1990

Aspen site index as related to plant indicators

D.K. Walters

J.P. Sloan

V. Kurmis

ASPEN SITE INDEX AS RELATED TO PLANT INDICATORS

D.K. Walters, J.P. Sloan, and V. Kurmis[1]

ABSTRACT.--Eighty-five fully stocked, even-aged, aspen stands representing a wide range of ages were examined. Using published site index equations, the site index of these stands was estimated. A second available indicator of site quality was the soil productivity group used by the Soil Survey. Each of these site quality indicators was related to synecological coordinates (moisture, nutrient, heat, light) of 85 stands. In this case, synecological coordinates were identified through the use of indicator plant species (synecological coordinates).

While site index is often the simplest and most straightforward method of predicting site productivity, problems can arise because of a number of factors (e.g., genetic differences, stand origin, inappropriate extrapolation of equations, and either understocking or overstocking). One possible way of avoiding some of these problems is to base estimates of site productivity on a more robust indicator. This study examines the hypothesis that synecological coordinates predicted from indicator plant species is such a robust indicator. Previous work by Sloan (1981) indicated that this was a possibility.

METHODS AND RESULTS

In this study, we examined 85 fully stocked, even-aged, aspen stands which represented a wide range of ages. The 85 stands were a subset of data collected in Carlton County, Minnesota (see Sloan, 1981 for a complete description). Table 1 provides a summary of these data.

INDICATORS OF SITE QUALITY

Several common indicators of site quality were available for these stands. Site index as estimated from published site index equations is one such indicator. Numerous published equations were examined and it was determined that the Gevorkiantz (1956) equations were most appropriate. This was based on an examination of the data and on the widespread acceptance of these equations. A second conventional indicator of site quality is the soil productivity groups used by the soil survey and developed by Lewis (1978). In this process, soil series are ranked and placed into one of seven soil productivity groups based on site index information obtained from the soil survey of Carlton County. Where possible, aspen site indices are used, otherwise interspecies correlations (Benzie 1977, Perala 1977) provide aspen site index estimates for the soil series. As part of the data collection effort in this study, various soils variables were collected, including soil series.

[1]D.K. Walters, J.P. Sloan, and V. Kurmis, Research Specialist, former Graduate Research Assistant, and Associate Professor, respectively, Department of Forest Resources, University of Minnesota, St. Paul, MN 55108

Table 1.--Data for 85 aspen stands in Carlton County, Minnesota.

	Mean	Standard Deviation
Age	71.47	10.99
Site Index (Gevorkiantz)	21.94	7.16
Soil Survey Productivity	58.07	16.95
Moisture Coordinate	2.53	0.20
Nutrient Coordinate	2.56	0.19
Heat Coordinate	2.33	0.18
Light Coordinate	2.83	0.24

SYNECOLOGICAL COORDINATES

The method of synecological coordinates is used to show distribution and interrelationships of forest communities in edaphic and climatic fields. More succinctly, four fields of influence are made explicitly; moisture, nutrients, heat, and light. For this study, the work by Bakuzis (1959, 1960) was used to determine synecological coordinates for the 85 aspen stands. This work is based on the premise that moisture, nutrient, heat, and light regimes can be measured indirectly by the presence of the plants. Therefore a complete list of plant species and frequency was made for sample plots on each of the 85 stands. Each species is assigned a coordinate value for moisture, nutrients, heat, and light. The coordinate values range from a low value of 1.0 to a high value of 5.0. The values are a function of where a species most commonly occurs under prevailing competition. The values for each species existing in a stand are then averaged to provide an estimate of the four coordinate values for the stand.

ANALYSIS

Using simple correlation analysis, the site index was related to the synecological coordinates. These results are contained in Table 2.

Table 2.--Pearson correlation matrix with site index[1][2].

	Site Index	Age	Moisture	Nutrients	Heat	Light
Site Index	1.00					
Age	-0.54*	1.00				
Moisture	0.25*	-0.06	1.00			
Nutrients	0.28*	-0.09	0.25*	1.00		
Heat	0.10	-0.07	-0.10	0.70*	1.00	
Light	-0.16*	0.01	-0.37*	-0.57*	0.02	1.000

[1]Based on 85 aspen stands in Carlton County, Minnesota.
[2]*Indicates significance at the 90 percent level.

Similarly, the relationship between soil productivity and synecological coordinates is simply portrayed through a correlation matrix in Table 3.

After examining these matrices, it is clear that nutrient and light coordinates are highly correlated with the moisture coordinate. The highest relationship between a site quality indicator and a synecological coordinate is that between site index and nutrient status, the second highest is between site index and moisture status. The correlations are significant at the 90 percent level. A third significant relationship is between soil survey productivity index and nutrient status. Several three dimensional graphs portraying these relationships are given in Figures 1 and 2.

CONCLUSIONS

Results from this study indicate that there are statistically significant relationships between synecological coordinates and various conventional indicators of site quality. These relationships can also be detected graphically (Fig. 1 and Fig. 2). This result is useful in cases where synecological coordinates are known (as part of a habitat type system, for example) so that the land manager can obtain a numeric estimate of the site quality. Such estimates often facilitate management decisions and may be required as input to various growth and yield or planning tools. Ten ecological types were recognized and delineated on these stands. Stands in any particular ecological type are expected to be of approximately the same productivity, to have similar tree reproduction, to follow common successional trends, and to respond uniformly to treatment. Of more importance is the implication that synecological coordinates or other, similar variables may have valuable and practical role as site quality estimators in their own right. Implicit in this study is the knowledge that both site index and the soil survey productivity codes are estimates, each having a certain amount of error. So the relationship between true site quality is only an estimate. Synecological coordinates may have a much higher relationship to the true site quality than they do to the two estimates of that parameter which were used in this study.

Table 3.--Pearson correlation matrix with soil productivity[1][2].

	Soil Prod.	Age	Moisture	Nutrients	Heat	Light
Soil Prod.	1.00					
Age	0.17	1.00				
Moisture	-0.12	-0.06	1.00			
Nutrients	-0.20*	-0.09	0.25*	1.00		
Heat	-0.14	-0.07	-0.10	0.70*	1.00	
Light	0.16	0.01	-0.37*	-0.57*	0.02	1.00

[1]Based on 85 aspen stands in Carlton County, Minnesota.
[2]*Indicates significance at the 90 percent level.

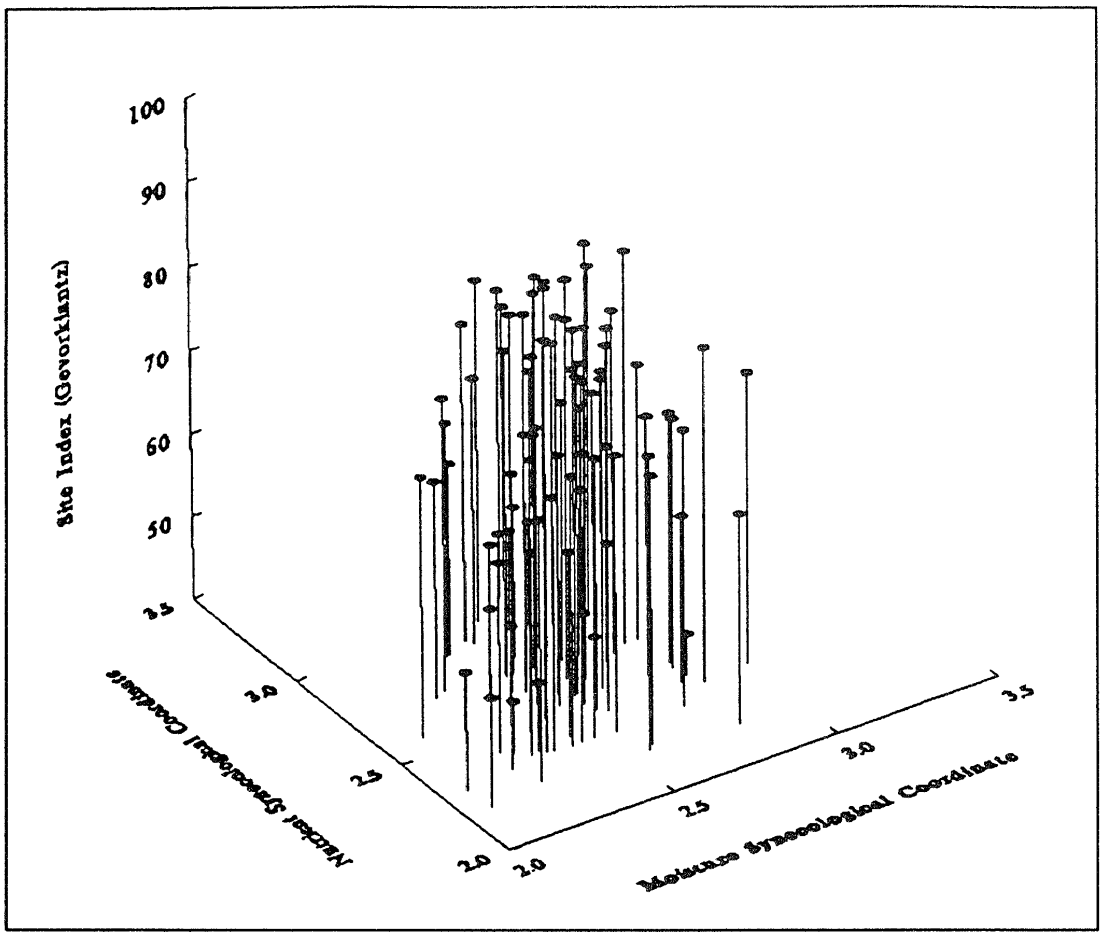

Figure 1.--Site index versus nutrient and moisture synecological coordinates for 85 natural aspen stands in Carlton County, Minnesota.

LITERATURE CITED

Bakuzis, E.V. 1959. Synecological coordinates in forest classification and in reproduction studies. Ph.D. Thesis. University of Minnesota, St. Paul, Minnesota. 244 p.

Bakuzis, E.V. 1960. Structural organization of forest ecosystems. Minnesota Academy of Science Proceedings 27(1959):97-103.

Benzie, J.W. 1977. Manager's handbook for jack pine in the North Central States. U.S.D.A. Forest Service, North Central Forest Experiment Station, General Technical Report. NC-32. 18 p.

Gevorkiantz, S.R. 1956. Site index curves for aspen in the Lake States. U.S.D.A. Forest Service, Lake States Forest Experiment Station, Technical Note 485. 2 p.

Lewis, R.R. 1978. Soil Survey of Carlton County, Minnesota. U.S.D.A. Soil Conservation Service. 77 p.

Perala, D.A. 1977. Manager's handbook for aspen in the North Central States. U.S.D.A. Forest Service, North Central Forest Experiment Station General Technical Report NC-36. 30 p.

Sloan, J.P. 1981. Aspen site productivity classification in Carlton County, Minnesota. M.S. thesis. University of Minnesota, St. Paul, Minnesota. 135 p.

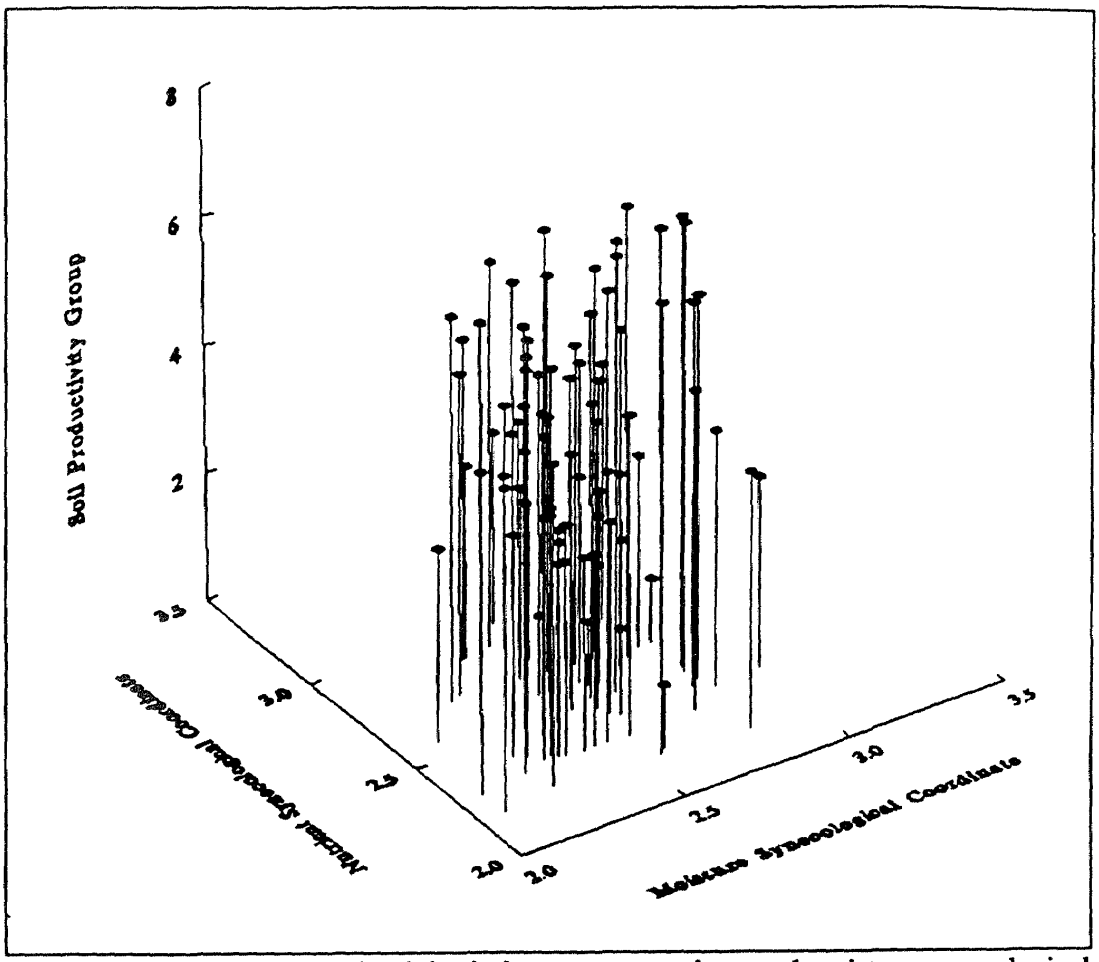

Figure 2.--Soil survey productivity index versus nutrient and moisture synecological coordinates for 85 natural aspen stands in Carlton County, Minnesota.