

A species-area curve analysis of floras in 62 New York State counties

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BACKGROUND

Among the 62 counties of New York, the number of known species of vascular plants per county varies fivefold from below 300 species to over 1500 species (www.nyflora.org). Species richness, the number of different species in an area, is typically attributed to three major factors: 1) surface area (Coleman et al. 1982), 2) distance to neighboring populations (MacArthur and Wilson 1967), and 3) habitat heterogeneity (Nichols et al. 1998). In particular, the species richness–area relationship (S-A curve) has been the foundation of island biogeography theory and remains one of the strongest ecological correlations recognized by ecologists (Gotelli 2001). Thus, large and ecologically diverse counties situated near other diverse counties would be expected to have the greater species richness. This prediction assumes that all areas are sampled with equal effort—a condition that is almost certainly invalid in the county data for our flora. The objective of this study was to use the S-A curve approach to identify New York counties likely to be under-sampled as one mechanism to identify research priorities for under-represented areas of the state.

METHODS AND RESULTS

Data for the 62 county flora totals were obtained from the New York Flora website (www.nyflora.org) and provided the measure of species richness. The area of each county in square miles was provided by Steve Young of the NYS Natural Heritage Program from their database (personal communication). I plotted an S-A curve for our 62-county flora data set using the \log_{10} of species richness and the \log_{10} of area in square miles (Figure 1) which is a standard analytical approach to S-A curve depictions (Gotelli 2001). As expected, the trendline was a positive and generally linear relationship, although that relationship was not statistically significant ($R^2 = .01$; $p = .37$).

Deviations above or below the predicted line were then examined to identify potential over- or under-sampling, respectively. The ten counties that deviated by the greatest amount below the predicted line were, in rank order of greatest deviation: Orleans, Montgomery, Broome, Wyoming, Fulton, Cortland, Franklin, Steuben, Otsego and Alleghany. Those that deviated above the predicted line by a similar degree were, in rank order of greatest deviation: Suffolk, Albany, Orange, and Nassau.

DISCUSSION

In this analysis, I attribute the lack of a significant trendline in S-A curve to undersampling in several counties. Alternately, deviations from the trendline could be the result of county-level differences in geomorphological heterogeneity (Nichols et al.

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1998). If the deviations were primarily the result of differences in heterogeneity, then we would expect adjacent counties of similar size and with similar geomorphological or physiographic conditions to contain nearly equal species richness. Several examples of counties paired by size and physiography but differing markedly in species richness indicate otherwise. For example, Schuyler, Chemung and Tioga are similar in that each are small agricultural counties of 400-600 mi² in area, all in the south central part of the State. Yet the species richness of Chemung (960 species) is nearly twice that of neighbors that border a Finger Lake (Schuyler, with 466 species) or the Susquehanna River (Tioga, with 581 species). Likewise, the neighboring Mohawk River valley counties of Schenectady and Montgomery differ in known flora, with the much smaller Schenectady Co. (202 mi² and 992 species) containing over three times the species richness of the larger Montgomery Co. (404 mi² but with only 269 species). Human population density and botanical expertise may play some role in these disparities. Substantial botanical effort and sampling interest may explain the rankings of Albany, Orange, Suffolk and Nassau counties as outliers in the direction of over-represented flora counts.

The ten under-represented counties in this analysis clearly deserve more efforts in the field, particularly with documented, vouchered specimen collections deposited in a State recognized herbarium. One strategy would be to survey under-represented counties in clusters of two or three counties and revisit them at intervals over the growing season in order to capture a better representation of species present. For example, because of the proximity of three of these ten counties to SUNY College at Oneonta's Biological Field Station (BFS) in Cooperstown, Otsego Co., it would make sense to investigate the floras of Otsego, Fulton and Montgomery counties as a group. Likewise, the counties of Cortland and Broome might be surveyed as another cluster.

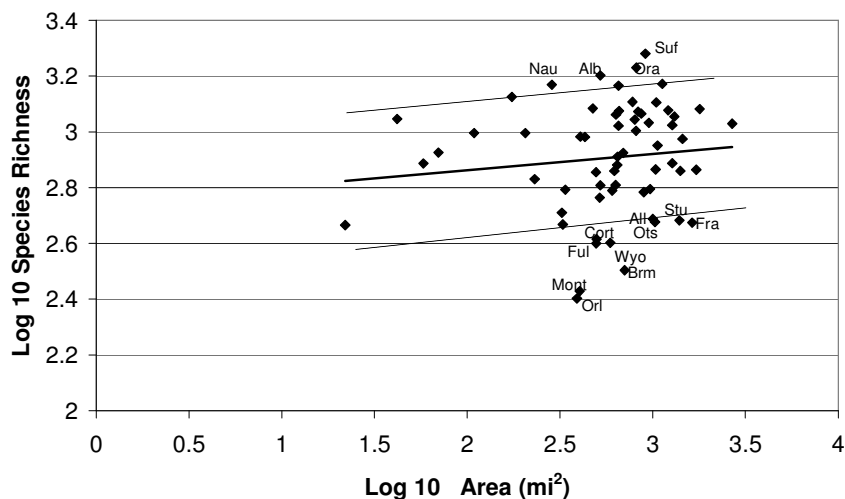


Figure 1. Species-area curve for 62 New York counties. Labeled counties are those deviating furthest from the trendline. Correlation was not statistically significant ($r = .11$, $R^2 = .01$, $p = .37$).

Admittedly, a few summer field surveys are likely to capture only the more obvious representatives of the flora, yet they would go a long way towards equity in the floristic database we now have. On the larger scale, under- and over-represented floras make it difficult to evaluate gaps in our knowledge base. With better equity of field investigations, a reanalysis of these county floras would more likely reflect a stronger S-A relationship. With a statistically significant S-A curve, deviations from the predicted line would more likely be the result of habitat heterogeneity and enable us to focus on regional hot spots of true biodiversity (Nichols et al. 1998). A realistic S-A curve would also enable us to fit the relationship $S = cA^z$ where c is the y-intercept constant representing a minimum species richness per unit (i.e., per mi^2) and z is the rate of increase in species richness as a function of area (Gotelli 2001). Values of c and z are taxon and region specific, but once they are reasonably estimated, a fitted S-A curve can be used to make improved inferences about under-sampled regions throughout the State.

Regional floristic surveys may have other benefits to understanding our State's biodiversity. Regional sampling would enable us to track the migrations of newly invasive species (e.g. swallowwort, www.ipcnys.org) across the counties of New York or the change in species composition as a response to climate change (Kareiva et al. 1993). Constant ground-truthing is necessary to monitor the integrity of our wetlands, which are technically protected by State and Federal law but are under constant threat of development and alteration. Poorly surveyed counties many contain unknown pockets of unusual diversity and possibly rare species. Perhaps most importantly, if we continue to assume that low species richness indicates a lack of true biodiversity rather than a lack of effort, then under- sampled counties will continue to be neglected.

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