

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

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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
¹⁵ soft-bottom benthos within European estuarine and coastal environments” and presented in a
¹⁶ paper by Á. Borja et al. (2000), which currently has 1291 citations in peer-reviewed articles
¹⁷ (Web of Science, 11. December 2025). A standalone program for calculating the AMBI index
¹⁸ was developed as a Matlab® distributable and made available free of charge by AZTI (Á.
¹⁹ Borja et al., 2004; Á. Borja et al., 2012). It has since been widely used by students,
²⁰ other researchers and managers. The R package ambiR allows the user to perform the same
²¹ calculations as the original AZTI software, including the multivariate M-AMBI index (Muxika
²² et al., 2007).

²³ Statement of need

²⁴ R is used widely by researchers in biological and environmental sciences. ambiR will allow
²⁵ students and researchers to incorporate AMBI and M-AMBI calculations directly in an R
²⁶ workflow. The motivation for creating the ambiR package began with attempts to calculate
²⁷ DKI in an R workflow. DKI (Dansk Kvalitetsindeks) is a Danish benthic biotic index which
²⁸ essentially adjusts the AMBI index to regions where relatively lower species diversity in pristine
²⁹ conditions might be expected, for example where salinity levels are lower (Carstensen et al.,
³⁰ 2014). To calculate DKI, one must first calculate AMBI. With the exception of the actual
³¹ AMBI calculations, all other steps from input data to performing analyses and plotting results
³² could be carried out in R. To calculate AMBI, observations have to be exported from R,
³³ imported to the AMBI program and the results exported before being imported to R. The
³⁴ AMBI index is already a well-established assessment methodology for assessing ecological
³⁵ status (Á. Borja et al., 2019) and the authors expect that the ease with which the package
³⁶ allows users to reproduce AMBI calculations in R will lead to a wide uptake. This will also
³⁷ improve reproducibility of analyses which include AMBI calculations.

38 Features

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

- 41 ▪ AMBI - the AZTI marine biotic index.
42 ▪ M-AMBI - the multivariate AMBI index.

43 The package also includes the auxiliary functions:

- 44 ▪ DKI - The Danish benthic quality index (2 alternative versions).
45 ▪ H' - the Shannon diversity index (Shannon, 1948).
46 ▪ S - species richness, the number of unique species in a sample.

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

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

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

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

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73 References

74 Borja, Á., Chust, G., & Muxika, I. (2019). Forever young: The successful story of a marine
75 biotic index. *Advances in Marine Biology*, 82, 93–127. <https://doi.org/10.1016/bs.amb.2019.05.001>

77 Borja, Á., Franco, J., & Muxika, I. (2004). The biotic indices and the Water Framework
78 Directive: The required consensus in the new benthic monitoring tools. *Marine Pollution
79 Bulletin*, 48(3-4), 405–408. <https://doi.org/10.1016/j.marpolbul.2003.10.024>

- 80 Borja, Á., Franco, J., & Pérez, V. (2000). A marine biotic index to establish the ecological
81 quality of soft-bottom benthos within european estuarine and coastal environments. *Marine
82 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)
- 83 Borja, Á., Mader, J., & Muxika, I. (2012). *Instructions for the use of the AMBI index
84 software (version 5.0)*. (No. 3; Revista de Investigación Marina, Vol. 19, pp. 33–44).
85 AZTI-Tecnalia.
- 86 Carstensen, J., Krause-Jensen, D., & Josefson, A. B. (2014). *Development and testing of
87 tools for intercalibration of phytoplankton, macrovegetation and benthic fauna in danish
88 coastal areas* (No. 93; Scientific Report from DCE – Danish Centre for Environment and
89 Energy, p. 85). Aarhus University, DCE – Danish Centre for Environment; Energy.
- 90 Muxika, I., Borja, Á., & Bald, J. (2007). Using historical data, expert judgement and multi-
91 variate analysis in assessing reference conditions and benthic ecological status, according
92 to the european water framework directive. *Marine Pollution Bulletin*, 55(1), 16–29.
93 <https://doi.org/10.1016/j.marpolbul.2006.05.025>
- 94 Shannon, C. E. (1948). A mathematical theory of communication. *The Bell System Technical
95 Journal*, 27(3), 379–423. <https://doi.org/10.1002/j.1538-7305.1948.tb01338.x>

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