Marine Pollution Bulletin 68 (2013) 117–126

Contents lists available at SciVerse ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Classification of the ecological quality of the Aysen and Baker Fjords (Patagonia, Chile) using biotic indices

Eduardo Quiroga [a,*], Paula Ortiz [b], Brian Reid [b], Dieter Gerdes [c]

[a] Pontificia Universidad Católica de Valparaíso (PUCV), Escuela de Ciencias del Mar, Casilla 1020, Valparaíso, Chile
[b] Centro de Investigación en Ecosistemas de la Patagonia (CIEP), Ignacio Serrano 509, Coyhaique, Chile
[c] Alfred Wegener Institute for Polar and Marine Research, Columbusstrasse, D-27568 Bremerhaven, Germany

ARTICLE INFO

Keywords:
Macrofauna
Soft-bottom communities
River-fjord interaction

ABSTRACT

The AZTI's marine biotic index (AMBI), an ecological indicator for managing estuarine and coastal waters worldwide, was tested in two fjords in Chilean Patagonia. The Aysen Fjord (42° Lat. S) supports intensive salmon farming in coastal ecosystems, while the Baker Fjord (48° Lat. S) is currently just beyond the limit of the southern expansion of salmon concessions. The ecological status of the Aysen Fjord was classified as good, while the status of the Baker Fjord was classified as high and unbalanced. These differences were consistent with our expectations, illustrating the effect of local environmental conditions and human activities, combined with river inputs into semi-confined fjords. This method is appropriate for the evaluation of the ecological status of the fjords, but requires a sufficient amount of data for the robust environmental assessment as proposed by the Water Framework Directive (WFD).

1. Introduction

Macrobenthic invertebrate communities are broadly recognized as indicators for environmental impact on marine and estuarine systems (e.g. Borja et al., 2000; Diaz et al., 2004; Pinto et al., 2009; Van Hoey et al., 2010; Teixeira et al., 2012). Macrobenthic invertebrate communities are sensitive to accumulated organic matter and/or many contaminants, because they are relatively immobile residents in sediments (Pearson and Rosenberg, 1978; Teixeira et al., 2012). Univariate diversity indices such as the Shannon diversity, species evenness and other community indices are insufficient to distinguish between the changes produced by natural disturbance and those produced by anthropogenic factors (Warwick and Clarke, 1993). Traditional environmental assessment studies on an undisturbed community at a particular locality and a disturbed one in another locality might show the same level of diversity (Muniz et al., 2005). These metrics are often non-intuitive, and confuse the interpretation of environmental impact and consequent effects, thus making marine quality monitoring difficult for non-scientists, regulators or policymakers (Muniz et al., 2005).

Development and testing of classification schemes and biotic indicators for assessing the ecological quality (EcoQ) of coastal waters have been a major investment in recent years (e.g. Simboura and Zenetos, 2002; Diaz et al., 2004; Pinto et al., 2009; Borja et al., 2008, 2009a, 2009b; Muxika et al., 2005, 2011). One extensively applied index that produces good results is the AZTI's marine biotic index (AMBI) developed by Borja et al. (2000). This index is based on the assignment of taxa observed during a survey to certain ecological groups. Five ecological groups, ranging from sensitive species to first-order opportunistic species, were established based on empirical data from various studies and also on general expert experience (Borja et al., 2000; Muxika et al., 2005, 2011). This index has been successfully applied for detecting and assessing different sources of impacts on marine systems worldwide, including also negative effects of aquaculture on benthic systems (e.g. Muxika et al., 2005; Tomassetti et al., 2009; Forchino et al., 2011).

A new index, the Multivariate-AMBI (M-AMBI) was recently developed in response to the Water Framework Directive (WFD 2000/60/EC) requirements, to include additional metrics addressing benthic community integrity, and parameters that better define environmental quality of marine systems (Borja et al., 2004, 2009a; Muxika et al., 2007; Pinto et al., 2009). The M-AMBI is an extension of the AMBI (Muxika et al., 2007), which incorporates species richness and Shannon–Wiener ($\log_2$) diversity values. The M-AMBI is the outcome of inter-calibration efforts among members of the WDF to develop common methodologies. It has been applied to various systems outside Europe, e.g. in the United States, where it was demonstrated to provide consistently high agreement with local indices (Borja et al., 2008).

Salmon aquaculture in coastal marine systems may be a major potential source of environmental impact, including organic enrichment of sediments, reduced availability of oxygen, reduction

* Corresponding author. Tel.: +56 32 2274207; fax: +56 32 2274206.
E-mail address: eduardo.quiroga@ucv.cl (E. Quiroga).

0025-326X/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.marpolbul.2012.11.041