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# RMAVIS v1.0: a Shiny application for the analysis of vegetation survey data and assignment to GB NVC communities

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## Summary

RMAVIS is a Shiny application for the assignment of vegetation sample plot data to British National Vegetation Classification (NVC) communities (Rodwell, 1991, 1992a, 1992b, 1995, 2000).

The assignment of vegetation sample plot data to established vegetation classification units using computational methods is a well established and recognised practice (Maciejewski et al., 2020). The results of this assignment process are used in various ways, including assisting in the phase 2 habitat survey (or NVC survey) process (Rodwell, 2006); establishing an ecological baseline and identifying important ecological features such as protected habitats (CIEEM, 2022); and in ecological restoration by providing a proxy for historical reference ecosystems to target and against which to measure restoration progress (Gann et al., 2019; Pywell et al., 2002; Sturbois et al., 2023).

In Great Britain (GB) the development of computational methods and programs for the assignment of vegetation survey data to NVC communities began with the development of TABLEFIT (Hill, 1989; Marrs, 2019) and was followed by MATCH (Malloch, 1998). The most recent program, the Modular Analysis of Vegetation Information System (MAVIS), was developed as a windows application in 2000 and was a DEFRA-funded output of the ECOFACT project (Bunce et al., 1999), with the latest version released in 2016 (Smart et al., 2016).

## Statement of need

The requirement for a new program in the form of a Shiny (Chang et al., 2024) application arises from several needs, namely to: 1) accommodate updates to the NVC; 2) provide a means to easily reproduce and attribute the results of the NVC assignment process; 3) broaden and simplify access through the provision of a web-based Graphical User Interface (GUI); and 4) facilitate the continuous development of such NVC assignment software. We developed RMAVIS considering these needs, with the view to providing a reliable system for use by the GB ecology and conservation community, analogous to the Engine for Relevés to Irish Communities Assignment (ERICA) tool (Perrin et al., 2018; Perrin, 2019) developed for Ireland, and the EuroVegChecklist Expert System (EVC-ES) (Mucina et al., 2016) developed for Europe.

## Application structure

Inspired by the extensible structure of the species niche and distribution modelling Shiny application `wallace` (Kass et al., 2023), we constructed `RMAVIS` with a modular architecture, facilitating both the maintenance of existing modules and development of new modules with ease.

`RMAVIS` currently contains a total of twenty-one modules, with the fourteen main modules summarised in the following table.

| Module | Description |
|---|---|
| Sidebar | Acts as the control module, containing the options for each module. |
| Data Input | Facilitates the entry of data, three methods are provided: manual, upload, and example. |
| Data Validation | Checks the format of the inputted data and provides means to adjust incorrectly formatted entries. |
| Data Structure | Checks the structure of the inputted data, displaying the availability of data by species and number of plots per year and group. |
| NVC Assignment | Displays the results of the NVC assignment process. |
| Habitat Correspondence | Displays the habitats from alternative habitat classifications associated with the top-fitted NVC communities. |
| Floristic Tables | Allows the comparison of floristic tables composed from the inputted data with the NVC's floristic tables. |
| Frequency | Summarises the frequency of occurrence of each species across all plots over time. |
| EIVs | Displays the mean Hill-Ellenberg ecological indicator values (EIVs) for each plot, group of plots, and all plots. |
| Diversity | Displays a number of diversity metrics for each plot and group of plots. |
| MVA National | Constructs an ordination space using all NVC pseudo-quadrats, with sample plots added in passively. |
| MVA Local, restricted | Constructs an ordination space using the top-fitted NVC communities pseudo-quadrats, with sample plots added in passively. |
| MVA Local, unrestricted | Constructs an ordination space using the top-fitted NVC communities pseudo-quadrats and sample plots. |
| Report | Provides the user with a downloadable report, containing user-selected outputs from the app session. |

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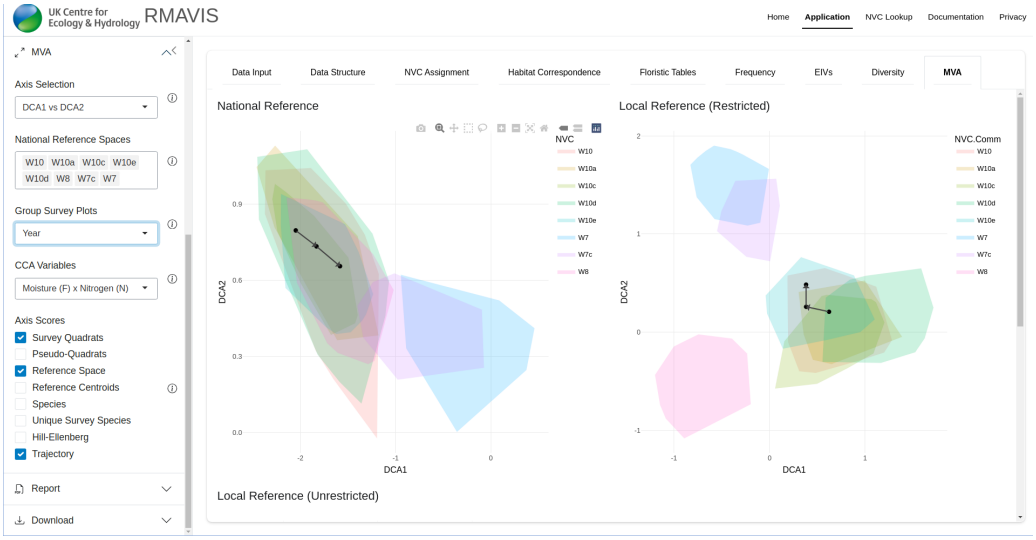


**Figure 1:** The MVA module of `RMAVIS`, showing the trajectory of all sample plots from the Leith Hill Wood example dataset in the ordination spaces over time.

## Data sources and dependencies

`RMAVIS` depends on a number of individual datasets. The list of accepted species was constructed using the vascular plant (*Tracheophyta* and *Pteridophyta*), moss (*Bryophyta*), liverwort (*Marchantiophyta*), and hornwort (*Anthocerotophyta*) taxa present in the UKSI (Raper, 2015), retrieved from the National Biodiversity Network (NBN), (NBN Trust, 2024d, 2024e, 2024b, 2024c, 2024a) filtered to include taxa at the species, species hybrid, species aggregate, subspecies, species sensu lato, and genus ranks; along with the limited number of lichen (*Lecanoromycetes*), charophyte (*Charophyta*), and alga (*Algae*) taxa present in the NVC floristic tables. The NVC communities present in `RMAVIS` are composed from Rodwell (1991), Rodwell (1992a), Rodwell (1992b), Rodwell (1995), Rodwell (2000), Wallace & Prosser (2017), Prosser et al. (2023), and Wallace et al. (2023). Data for habitat correspondences is derived from: the Joint Nature Conservation Committee (JNCC) Spreadsheet of Habitat Correspondences (JNCC, 2008), UKHab V1.1 (Butcher et al., 2020), and the National Plant Monitoring Scheme (NPMS) habitat correspondences (Pescott et al., 2019). Data for the vascular plant Hill-Ellenberg values were retrieved from the BSBI checklists, specifically the Nitrogen Score (N) (BSBI, 2017c), Moisture Score (F) (BSBI, 2017d), Reaction Score (R) (BSBI, 2017a), Salinity Score (S) (BSBI, 2017b), and Light Score (L) (BSBI, 2017e) checklists. The corresponding data for bryophytes was taken from BRYOATT (Hill et al., 2007). Four example datasets are bundled with `RMAVIS`: 1) Parsonage Down (Ridding et al., 2020), 2) Leith Hill Place Wood (Smart et al., 2024; Wood et al., 2015), 3) Whitwell Common (Smart, 2000), and 4) Newborough Warren (Wallace & Jones, 2018).

Version 1.0 of `RMAVIS` was built under R 4.4.0 (R Core Team, 2024) and depends on the `bookdown` (Xie, 2016), `bsicons` (Sievert, 2023), `bslib` (Sievert et al., 2024), `dplyr` (Wickham et al., 2019), `ggplot2` (Wickham et al., 2019), `htmltools` (Cheng et al., 2024), `htmlwidgets` (Vaidyanathan et al., 2023), `kableExtra` (Zhu, 2024), `knitr` (Xie, 2024), `magrittr` (Bache & Wickham, 2022), `markdown` (Xie et al., 2023), `plotly` (Sievert, 2020), `purrr` (Wickham et al., 2019), `reactable` (Lin, 2023), `readr` (Wickham et al., 2019), `rhandsontable` (Owen, 2021), `rmarkdown` (Allaire et al., 2024), `shiny` (Chang et al., 2024), `shinybusy` (Meyer & Perrier, 2024), `shinyjs` (Attali, 2021), `shinyWidgets` (Perrier et al., 2024), `stringr` (Wickham et al., 2019), `tibble` (Wickham et al., 2019), `tidyr` (Wickham et al., 2019), `vegan` (Oksanen et al., 2022), and `writexl` (Ooms, 2024) R packages.

## Conclusion

RMAVIS provides a web-based, easily accessible GUI for the assignment of vegetation sample plot data to GB NVC communities. RMAVIS also provides a number of other exploratory analyses, which compliment the NVC assignment results. We plan to maintain, optimise, and expand the functionality found in v1.0 of RMAVIS and hope that it acts as a useful tool for the GB ecology and conservation community.

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