— NOTE —

The Self-Similarity Curve: a New Method of Determining the Sampling Effort Required to Characterize Communities

ABSTRACT

Species-area curves are frequently used to suggest sampling effort requirements for characterization of communities. However, this method utilizes only species richness information, while ignoring species identities and abundances. By plotting H′ (Shannon-Weaver diversity) against sampling effort, species richness and species abundances are considered, but species identities are still ignored. The self-similarity method described here utilizes information on species richness, species abundances, and species identities to suggest sampling effort requirements. This self-similarity curve plots the Morisita similarity of two sample sets from a single community against progressively larger sampling effort. When sampling effort sufficiently represents a community, the similarity plateaus near a value of one.

Ecologists frequently confront the question of sampling adequacy. If too few samples are collected, patterns in the data are obscured by random "noise," while over-collection of samples wastes resources and time. Sampling-effort curves suggest the appropriate effort that is required to adequately represent a community by plotting progressively larger sampling effort against a community parameter derived from the samples. The validity of such a technique hinges on the ability of the selected parameter to represent the community.

A commonly used sampling-effort curve is the species-area curve in which the cumulative species richness is plotted against sampling effort (Pielou 1977, Gilbertson et al. 1985). The curve tends to plateau when the majority of common species have been collected, and thus a sampling effort corresponding to the asymptote of the curve should provide an adequate representation of species present in the community. This approach assumes that the number of species is a sufficient measure of community structure even though information regarding the abundances and identities of individual species is ignored.

Information regarding abundances of individual species and species richness may be incorporated into a sampling-effort curve by replacing cumulative species richness with species diversity (Bloom 1992). Unfortunately, plots of sampling effort against species diversity do not necessarily result in curves which rise monotonically and plateau. Instead, curves may peak and then decrease as addition of rare species drives the evenness component of diversity downward. Furthermore, diversity indices focus only upon the number of species and their abundances, while ignoring the actual identities of individual species.

Information regarding abundances of individual species, identities of individual species, and species richness will be retained by a sampling-effort curve based on a similarity index. A curve of this type, which we call a self-similarity curve, plots the similarity of two sample sets from the same community against progressively larger sampling efforts. Low sampling effort provides poor representation of the community, or large random error, and subsequently results in low similarity . Progressively greater sampling effort provides better representation of the community and higher similarity. When sample sets are large enough to be truly representative of the community, similarity of the two sample sets will increase to approximate a constant value, typically one.

Self-similarity curves plotted for two data sets will serve as an example. The data sets consist of counts of Chironomidae genera found in core samples collected from two freshwater herbaceous wetlands, designated R5 and G1, in central Florida. One hectare grids were established in each wetland, and samples were collected from evenly spaced intervals within the grids. At wetland R5, 100 samples contained a mean of 11.3 (S.D. = 8.6) individuals and 3.8 (S.D. = 1.5) genera per sample. At wetland G1, 97 cores contained a mean of 21 (S.D. = 36) individuals and 3.0 (S.D. = 2.0) genera per sample. We have chosen to use Morisita's index of similarity (Morisita 1959) because its expected maxima is not directly affected by sampling effort once that effort is great enough to overcome random sampling error (Wolda 1981).

For clarity, let m = total number of samples collected from a wetland and let n = number of samples, or sampling effort, considered in the similarity computation. Thus m also represents all of the samples available in the data matrix. To construct the similarity curve, two sets of n samples are randomly drawn from the data matrix without replacement, such that no individual sample occurs in both sets, and the similarity of the two sample sets is computed. Sample sets of size $n = 1..m/2$ are possible. For each value of n, the process is repeated with replacement r times to allow computation of a mean similarity and standard error. For our example, calculations were run using Community Analyses System software (Bloom 1992) with $r = 10$.

The self-similarity curve consists of a plot of mean similarity against progressively greater sampling effort (Figure 1). For wetland R5, similarity between the two sample sets plateaus at approximately 1 with a sampling effort of about $n = 25$. For wetland G1, similarity between the two sample sets plateaus at approximately 1 with a sampling effort of about $n = 35$. Thus, the community in R5 could be characterized by 25 samples, and the community in G1 could be characterized by 35 samples. In both cases, curves are somewhat irregular due to chance events in the selection of sample sets.

The self-similarity method shares at least three limitations with other sampling-effort curves. First, the exact position of the similarity plateau must be judged subjectively. Second, relative "importance" of species is not considered, and thus species which play a major role in structuring communities will be treated no differently than other species. Third, the variety of form, or phylogenetic distance between species (Van Valen 1965), is not considered. Nevertheless, the self-similarity curve is superior to other sampling-effort curves because it retains information on species identities, species abundances, and species richness, while other sampling-effort curves do not.

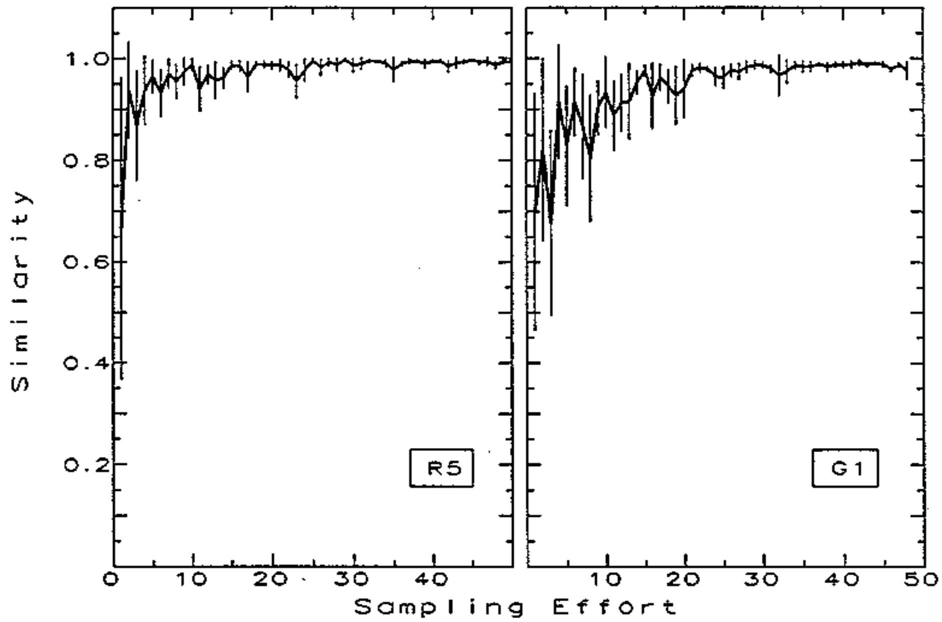

Figure 1. Self-similarity curves for Chironomidae communities from two freshwater herbaceous wetlands in central Florida.

Literature Cited

Bloom, S.A. 1992. The Community Analysis System 4.2. Ecological Data Consultants, Inc. Archer, Florida.

Gilbertson, D.D., M. Kent, and F.B. Pyatt. 1985. Practical Ecology for Geography and Biology; Survey, Mapping and Data analysis. Hutchinson and Company. London.

Morisita, M. 1959. Measuring of interspecific association and similarity between communities. Memoirs of the Faculty of Science, Kyushu University, Series E, Biology. 3: 65-80.

Pielou, E.C. 1977. Mathematical Ecology. John Wiley & Sons, Inc. New York.

Van Valen, L. 1965. Morphological variation and width of ecological niche. American Naturalist. 99: 377-390.

Wolda, H. 1981. Similarity indices, sample size and diversity. Oecologia. 50: 296-302.

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