The Irish Vegetation Classification – An Overview of Concepts, Structure and Tools

Philip M. Perrin CEnv MCIEEM
BEC Consultants Ltd, Dublin

Úna FitzPatrick
National Biodiversity Data Centre, Waterford

Deirdre Lynn
National Parks and Wildlife Service, Dublin

Keywords: distribution maps, ecological databases, fuzzy analysis, quadrat data, synoptic tables, vegetation communities

A new classification of the vegetation of Ireland is being developed utilising multivariate analysis and a large resource of existing quantitative plot data. In this article we introduce the concepts underlying the new system, the structure of the classification and the outputs and tools which are being made freely available to practitioners.

Figure 1. RH1A *Asplenium trichomanes – Ctenidium molluscum* crevice community, Gorteendarragh, Arroo Mountain, Leitrim. Photo credit NPWS.

Classifying, mapping and describing habitats and vegetation is a bread-and-butter task for many people involved in ecological research or environmental management. It is thus perhaps surprising that Ireland lacked a standard scheme for this purpose until 2000 when *A Guide to Habitats in Ireland* (Fossitt 2000) was published by The Heritage Council. It was soon widely adopted by those working in the public and private sectors, being often referred to simply as 'Fossitt'. It provides descriptions of natural, semi-natural and artificial habitats and is analogous to the Phase I habitat classification used in the UK. The accounts of terrestrial and freshwater habitats in this scheme draw in part on the numerous academic phytosociological studies conducted in Ireland over several decades, following the Braun-Blanquet approach widely used in continental Europe (see White and Doyle 1982). This approach conceives plant communities based on floristic composition and uses subjectively chosen diagnostic species to both differentiate between communities and to organise them into a hierarchical classification (Maarel 1975).

Notwithstanding the success of the Fossitt classification, there is still a need in Ireland for a scheme that will permit a more detailed level of recording, such as when monitoring change in vegetation or conducting surveys of protected habitats or sites (Phase II surveys in UK parlance). This requirement is reflected in the National Biodiversity Action Plan. Numerous theses and national surveys have produced detailed, separate classifications of specific habitats, but they vary considerably in methodology and the specificity of the categories. Although the British National Vegetation Classification (NVC) has been employed for some purposes in Northern

Ireland, it is not directly applicable to Irish vegetation due to significant differences in habitats and flora.

The Irish Vegetation Classification (IVC) seeks to meet this requirement by producing a single, unified framework which describes in detail all aspects of Irish natural and semi-natural vegetation. The project was commissioned by the National Biodiversity Data Centre (NBDC) in 2015 with funding from the National Parks and Wildlife Service (NPWS) and is being conducted by BEC Consultants. So far, grasslands, woodlands, saltmarsh, heath, bog and rocky habitats have been tackled (Figures 1-3). Initial development is due to be completed around 2020. The project has a number of underlying principles which guide development; these are outlined below.

Vegetation classification

As the name states, the IVC is a vegetation classification whose basic categories (the communities) are defined purely on floristic composition, with data on environmental parameters (e.g. substrate, altitude or inundation frequency) and management (e.g. mowing or fertilisation) being used only to ecologically interpret the categories *post hoc*, rather than helping to define the categories in the first place, as would be the case in a habitat classification such as the Fossitt or Phase I schemes.

Vegetation continuum

Species respond individually to changes along environmental gradients, creating continuous variations in species composition. Vegetation classifications are thus inherently artificial frameworks, but we need them so that we can divide this continuum into practicable units for tasks such as mapping and management. The IVC system incorporates the concept of transitional vegetation by using a statistical method called 'fuzzy analysis' to calculate for vegetation samples a degree of membership or best fit to each of the various possible communities, rather than samples belonging to only one community and not at all to others.

Figure 2. SM3B *Plantago maritima – Puccinellia maritima* saltmarsh, Ballyvoreen, Cork Harbour, Cork. Photo credit Marcin Penk.

Figure 3. GL3E *Festuca rubra – Rhinanthus* minor grassland, Cloongee, Mayo. Photo credit NPWS.

Statistically based

The classification is based on multivariate analysis of existing quantitative vegetation data from Ireland, mostly manually extracted from the National Vegetation Database (NVD) (see Box 1). Not all of the records used are relevés in the strict sense (i.e. subjectively placed quadrats for the purposes of phytosociology), so we refer to them by the more general term of 'plots'. These data have been collected by generations of ecologists, using different vegetation cover scales and for various purposes; inevitably, there are issues with suitability and consistency. Most data have not been recorded using percentage cover and need to be converted to mid-range values. Data from unusually large or small plots, plots seemingly lacking in bryophyte records, and plots where 5% or more of cover is recorded only at the genus level are excluded. Furthermore, it has been necessary to make numerous amendments and some compromises to overcome nomenclatural and taxonomic issues (e.g. combining records of *Agrostis canina* and *Agrostis vinealis*). In selecting an analytical approach from the wide selection available, we were influenced by a recent body of work on defining and managing dynamic vegetation classifications (see for example Wiser and De Cáceres 2013) and decided to use a version of fuzzy analysis called noise clustering which also identifies any outlier data that are poorly described by the current classification. Analysis has been conducted within the R statistical environment (R Core Team 2017).

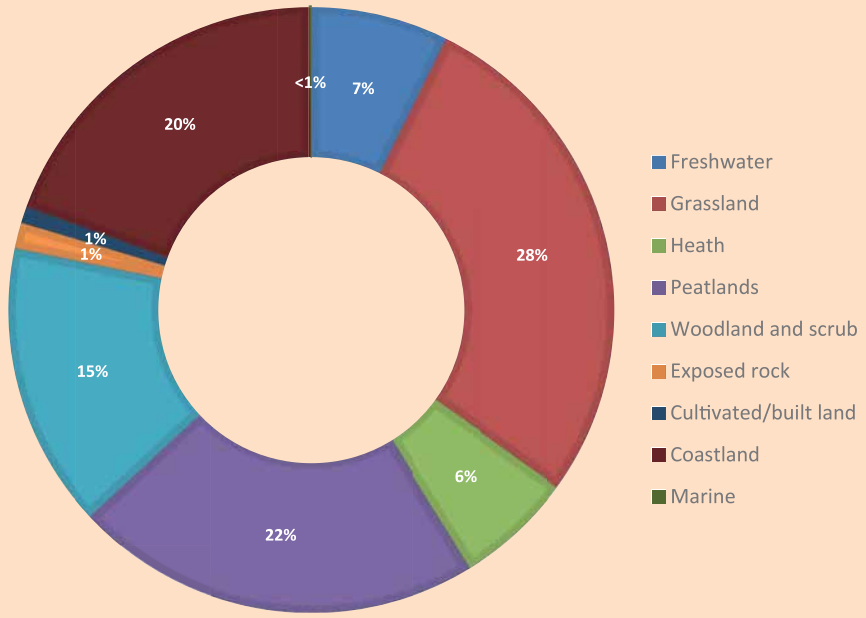
User-friendly

The IVC is designed to be accessible for a range of potential users, including field surveyors, environmental managers, planners, scientific officers, policy-makers, researchers and students. To this end, we have steered away from using the less intuitive phytosociological conventions to name our categories or to structure the classification.

The first main resource that the IVC provides is a series of 'community synopsis' documents, one for each community, and similar to the association descriptions produced by the United States National Vegetation Classification. Each synopsis contains a concise description of the vegetation, plus notes on its ecology, conservation, management, threats and similar communities, (cf. Averis *et al*. 2004). Extended descriptions (cf. Rodwell 1991) have been omitted so that users are able to quickly grasp the essence of each vegetation type. Distribution maps at the hectad level are included (Figure 4) showing when the most recent records were made (cf. Blockeel *et al*. 2014), whilst also indicating the number of records within each hectad. Synoptic tables display median Domin values in addition to the range (cf. Stevens *et al*. 2010). Mean cover-weighted values for Ellenberg's indicator values are provided. Finally, affinities with the categories of Fossitt, EU Habitats Directive Annex I habitats,

Box 1. National Vegetation Database

The National Vegetation Database (NVD) was established in January 2007 by the National Biodiversity Data Centre (NBDC) in conjunction with the National Parks and Wildlife Service. Ireland has a rich history in the collection of vegetation data, and it was recognised that this information is a valuable resource that should be digitally captured in a centralised national database. A national vegetation audit was conducted initially to identify sources of vegetation data, followed by a five-year phase of historical data capture to collate Irish vegetation plot data in the NVD. By May 2012, there were approximately 30,000 plots in the NVD. New data are being added as they become available.



Breakdown of all plots in the NVD (May 2012) by level one Fossitt habitat categories.

The software package Turboveg (Hennekens and Schaminée 2001) is used to store the NVD. This specialist vegetation data management program provides a standardised format for the exchange of data between researchers and is widely used in Europe. An Irish plant checklist, 'Ireland2008', was specially constructed by the National Botanic Gardens for use within the NVD. It includes vascular plants, bryophytes, lichens and charophytes, and incorporates all known synonyms that have been used in Ireland. Plot data can now be submitted to the NBDC in Turboveg file format and, indeed, projects such as the National Survey of Upland Habitats have made use of mobile device versions of Turboveg to record data in this format in the field. The NVD is part of the European Vegetation Archive and has been utilised by more than fifteen European initiatives to date.

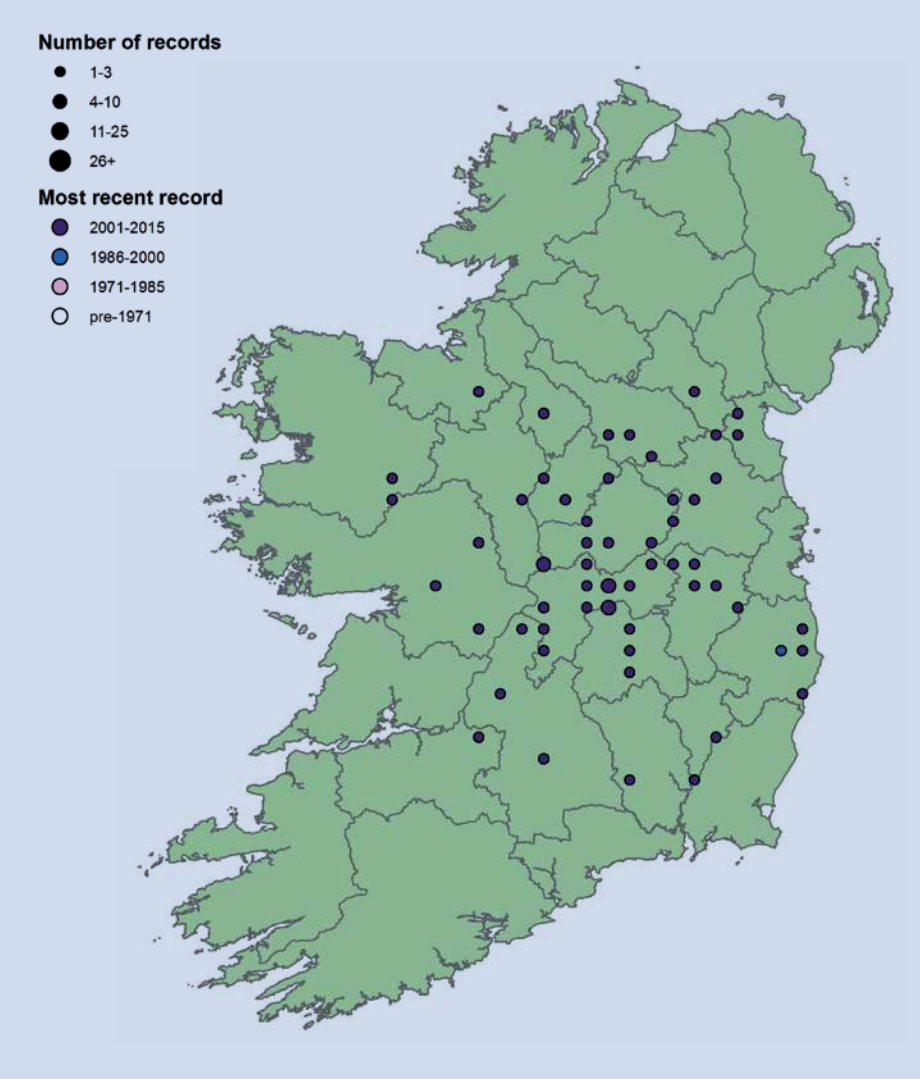


Figure 4. Hectad distribution map for WL4F *Betula pubescens – Pteridium aquilinum* woodland, which has established widely in the midlands on degraded raised bogs.

Level of hierarchy	Basis of differentiation	Example
Division	Dominant growth form and broad diagnostic species	Grassland
Group	Major environmental gradients	GL3 *Cynosurus cristatus* – *Plantago lanceolata* group
Community	Overall floral composition	GL3A *Briza media* – *Thymus polytrichus* grassland
Sub-community	Specific indicator species or subtle differences in floral composition	GL3Ai *Briza media* – *Thymus polytrichus* grassland Sesleria caerulea – Tortella tortuosa sub-community

Table 1. Hierarchy used in the Irish Vegetation Classification with examples.

phytosociological alliances, EUNIS habitats and the NVC are given. For example, an estimated 92% of plots defining GL3A *Briza media – Thymus polytrichus* grassland had been described as Annex I calcareous grassland (habitat code 6210) and 97.6% as Fossitt habitat GS1 Dry calcareous and neutral grassland.

Using the Irish Vegetation Classification in practice

Categories within the IVC are organised into a hierarchy (Table 1). Different levels within this can be used depending upon the scale and focus of a particular project. For larger surveys, scoping exercises and studies covering a wide range of habitats, the group level may be appropriate. For habitat-specific surveys, perhaps involving vegetation monitoring and assessment, the community level will provide the greater differentiation required. Sub-communities can be recorded where particular precision is needed. For example, within the heaths division, four groups are currently defined. The HE1 *Dryas octopetala – Sesleria caerulea* group comprises a single community representing the limestone heath found in karst areas of Galway and Clare. The HE2 *Erica cinerea – Calluna vulgaris* group contains five communities of dry or damp acidic heath, often dominated by *Calluna* and occurring at lower altitudes. The HE3 *Vaccinium myrtillus – Racomitrium lanuginosum* group comprises six communities of heath and heathy bog found in the montane zone. Lastly, the HE4 *Molinia caerulea – Polygala serpyllifolia* group contains five communities of wet heath and bog in which *Molinia* is usually abundant or dominant. See examples in Figure 5.

In the field, workers should find that compiling a quick list of the main plant species and referring to the descriptions, species tables and maps in the community synopses will often be sufficient to identify the best IVC category for any given area of vegetation. When working in unfamiliar habitats or areas of transitional or intermediate vegetation, some further guidance may be helpful. Furthermore, inter-observer variation in assigning vegetation to categories within a classification can be significant even when professional ecologists are using well-described categories (Cherrill 2013)




Figure 5. Communities from each of the heath groups within the IVC. Clockwise from top-left: HE1A *Dryas octopetala – Sesleria caerulea* heath; HE2A *Ulex gallii –Erica cinerea* heath; HE3D *Calluna vulgaris – Racomitrium lanuginosum* heath; HE4C *Molinia caerulea – Schoenus nigricans* bog/heath. Photo credit NPWS except top-left, Orla Daly.

with potential consequences for decision-making based on such data (Cherrill 2016). To this end, the second main resource the IVC provides is a software application called ERICA (Engine for Relevés to Irish Communities Assignment) to help users to consistently identify the communities to which their data fit best. It is thus similar in purpose to TABLEFIT and MATCH used in the UK. ERICA uses the same noise clustering method that defines the classification.

To use ERICA, fieldworkers have the option of two approaches. For each area of vegetation for they which need guidance, they can simply compile a list of the vascular plants and bryophytes. Or they can record the percentage cover of these plants in a plot or series of plots; 2 × 2 m plots are recommended for many habitats such as grassland, bogs and heaths. Plots may take longer to record but will yield more informative results. Species nomenclature needs to match that used by the IVC and a checklist is provided. Both species lists and plot data are uploaded to the ERICA application as simple spreadsheets (.csv files) with samples in rows and species in columns so multiple vegetation samples can be analysed at the same time. Formatting is explained in the manual and example data are provided. The analysis compares the uploaded samples with a reference dataset, currently comprising over 16,000 individual plots. For each sample, ERICA calculates the degree of membership to each IVC community as a percentage, highlighting the best match (Figure 6). Transitional samples and outliers are identified and summary data on species richness are given. Supplementary analyses provide a range of additional information: Simpson's index of diversity, Simpson's measure of evenness, mean values for Ellenberg's indicator values and measures of taxonomic diversity and species rarity. All results can be downloaded as a .csv file. ERICA is currently available as a web application, accessed through the NBDC website. A mobile phone version that can inform decision-making in the field is being trialled. Uploading data to ERICA does not automatically submit them to the NVD, although we do encourage users to submit their final datasets, if possible using Turboveg or the NBDC's standardised spreadsheet template.

Updateable

Any classification is naturally limited by the data upon which it is based. As classifications are used and new data are collected, it is inevitable that gaps,

either geographical or compositional, will become apparent and that revisions or additions to the scheme will become desirable (e.g. JNCC 2011). The IVC is a dynamic system that will be relatively straightforward to update or expand after initial development ends. The statistical approach facilitates this, allowing us to build the IVC progressively. Furthermore, the use of individual documents for the community synopses means that these can be more easily updated. Since all outputs from the project are web-based, they are free to access and use and we can also provide a large number of photographs to illustrate the vegetation.

Conclusions

Whilst acknowledging that all models are idealised, we hope that this one will be useful. There is still a substantial amount of work to be done: data from several habitats including fens, flushes, swamps and sand-dunes have yet to be incorporated into the classification, and some further optimisation will certainly be required. The cross-walk with phytosociological syntaxa will be strengthened by using the EuroVegChecklist Expert System to objectively identify classes. Note also that, currently, no data are included from Northern Ireland although it is hoped that this will be possible in the future to provide all-Ireland distributions in vegetation and assist cross-border initiatives. The IVC is already being used by national monitoring programmes (e.g. Annex I saltmarsh assessments) and some Irish universities. We hope that the project will stimulate further recording of appropriate plot data that can be used in future revisions, and will provide assistance to everyone working with vegetation in Ireland.

For further details on the IVC, to download the community synopses and to access ERICA, please visit: http://www.biodiversityireland.ie/projects/ivc

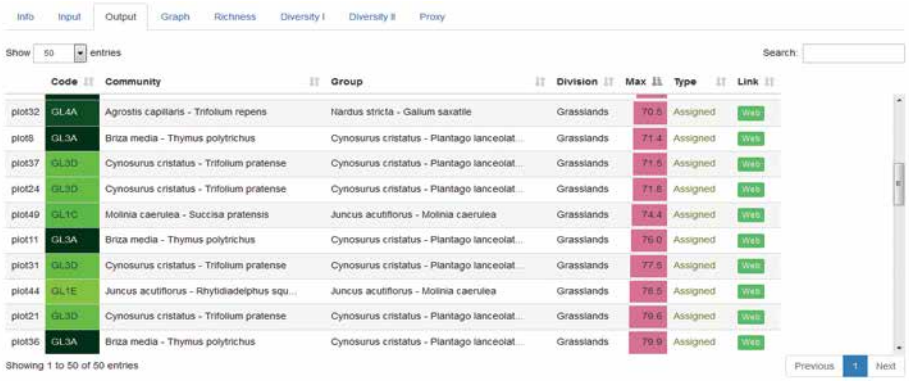


Figure 6. Example of main output from the ERICA application. For each sample plot, the maximum degree of community membership is shown together with the relevant community, community code, group and division. Each green 'web' button links to the online PDF of the relevant community synopsis.

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About the Authors

Dr Philip Perrin is a Director of Ecology at BEC Consultants Ltd, Dublin. He has been involved in national surveys and assessments of woodlands, grasslands and upland habitats in Ireland and is currently conducting research on saltmarshes.

Contact Philip at:
pperrin@botanicalenvironmental.com

Dr Úna FitzPatrick is a Senior Ecologist at the National Biodiversity Data Centre in Waterford. She has responsibility for managing the National Vegetation Database and the National Vascular Plant Database and is also project coordinator of the All-Ireland Pollinator Plan.

Contact Úna at:
ufitzpatrick@biodiversityireland.ie

Dr Deirdre Lynn works in the Scientific Unit of the National Parks and Wildlife Service. Her remit includes biodiversity policy formulation, biodiversity monitoring and also reporting at the national, EU and global level.

Contact Deirdre at:
Deirdre.Lynn@chg.gov.ie