



Contents lists available at ScienceDirect

## Marine Environmental Research

journal homepage: [www.elsevier.com/locate/marenvres](http://www.elsevier.com/locate/marenvres)

## Assessing environmental quality status by integrating chemical and biological effect data: The Cartagena coastal zone as a case

Concepción Martínez-Gómez<sup>a, \*</sup>, Beatriz Fernández<sup>a</sup>, Craig D. Robinson<sup>b</sup>,  
J. Antonio Campillo<sup>a</sup>, Víctor M. León<sup>a</sup>, José Benedicto<sup>a</sup>, Ketil Hylland<sup>c</sup>,  
A. Dick Vethaak<sup>d, e</sup>

<sup>a</sup> Instituto Español de Oceanografía (IEO), Oceanographic Centre of Murcia, Varadero 1, PO BOX 22, 30740 San Pedro del Pinatar (Murcia), Spain

<sup>b</sup> Marine Scotland Science, Marine Laboratory, 375 Victoria Road, Aberdeen, AB11 9DB, UK

<sup>c</sup> Department of Biosciences, University of Oslo, PO Box 1066, Blindern, N0316 Oslo, Norway

<sup>d</sup> VU University Amsterdam, Institute for Environmental Studies, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands

<sup>e</sup> Deltares, Marine and Coastal Systems, P.O. Box 177, 2600 MH Delft, The Netherlands

## ARTICLE INFO

## Article history:

Received 15 July 2015

Received in revised form

13 April 2016

Accepted 15 April 2016

Available online xxx

## Keywords:

Biomonitoring

Chemical pollution

Good Environmental Status

MSFD

Integrated assessment

*Mullus barbatus**Mytilus galloprovincialis*

Sublethal effects

Western Mediterranean

## ABSTRACT

Cartagena coastal zone (W Mediterranean) was chosen for a practical case study to investigate the suitability of an integrated indicator framework for marine monitoring and assessment of chemicals and their effects, which was developed by ICES and OSPAR. Red mullet (*Mullus barbatus*) and the Mediterranean mussel (*Mytilus galloprovincialis*) were selected as target species. Concentrations of contaminants in sediment and biota, and contaminant-related biomarkers were analysed. To assess environmental quality in the Cartagena coastal zone with respect to chemical pollution, data were assessed using available assessment criteria, and then integrated for different environmental matrices. A qualitative scoring method was used to rank the overall assessments into selected categories and to evaluate the confidence level of the final integrated assessment. The ICES/OSPAR integrated assessment framework, originally designed for the North Atlantic, was found to be applicable for Mediterranean species and environmental matrices. Further development of assessment criteria of chemical and biological parameters in sediments and target species from the Mediterranean will, however, be required before this framework can be fully applied for determining Good Environmental Status (GES) of the Marine Strategy Framework Directive in these regions.

© 2016 Elsevier Ltd. All rights reserved.

## 1. Introduction

Over the last decade, a large number of studies have demonstrated that the best way to assess the quality of the marine environment and to conduct an environmental risk assessment with respect to hazardous substances is by assessing a suite of chemical and biological measurements (biomarkers and bioassays) in an integrated way (Van der Oost et al., 2005; ICES, 2006; Thain et al., 2008; Lyons et al., 2010; Vethaak et al., 2015). Since 2008, the

Marine Strategy Framework Directive (MSFD, Directive, 2008/56/EC) and the gradual application of the ecosystem approach (EcAp) in the Mediterranean region (UNEP/MAP, 2013) has put additional emphasis on the importance of assessing key biological responses for evaluating the health of organisms, linking alterations in these responses to putative contaminant effects.

Working groups have developed guidelines and criteria for biological effect methods within the International Council for Exploration of the Sea (ICES) and Oslo-Paris Commission (OSPAR). A framework has been developed for integrated assessment of contaminant impacts in coastal and offshore areas (Vethaak et al., 2015). In this proposed framework, different components of the ecosystem (water, sediment and biota) have to be jointly monitored. The biota component comprises fish, mussels and gastropods. Chemical (contaminant concentrations) and biological (bioassay and biomarker responses) parameters are measured for

\* Corresponding author.

E-mail addresses: [concepcion.martinez@mu.ieo.es](mailto:concepcion.martinez@mu.ieo.es), [concepcion.martinez@mu.ieo.es](mailto:concepcion.martinez@mu.ieo.es) (C. Martínez-Gómez), [bfernandezgalindo@gmail.com](mailto:bfernandezgalindo@gmail.com) (B. Fernández), [Craig.Robinson@scotland.gsi.gov.uk](mailto:Craig.Robinson@scotland.gsi.gov.uk) (C.D. Robinson), [juan.campillo@mu.ieo.es](mailto:juan.campillo@mu.ieo.es) (J.A. Campillo), [victor.leon@mu.ieo.es](mailto:victor.leon@mu.ieo.es) (V.M. León), [nanebenedicto@gmail.com](mailto:nanebenedicto@gmail.com) (J. Benedicto), [ketil.hylland@ibv.uio.no](mailto:ketil.hylland@ibv.uio.no) (K. Hylland), [dick.vethaak@deltares.nl](mailto:dick.vethaak@deltares.nl) (A.D. Vethaak).