

¹ ambiR: an R package for calculating AMBI marine biotic index

³ **Ciarán J. Murray**  ^{1,2*}, **Sarai Pouso**  ^{3*}, **Iñigo Muxika**  ^{3*}, **Joxe Mikel Garmendia**  ^{3*}, and **Ángel Borja**  ^{3*}

⁵ 1 NIVA Denmark Water Research, Copenhagen, Denmark 2 Aquatic Synthesis Research Centre (AquaSYNC), Copenhagen, Denmark 3 AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Spain * These authors contributed equally.

DOI: [10.xxxxxx/draft](https://doi.org/10.xxxxxx/draft)

Software

- [Review](#) 
- [Repository](#) 
- [Archive](#) 

Editor: [Open Journals](#) 

Reviewers:

- [@openjournals](#)

Submitted: 01 January 1970

Published: unpublished

License

Authors of papers retain copyright and release the work under a Creative Commons Attribution 4.0 International License ([CC BY 4.0](#)).

⁸ Summary

⁹ Being able to assess the health of ecosystems and monitor response to changes in pressures is key
¹⁰ for their management. In coastal ecosystems, the species composition of benthic invertebrate
¹¹ communities responds to pollution pressures: the species most sensitive to pollution will be
¹² present only in pristine conditions whilst domination by other opportunistic species groups is
¹³ an indication of a heavily polluted system.

¹⁴ 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
¹⁵ 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
¹⁶ developed as a Matlab® distributable and made available free of charge by AZTI (Borja et al.,
¹⁷ 2004). It has since been widely used by students, other researchers and managers. The R
¹⁸ package ambiR allows the user to perform the same calculations as the original AZTI software,
¹⁹ including the multivariate M-AMBI index (Muxika et al., 2007).

²² Statement of need

²³ R is used widely by researchers in biological and environmental sciences. ambiR will allow
²⁴ students and researchers to incorporate AMBI and M-AMBI calculations directly in an R
²⁵ workflow. The motivation for creating the ambiR package began with attempts to calculate
²⁶ DKI in an R workflow. DKI (Dansk Kvalitetsindeks) is a Danish benthic biotic index which
²⁷ essentially adjusts the AMBI index to regions where relatively lower species diversity in pristine
²⁸ conditions might be expected, for example where salinity levels are lower (Carstensen et al.,
²⁹ 2014). To calculate DKI, one must first calculate AMBI. With the exception of the actual
³⁰ AMBI calculations, all other steps from input data to performing analyses and plotting results
³¹ could be carried out in R. To calculate AMBI, observations have to be exported from R,
³² imported to the AMBI program and the results exported before being imported to R. The
³³ AMBI index is already a well-established assessment methodology and the authors expect that
³⁴ the ease with which the package allows users to reproduce AMBI calculations in R will lead to
³⁵ a wide uptake. This will also improve reproducibility of analyses
³⁶ which include AMBI calculations.

³⁷ Features

³⁸ The package allows the user to match species observations to lists of pollution sensitivity
³⁹ groups and calculate the key AMBI functions:

40 ■ AMBI - the AZTI marine biotic index.
41 ■ M-AMBI - the multivariate AMBI index.

42 The package also includes the auxiliary functions:

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

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

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

55 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
56 style of figures generated by the standalone AMBI program, vignette("ambi-figures"), and
57 how to run the AMBI index calculations in *interactive* mode, vignette("interactive").

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

64 Acknowledgements

65 Steen Knudsen  created the artwork used in the ambiR logo.
66 ÁB, SP, IM and JMG received support from the GES4SEAS - Grant Agreement 101059877.
67 The GES4SEAS project has been approved under the HORIZON-CL6-2021-BIODIV-01-04 call:
68 'Assess and predict integrated impacts of cumulative direct and indirect stressors on coastal
69 and marine biodiversity, ecosystems and their services'. Funded by the European Union.

70 References

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

¹the number of unique species in a sample.

- 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 Journal*, 27(3), 379–423. <https://doi.org/10.1002/j.1538-7305.1948.tb01338.x>
- 85

DRAFT