Escuela Practica: an introduction to vegetation sampling using computer simulation

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Bill's main teaching responsibilities are with first year science and agriculture students in general botany, and third year students in quantitative ecology and community ecology. Research interests are biased towards applied ecology and include conservation of urban remnant vegetation, restoration of mined land, rangeland ecology and dendrochronology.

Introduction

The fact that vegetation varies from location to location and with time is common knowledge. The description of this spatial and temporal variation, or pattern, is a prelude to seeking an ecological explanation for the observed variation. It is essential, therefore, that students in ecology receive a grounding in the methods used to describe vegetation.

The elements of vegetation description are outlined in any of the large number of available standard texts (*e.g.,* Greig-Smith 1983; Causton 1988). These elements include sampling design, measures of plant abundance, type of distribution, identification of association between species, and the scale of any observed pattern.

Prior to 1987 third year plant ecology students at The University of Western Australia were given their introduction to the methods of vegetation description in the field. A set of four artificial populations were occasionally used in the laboratory, principally when the weather was too wet for field work, to illustrate the effects of plant distribution and quadrat size on estimates of frequency and density. It was found that these exercises offered several advantages over conventional field work. Compared with the field work they could be completed relatively quickly; the students did not have to cope with problems of species identification; and, because they were able to compare their sample estimates with the known parameters of the artificial populations they had greater confidence in the methods being demonstrated.

In 1987 the four artificial populations were designated as separate species and combined into a single map. To introduce more variation additional species exhibiting a range of distributions (random, clumped and regular) and associations (positive, independent, and negative) were added. In an attempt at further realism separate overlays were generated containing information representing soil type and topography. Students were now able to investigate not only aspects of vegetation description but the next ecological step of how the discovered species patterns might be related to abiotic factors of the environment. An Apple University Development Fund award in 1990 of $3000 enabled the transfer of the map information to the Macintosh microcomputer format.

EcoMap Software

The vegetation and environmental information is represented in the computer as a mythical reserve, *Escuela Practica* (from the Spanish *Escuela* = School and *Practica* = Practical). Four files make up this data representing, respectively, the species symbols, their coordinates, the soil type and topographical elevations.

The application to run *Escuela Practica* is EcoMap, a software package written in Pascal† . EcoMap is believed to run on all Macintosh microcomputers from the MacPlus upwards using System 6.0.3 or later and Finder 6.1.3 or later. It can be run from a floppy disk, is faster from a hard disk but once loaded no further use of the disk is required. Memory requirements are less than 200K of RAM. Currently the software has to be installed on individual machines. At present the software will not run on PC-compatibles.

Once the data files have been loaded the main Map window appears showing a portion of the *Escuela Practica* Reserve. Location of the observer (the cursor) is indicated by coordinates on the top and left screen margins. Two other optional windows are available. The Key window provides a legend of the species symbols while a floating Measure window allows distances between points to be measured on the screen.

Laboratory Use

Escuela Practica currently comprises 12 species (max is 20). The 10 species forming the understorey are represented by small geometric shapes, the two tree species and their respective canopies by circles. Students are encouraged to begin their investigation as they would in the field, by carrying out a simple reconnaissance. In this phase they are expected to 'stroll' through the Reserve using the scrolling controls and note any obvious patterns in species distributions, the relative abundances of the species and their association with environmental features. This scrolling feature offers a major improvement over the original paper version as it is no longer possible for students to see all the Reserve at once, just as would apply in the normal field situation. Impressions gained during the reconnaissance can be checked against results obtained during the later detailed sampling.

The reconnaissance phase is followed by a series of exercises aimed at developing a more complete description of *Escuela Practica's* vegetation and environment. Vegetation sampling is possible using plot or plotless methods. Plot methods involve placement of sampling units (quadrats or transects) of some specified size and shape. In the *Escuela Practica* simulation, the quadrats (max 20) can be square (the default option), rectangular, circular or oval. Quadrat shape and size are selected from dialogue boxes under the Sampling menu. Belt transects are located and sized using the rectangular quadrat command. A separate option is available for locating line transects. Apart from the line transects all plot samples are positioned with their sides parallel to the Reserve boundaries. Quadrats that happen to be inadvertently positioned too close to the Reserve boundaries will be 'flipped' over so as to fit within the Reserve.

Plotless methods involve selection of one or more individuals from, usually, a series of randomly selected points. Distances between the selected individuals and sampling points will also be measured using the Measure device. In practice the easiest way to set up the sampling points is to position a series of line transects across the Reserve and position the sampling points randomly along these lines.

The Instructor's Manual which accompanies the *Escuela Practica* simulation presents a series of basic exercises for students to complete. These include the relationship between plot size and species richness (for species-area curves); estimating the density and frequency of each species and the effect of quadrat size on these estimates; and determination of plant distribution type.

A second group of exercises explore possible relationships, for example, whether there is any association between the tree species and understorey species; the relationship of tree biomass and distance between nearest neighbours; and between tree diameter and canopy cover.

Two of the included plant genera have simulated mosaic distributions. The scale of these mosaics is estimated using the block-size analysis of variance approach of Greig-Smith (1952).

While some of the statistical implications of the various sampling procedures are covered in the Instructor's Manual, supplementary exercises are given to the students to develop their experience in the use of basic univariate and bivariate statistical methods, both parametric and non-parametric. The same exercises are also used to introduce students to graphing procedures, spreadsheets and word processing. Selected exercises are written up as a formal assignment for marking.

Current Use and further Development

Consideration was given during the writing of EcoMap to having the exercise data recorded automatically but costs precluded this option. At present all data are recorded manually by the students and then entered into the appropriate software application. While there would be savings in time with automatic recording it is believed that, despite availability of hand held microcomputers, the manual system is still more like the field situation in which most students will find themselves later working.

The availability of present day colour monitors offers potential for some further innovations, for example, subjective estimations of plant abundances in the field can be influenced by whether or not particular species are flowering.

Student response to *Escuela Practica* over the six years it has been used at The University of Western Australia has been positive. Students with little familiarity of microcomputers seem especially to benefit because of the multiplicity of ancillary software applications they are introduced to as part of the overall exercise. However, it has been found important to match students based on their familiarity with microcomputers otherwise the more experienced tend to take over.

In 1995 the Department of Geography at The University of Melbourne introduced *Escuela Practica* into its first year teaching program. Exercises successfully used were the introductory ones on species area curves and quadrat sampling. Further extension of the use of *Escuela Practica* is likely to be dependent upon producing a PC version of the EcoMap software and plans are in hand to do this over the next 12 months.

References

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† EcoMap was written by Dr M Wheatley, currently at the UWA Development Unit for Instructional Technology. The concept and data for *Escuela Practica* were developed by Associate Professor David T. Bell and the author.