The Journal of Open Source Software

ambiR: an R package for calculating AMBI marine biotic index

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DOI: 10.xxxxxx/draft

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Submitted: 01 January 1970
Published: unpublished

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 Á. 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 (Á. Borja et al., 2004; Á. Borja et al., 2012). It has since has 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 for assessing ecological status (Á. Borja et al., 2019) 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

The package allows the user to match species observations to lists of pollution sensitivity groups and calculate the key AMBI functions:

- AMBI - the AZTI marine biotic index.
- M-AMBI - the multivariate AMBI index.

The package also includes the auxiliary functions:

- DKI - The Danish benthic quality index.
- H' - the Shannon diversity index (Shannon, 1948).
- S - species richness [1]

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

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

Full documentation of the package and AMBI index calculations can be found at https://niva-denmark.github.io/ambiR/ including vignettes demonstrating how to reproduce the style of figures generated by the standalone AMBI program, `vignette("ambi-figures")`, and how to run the AMBI index calculations in *interactive* mode, `vignette("interactive")`.

The source code for the package is available in a public GitHub repository. Users can report bugs or other issues regarding functionality and the label Species data can be assigned to notify the package maintainers about issues specifically related to the AMBI species list and classification of species and genera according to pollution sensitivity which can then be addressed in regular updates of the species list.

Acknowledgements

Steen Knudsen created the artwork used in the ambiR logo.

ÁB, SP, IM and JMG received support from the GES4SEAS - Grant Agreement 101059877. The GES4SEAS project has been approved under the HORIZON-CL6-2021-BIODIV-01-04 call: 'Assess and predict integrated impacts of cumulative direct and indirect stressors on coastal and marine biodiversity, ecosystems and their services'. Funded by the European Union.

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[1] the number of unique species in a sample.

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