MINNESOTA FORESTRY NOTES

No. 91
April 15, 1960

USE OF ECOGRAPHS IN ANALYZING SPECIES - ENVIRONMENTAL RELATIONSHIPS IN FOREST COMMUNITIES[1]

Egolfs V. Bakuzis and Henry L. Hansen[2]

An ecograph is a graphic (geometric, topological) presentation of the requirements or adaptation of a specis to two or more environmental factors simultaneously. Ecographs may simply outline the possible factor combinations at which a species occurs, or they may indicate relative frequencies of species at particular combinations of factors. By means of this procedure it is possible to visualize general relationships between a tree species and its environmental complex. Such relationships when described verbally or by conventional mathematical and statistical procedures are often difficult to understand.

The primary purpose of this report is to describe the skeletal steps involved in preparation of ecographs and to illustrate by means of tree species data collected in 1957 from 356 forest stands throughout Minnesota.

Because of the difficulties of measuring species' synecological requirements, ecographs have usually been constructed on a relative scale basis using vegetational or physiographic indicators of the relative intensity levels of the factors involved. While ecographs can be constructed for any factor combinations, the most useful are the bivariate combinations of moisture-nutrients (edaphic coordinates) and heat-light (climatic coordinates). The general procedure for this construction is as follows:

1. Community synecological requirements for moisture, nutrients, heat, and light were determined from field data for 356 forest communities in Minnesota following the method described in Minn. For. Note No. 84.
2. The community requirements data were plotted on the ecographs in terms of the pairs of coordinates used. The resultant scatter diagrams represent the distribution of the communities over the edaphic and climatic fields. Insofar as the communities sampled represent the conditions within the State, these diagrams also depict the general nature of the factor complex in Minnesota. These total fields are indicated in the figure by the total outline of the squares, each square (ecotope) being a unit combination of a pair of factors.
3. For each species a scatter diagram was similarly prepared using only those communities containing the species in question.
4. Frequencies were computed in individual ecotopes by dividing the number of communities containing the species by the total number of communities in the ecotope and expressing it as a percent.
5. Isolines at the 0, 40, and 70 percent levels of frequency were drawn using ordinary contour mapping procedures. These isolines define the shaded zones in the figures.

The xeric, low-nutrient position of both Pinus banksiana Lamb. and Pinus resinosa Ait. in their ecographs agrees with common knowledge. However, Pinus banksiana is shown to occur with greater frequency on xeric sites which have higher nutrient levels.

With few exceptions the ecographs show one distribution maximum. However, for Quercus macrocarpa Michx. and Quercus ellipsoidalis E. J. Hill there are two maxima. In both species one maximum zone represents lower heat requirements (more northerly) and higher light requirements (less shade tolerancy) than does the other.

1/ This project was supported in part by Graduate School Research Grant Funds.
2/ Research Associate and Professor, respectively, School of Forestry, Univ. of Minn.

Published by the School of Forestry, University of Minnesota, St. Paul 1, Minnesota, cooperating with the Division of Forestry, Minnesota Conservation Department, and Forest Industries of Minnesota

Shade tolerance seems to increase with an increase in the heat factor for several species (Tilia americana L., Ostrya virginiana (Mill.) Koch, Acer saccharum Marsh., Abies balsamea (L.) Mill., Picea mariana (Mill.) B.S.P., Picea glauca (Moench) Voss, and others). By contrast, Pinus banksiana, Pinus resinosa, and Populus tremuloides Michx. become more intolerant with increasing heat. This may explain the inability of the latter species to extend their distribution southward by existing as understories to species better adapted climatically.

Besides the analysis of individual ecographs, a comparison of several ecographs of trees or other species (e.g. comparison between the Pinus strobus L. and Ribes spp. ecographs), an analysis of a series of ecographs, comparisons of the distribution patterns of soil groups (see Minn. For. Note No. 90), or other combinations, may be very helpful in synecological studies.

ECOGRAPHS OF TREE SPECIES IN MINNESOTA

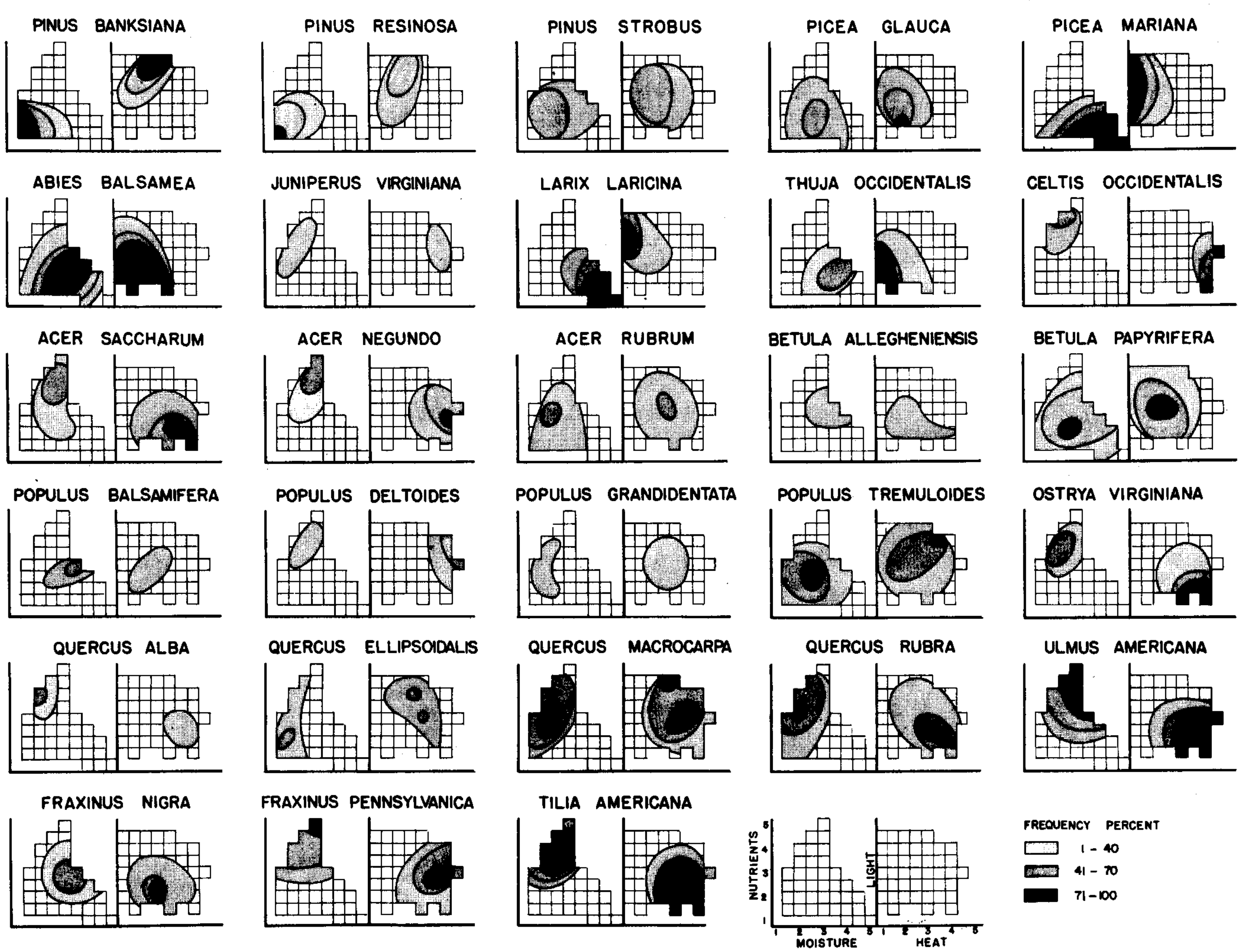

Figure. Ecographs of tree species in Minnesota based on frequency of occurrence in systems of edaphic and climatic coordinates.

Published as Sci. Jour. Series Paper No. 4360 of the Minnesota Agr. Expt. Station