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Compositae

Bidens cernua L.—Buell & Buell 643.
B. coronata (L.) Britt.—Huff (photo in private collection of Prof. N. L. Huff); Buell & Buell 660.
Eupatorium maculatum L.—Buell & Buell 623.
Helianthus giganteus L.—Rosendahl 6421.
Lactuca biennis (Moench.) Fern.—Buell & Buell 706.
Prenanthes alba L.—Buell & Buell 698.
Solidago gigantea Ait.—Rosendahl 6428 (*sub* S. canadensis); Buell & Buell 626 (*sub* S. serotina).
S. uliginosa Nutt.—Buell & Buell 690.

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INDICATOR VALUE OF PLANTS IN JACK PINE STANDS

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For several hundred years foresters have been classifying forests and forest lands. This classification has been along several different lines and for several different purposes. The most obvious system of classification is one which is based on the species of trees actually occupying the area at the time of classification. This has been commonly referred to as the "cover type" system of classification, and gives primary consideration to the practical and immediate problems of the forester in managing the forest.

This cover type system of classification fulfills quite adequately the need for simple, reasonably homogeneous units into which the forest can be classified. However, although the cover type classification serves some of the practical management needs of the forester in dealing with his forest, it fails in several respects. For example, two areas having identical

cover types may differ widely in the rate of growth taking place on the trees in the two areas. This is a matter of great concern to foresters. It is important to know how fast the trees are growing and what rate of future growth can be expected. Without this information, it is impossible to plan intelligently for the harvesting of the trees and their utilization.

This basic need for knowledge of the growth rate of forest stands led to the development in the early days of forestry in Europe of the concept to which the term "site" has been applied. In American forestry usage, this term has been defined by the Society of American Foresters, Committee on Forest Terminology (Society of American Foresters, 1944) as "an area considered as to its ecological factors with reference to capacity to produce forests or other vegetation; the combination of biotic, climatic, and soil conditions of an area." The ecologists term "habitat" is essentially a synonym of site. Where a classification of site has been developed, the various units are referred to as "site classes" and express gradations of "site quality."

A number of different kinds of site classification systems have been developed. These group under three primary headings: those systems based on some aspect of tree or stand growth such as height or volume, those based on selected factors of the environment such as soil or topography, and those based on the use of indicator plants.

By far the most common and generally accepted criterion of site quality in American forestry has been the relative rate of height growth of the dominant trees. The use of height growth has been formalized into a system of "site index" classes. These site index classes express what is considered to be the productivity of the area in terms of the tree species for which the classification is made.

European foresters, particularly those in Russia, Finland, the Baltic countries and Sweden have in more recent years developed classification systems which they feel are based on criteria having more fundamental significance than the relative rate of height growth. In these systems, plant indicators play an important role. These systems are based on the assumption that the plants growing on an area are in themselves the best criterion of the productive capacity of the area, and best express the composite effect of all the complex of the environment. The term "site type" is commonly applied to the units in such a system. Perhaps the closest synonym in ecological terminology is the term "edaphic climax."

The writer was interested in determining the possible relationships between site index classes for jack pine as determined by the conventional use of rate of height growth of the dominant trees and the possible occurrence of plant indicators. One of the specific objectives was to determine whether plants could be used with any reliability to indicate the site quality of the area in terms of site index of jack pine. A study was undertaken of sixty-five separate jack pine stands distributed so as to sample most of the major jack pine areas of Minnesota.

In connection with this study one of the major problems lay in the fact that a search of the literature of a phytosociological nature failed to uncover any satisfactory concept which would evaluate in quantitative terms the reliability of plants as indicators of site or habitat conditions.

It was felt that such a concept was essential to place any investigation on an objective basis. The purpose of this paper is to report on this phase of the broader investigations into site factor relationships of jack pine. It was felt that the approach used in this study might have possible application in other studies of the use of plant indicators.

The sixty-five jack pine stands were examined by laying out large tenth-acre plots on which data on the trees were collected. Within each tenth-acre plot, twenty (20) one-foot-square quadrats were distributed at random. A complete listing of the secondary vegetation by species and number of individuals was recorded for each quadrat.

The frequency and constancy concepts as described by Braun-Blanquet (Braun-Blanquet; 1932) were used in the study of the vegetation. In general form, these are the figures obtained by dividing the number of occurrences of a species by the number of possible occurrences and expressing the resultant figure in per cent. When this was computed for a species within a single stand of jack pine, the figure was considered to be the frequency per cent. When the computation was applied to the possible occurrences of a species on all different stands, the result was considered to be the constancy per cent.

In deciding on the usefulness of a plant species as an indicator of site, the constancy of that species on the site condition it represents does not give a complete analysis of its indicator value. For example, one of the common jack pine grasses, *Oryzopsis asperifolia,* has a constancy value of 100 per cent on poor sites. However, it also has a constancy of over 75 per cent on both medium and good sites, so that it cannot be said to indicate poor site with any degree of reliability. Some measure of exclusiveness to the site conditions it should indicate must exist. This exclusiveness is the "fidelity" concept referred to by Braun-Blanquet. The degree of fidelity or exclusiveness expresses the rigidity of the limitation of the species to a particular community or habitat. Several classifications of the degree of fidelity have been used, but none is well suited to quantitative determination and evaluation.

It must also be noted that fidelity alone is no better as a criterion of value as an indicator species than is constancy. In this study there were approximately 60 species restricted entirely to good sites as indicated by a O constancy in the other site classes. Such species have high fidelity to the good site habitat, but are so infrequent of occurrence as to be of little practical value as indicators of good site. The ideal indicator is thus one which is always found on a given habitat or in a certain community and is never found elsewhere. Such a species is perhaps nonexistent in nature, and we must be content with a reasonable approach to this ideal. In connection with the present study it was considered desirable to devise some numerical index by which an evaluation could be made of the various species in terms of both constancy and fidelity. This index has been called "Indicator Value" and is very easily computed:

$$\text{Indicator value} = \left\{ \frac{X}{N_1} - \frac{Y}{N_2} \right\} .100$$

X = number of plots in the site class being considered on which the species occurs.
N_1 = total number of plots examined in the site class in question.
Y = number of plots on all other sites examined on which the species occurs.
N_1 = total number of plots on all sites examined except those in N_1.

The $\frac{X}{N_1}$ factor is an expression of constancy while the Y factor expresses lack of fidelity. If a species were a theoretically perfect indicator species, occurring on one site only and on all stands of that particular site, it would have an $\frac{X}{N_1}$ (constancy) factor of 1 and a $\frac{Y}{N_2}$ (lack of fidelity) factor of O. The indicator value would thus be 100 per cent by the above formula. Conversely, if a species were not present on the sites in question, it would have a constancy factor of O and the Indicator Value would also be O. Thus it is possible to express indicator value numerically on a scale in which O represents no indicator value and 100 represents the perfect indicator.

The number of stands examined must be sufficient to give reliability to the two factors of the formula. In the case of the number of stands examined for the second factor (sites other than the one being considered), all the communities or sites which are to be distinguished from the site or community in question should be adequately sampled.

A specific example from the data collected may serve to illustrate the way in which the formula may be applied. In the examination of the sixty-five plots it appeared that bearberry, *Arctostaphylos Uva Ursi (L.) Spreng.* might have considerable value as indicating poor sites for jack pine. Its indicator value was accordingly determined. The species was found to have a constancy of occurrence of one hundred per cent on poor sites; that is, it occurred on all plots taken in poor site stands examined in the study. However, it also occurred (or had a lack of fidelity) on thirty nine per cent of the good and medium site plots. Its indicator value was therefore one hundred minus thirty-nine per cent, or sixty-one per cent.

It is interesting to note that of the 189 species encountered in the study of jack pine sites, the bearberry which had a value of 61 per cent had the highest indicator value of any species. In other words, this means that while the presence of bearberry correctly indicated poor jack pine sites on 100 per cent of the poor site stands examined, it incorrectly indicated poor site jack pine conditions on 39 per cent of the medium and good sites. Hence its net indicator value was only 61 per cent.

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