


ambiR: an R package for calculating AMBI marine biotic index

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Summary

Being able to assess the health of ecosystems and monitor response to changes in pressures is key for their management. In coastal ecosystems, the species composition of benthic invertebrate communities responds to pollution pressures: the species most sensitive to pollution will be present only in pristine conditions whilst domination by other opportunistic species groups is an indication of a heavily polluted system.

The AZTI marine biotic index (AMBI) was developed to “*establish the ecological quality of soft-bottom benthos within European estuarine and coastal environments*” and presented in a paper by Borja et al. (2000), which currently has 1291 citations in peer-reviewed articles (Web of Science, 11. December 2025). A standalone program for calculating the AMBI index was developed as a Matlab® distributable and made available free of charge by AZTI (Borja et al., 2004). It has since been widely used by students, other researchers and managers. The R package ambiR allows the user to perform the same calculations as the original AZTI software, including the multivariate M-AMBI index (Muxika et al., 2007).

Statement of need

R is used widely by researchers in biological and environmental sciences. ambiR will allow students and researchers to incorporate AMBI and M-AMBI calculations directly in an R workflow. The motivation for creating the ambiR package began with attempts to calculate DKI in an R workflow. DKI (Dansk Kvalitetsindeks) is a Danish benthic biotic index which essentially adjusts the AMBI index to regions where relatively lower species diversity in pristine conditions might be expected, for example where salinity levels are lower (Carstensen et al., 2014). To calculate DKI, one must first calculate AMBI. With the exception of the actual AMBI calculations, all other steps from input data to performing analyses and plotting results could be carried out in R. To calculate AMBI, observations have to be exported from R, imported to the AMBI program and the results exported before being imported to R. The AMBI index is already a well-established assessment methodology and the authors expect that the ease with which the package allows users to reproduce AMBI calculations in R will lead to a wide uptake. This will also improve reproducibility of analyses which include AMBI calculations.

Features

AMBI functions:

- 39 ▪ AMBI - the AZTI marine biotic index.
- 40 ▪ M-AMBI - the multivariate index.
- 41 ▪ DKI - The Danish benthic quality index.

42 auxiliary functions:

- 43 ▪ H' - the Shannon diversity index.
- 44 ▪ S - species richness.

45 A key feature of the original AMBI program is the included list of marine species and genera
 46 which is used to match species names in observations to that they can be assigned to one of
 47 the five AMBI categories, according to their sensitivity to pollution pressures. The species list
 48 has been updated several times by the authors and the most recent version from October 2024
 49 contains almost 12000 records. This species list is included in ambiR

50 The test_data dataset included in the package is identical to the example data which
 51 accompanies the original program with real examples of species count observations from the
 52 Basque coast. Testing has ensured that the results from ambiR are identical to those calculated
 53 by the AMBI program.

54 The package has an public GitHub repository where users will be able to raise issues.

55 Features

$$56 \quad \text{Biotic Index} = 0.0 \cdot f_I + 1.5 \cdot f_{II} + 3.0 \cdot f_{III} + 4.5 \cdot f_{IV} + 6.0 \cdot f_V$$

57 where:

58 f_i = fraction of individuals in Group $i \in \{I, II, III, IV, V\}$

59 The multivariate *M-AMBI* method combines the AMBI index with H' , the Shannon diversity
 60 index (Shannon, 1948), and S , the species richness¹ to give an *ecological quality status* (EcoQS)
 61 index :

$$62 \quad EcoQS = K + a \cdot AMBI + b \cdot H' + c \cdot S$$

63 where: K , a , b and c are determined by factorial analysis.

64 All required functionality is included in the package: Hdash S MAMBI

65 and refer to ?? from text.

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70 References

- 71 Borja, Á., Franco, J., & Muxika, I. (2004). The biotic indices and the Water Framework Direc-
 72 tive: The required consensus in the new benthic monitoring tools. *MARINE POLLUTION*

¹the number of unique species in a sample

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- 73 *BULLETIN*, 48(3-4), 405–408. <https://doi.org/10.1016/j.marpolbul.2003.10.024>
- 74 Borja, Á., Franco, J., & Pérez, V. (2000). A marine biotic index to establish the ecological
75 quality of soft-bottom benthos within european estuarine and coastal environments. *Marine*
76 *Pollution Bulletin*, 40(12), 1100–1114. [https://doi.org/10.1016/S0025-326X\(00\)00061-8](https://doi.org/10.1016/S0025-326X(00)00061-8)
- 77 Carstensen, J., Krause-Jensen, D., & Josefson, A. B. (2014). *Development and testing of*
78 *tools for intercalibration of phytoplankton, macrovegetation and benthic fauna in danish*
79 *coastal areas* (No. 9788771560619).
- 80 Muxika, I., Borja, Á., & Bald, J. (2007). Using historical data, expert judgement and multi-
81 variate analysis in assessing reference conditions and benthic ecological status, according
82 to the european water framework directive. *Marine Pollution Bulletin*, 55(1), 16–29.
83 <https://doi.org/10.1016/j.marpolbul.2006.05.025>
- 84 Shannon, C. E. (1948). A mathematical theory of communication. *The Bell System Technical*
85 *Journal*, 27(3), 379–423. <https://doi.org/10.1002/j.1538-7305.1948.tb01338.x>

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