4.1 Ordinations

An *ordination* is a *map* of the samples, usually in two or three dimensions, in which the placement of samples, rather than representing their location in space (or time), reflects the similarity of their biological communities. To be more precise, *distances* between samples on the ordination attempt to match the corresponding *dissimilarities* in community structure: nearby points have very similar communities, samples which are far apart have few species in common or the same species at very different levels of abundance (or biomass). The word 'attempt' is important here since there is no uniquely defined way in which this can be achieved. Indeed, when a large number of species fluctuate in abundance in response to a wide variety of environmental variables, with many species being affected in different ways, the community structure is essentially *high-dimensional* and it may be impossible to obtain a useful two or three-dimensional representation.

So, as with cluster analysis, several methods have been proposed, each using different forms of the original data and varying in their technique for approximating high-dimensional information in low-dimensional plots. They include:

a) *Principal Components Analysis*, PCA (see, for example, Chatfield & Collins (1980));

b) *Principal Co-ordinates Analysis*, PCO (Gower (1966));

c) *Correspondence Analysis* and *Detrended Correspondence Analysis*, DECORANA (Hill & Gauch (1980));

d) *Multi-Dimensional Scaling*, MDS; in particular *non-metric MDS* (see, for example, Kruskal & Wish (1978)).

A comprehensive survey of ordination methods is outside the scope of this manual. As with clustering methods, detailed explanation is given only of the techniques required for the analysis strategy adopted throughout the manual. This is not to deny the validity of other methods but simply to affirm the importance of applying, with *understanding*, one or two techniques of proven utility. The two ordination methods selected are therefore (arguably) the simplest of the various options, at least in concept.

a) PCA is the longest-established method, though the relative inflexibility of its definition limits its practical usefulness more to multivariate analysis of environmental data rather than species abundances or biomass; nonetheless it is still widely encountered and is of fundamental importance.

b) Non-metric MDS does not have quite such a long history (though the key paper, by Kruskal, is from 1964!). Its clever and subtle algorithm, some years ahead of its time, could have been contemplated only in an era in which significant computational power was foreseen (it was scarcely practical at its time of inception, making Kruskal's achievement even more remarkable). However, its rationale can be very simply described and understood, and many would argue that the need to make few (if any) assumptions about the data make it the most widely applicable and effective

method available.

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