquatic systems has been extensively investigated in recent years, mainly prompted by the need to implement the Water Framework Directive (WFD, 2000/60/EC). This directive established a framework for the development of integrated policies for the protection and enhancement of water quality status within all European water bodies by taking into account biological, physical–chemical and hydro-morphological quality elements. The obligation to use the WFD supports evident progress in the knowledge of biological communities from freshwater, transitional and coastal waters throughout Europe (Birk et al., 2012). However, the type of information produced within different water body categories could be quite heterogeneous. Often, different research teams, despite having similar scientific objectives, work in specific and well-defined habitats, use different sampling strategies for the same biological quality element and employ diverse classification methodologies to infer the ecological quality of each water category. This is due to what we may call the "historical context" of bioassessment, which has resulted in distinct expertise teams with specific sampling strategies adapted to habitat conditions and analytical methodologies.

On the other hand, there is a growing demand to look at the aquatic environment as an integrated unit that is made up of several water bodies with clear and distinct features that have transition zones (*sensu* Yarrow and Marin, 2007), where attributes are shared between adjacent areas and, simultaneously, show new and unique properties. Often, due to several different constraints, these transition zones that are geographically stuck between the traditional "domains of expertise" have been modestly investigated. An increasing number of researchers (e.g., Rundle et al., 1998; Attrill and Rundle, 2002) consider the freshwater–saltwater transition zone (FSTZ) to be one of these neglected ecological boundaries that could also be one of the most biologically productive sections of a river (Vincent and Dobson, 1999). These transition zones could be areas where important changes occur in the community, such as the reduction in abundance of mayflies and some feeding groups (Marshall and Bailey, 2004) and the concomitant increase in dominance of other groups in the community with the salinisation of freshwaters (Cushing et al., 1983; Brown et al., 1998). Although few studies have assessed and/or discussed the macrobenthic conditions at this interface area (e.g., Attrill and Rundle, 2002; Cortelezzi et al., 2007; Sousa et al., 2008; Medeiros et al., 2012; Thompson et al., 2012), information regarding subtidal benthic communities indicates that the FSTZ is characterised by a lower species diversity when compared to higher salinity areas (Jordan and Sutton, 1984; Teixeira et al., 2008; Medeiros et al., 2012).

In the scope of the WFD, ecological quality status classifications need to be coherent and consistent between regions, biological quality elements and water categories (WFD, 2000/60/EC). However, for practical reasons, the aquatic environment has been artificially divided into smaller parts: ground and surface waters,

* Corresponding author. Tel.: +351 239855760; fax: +351 239823603.
E-mail address: jneto@ci.uc.pt (J.M. Neto).

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including natural lakes, rivers, transitional and coastal waters. Thompson et al. (2012) reported low levels of agreement among experts using professional judgment for low salinity estuarine and freshwater habitats. However, if integrity assessments are being performed separately based on water category (coastal, transitional and rivers), what will be the final ecological quality status classification reported for those water bodies within the FSTZ? Will the classifications derived using freshwater (FW) methodologies, the classifications resulting from transitional water (TW) methodologies or the classifications given by a hybrid approach be the most effective? Do the artefacts resulting from conceptual and methodological divergences influence perceptions regarding the structure and status of the communities under assessment?

With the aforementioned questions in mind, the general aim of this study was to compare the ecological quality status classifications (*sensu* WFD) based on macrobenthic invertebrates in the FSTZ (transition zone between two adjacent water categories – river vs. transitional), using two different approaches: the "freshwater methodology" and the "transitional water method". The specific objectives were as follows:

(1) To contrast the "description" of the macrobenthic community provided by the two different survey methods.
(2) To compare the ecological quality status results obtained for the FSTZ using both the freshwater and the transitional water assessment methodologies.
(3) To propose a coherent and harmonious approach to overcome the "one site-two classifications" dilemma.
(4) To discuss possible implications for River Basin Management Plans.

2. Materials and methods

2.1. Study site

The Mondego River catchment basin is located on the Central Atlantic coast of Portugal (Fig. 1). It is the largest river entirely enclosed by the Portuguese territory (227 km long) between the coordinates 39°46′ – 40°48′N and 7°14′ – 8°52′W, where it drains a hydrological basin of approximately 6670 km^2 (Marques et al., 2002). The initial part of the river flows through deep and slender valleys until it reaches the city of Coimbra, after what it flows through a vast open plain (Lower Mondego Valley) for the last 40 km until it reaches the sea. The climate is warm and temperate, with a marked seasonal pattern, a mean annual water temperature of 14.8 °C and a mean annual precipitation of 986 mm. The average water flow is 79 $m^3 s^{-1}$, but it can vary from 27 to 140 $m^3 s^{-1}$ depending on the climate.

In the sense of the WFD, the Mondego River encompasses several different river types along its course, all with permanent flow: type N1 $\leqslant$ 100 (northern rivers with a drainage area $\leqslant$100 km^2) near to the source; type N1 > 100 (northern rivers with drainage area >100 km^2) over part of the upper and the middle sections of the catchment; type L (littoral lowland rivers) in the lower section; and finally, the type NEA 11 in the last 21 km until the river mouth.

The study area (Fig. 1) had three sampling stations located within the Mondego FSTZ: the contact area between the end of the freshwater type L, where salinity was usually below 0.1; and the beginning of type NEA11, where, on average, salinity was higher than 0.5 (Vincent and Dobson, 1999). At the study area, the river was ~100 m wide and 1 m deep. The dominant sediment type was coarse sand, but there were also occasional stone patches and mud near the river banks where macrophytes were more abundant.

2.2. Hydromorphological changes and anthropogenic pressures

The Mondego River bed and margins have suffered severe physical and hydromorphological changes. After the 1980s, intense channelisation work created a complex network of water channels in the Lower Mondego Valley (Neto et al., 2010). Together with the artificial embankments at the margins and the intense re-vegetation of the riparian corridor, the water regime suffered important changes due to the physical barriers and the water use practices associated with local agriculture. The hydrological regime of the river is considered to be intermediately modified due to several power plants existing approximately 70 km upstream from the mouth, as well as other smaller dams and gates used to control the water level inside the fields in the Lower Mondego Valley.

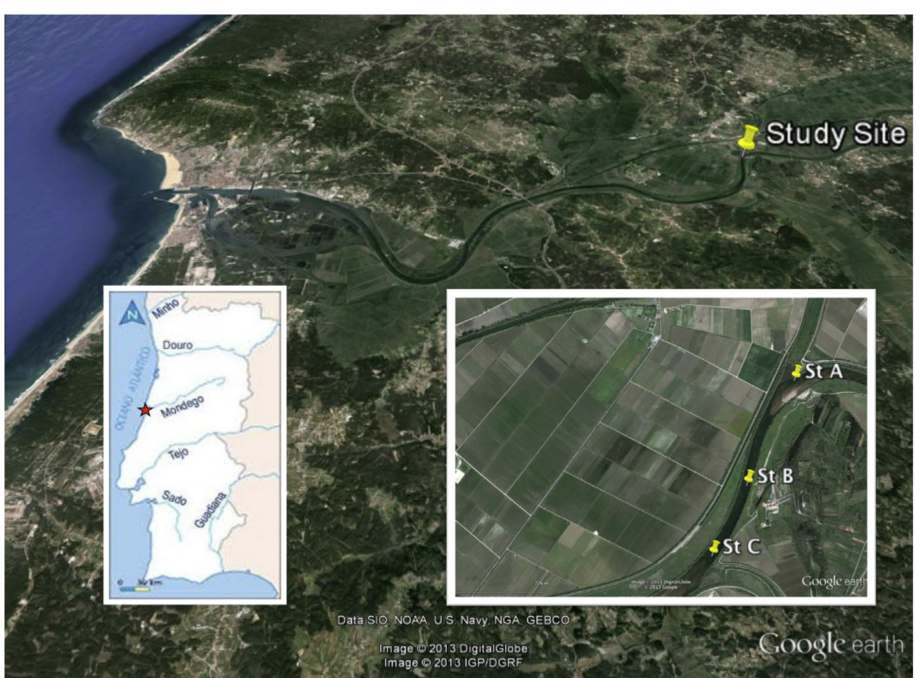

Fig. 1. Sampling stations in the FSTZ of the Mondego River.