Vegetation Within A Portion of the Copper-Nickel Study Region

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ABSTRACT—Cluster analysis of data from 277 Braun-Blanquet releves differentiates 11 major forested communities in a 1,450 sq km area of northeastern Minnesota. Upland communities include black spruce-jack pine, jack pine, red pine, aspen-birch, aspen-birch-fir, and mixed conifer-deciduous. Forested wetland communities include black spruce, tamarack, cedar, ash, and alder carr. The greatest floristic differences are between those communities at opposite extremes of the moisture spectrum, and greatest similarities between red pine and aspen-birch-fir communities. Floristic similarities and differences are reflected by the positions of communities in the synecological moisture nutrient field Structural differences between upland communities are more notable than floristic differences.

Northeastern Minnesota's copper and nickel deposits have long been known, but increased interest in mineral exploration during the 1970's prompted a proliferation of scientific investigations into the other natural resources of the area identified with these deposits. The research reported here was initiated in 1972 as part of the Kawishiwi mapping project, continued through preparation of the logging history map for the State Department of Natural Resources (DNR) MINESITE project, and was completed as part of the MEQB's Regional Copper-Nickel Study. This aspect of the investigation sought to characterize vegetation of a 1,450 sq km portion of the Copper-Nickel study area (figure 1). Summarized data from the regional study, archived in the Minnesota Land Management Information System (MLMIS), provides a general understanding of present vegetation within the area but are limited in usefulness as baseline data by the low sampling intensity of vegetation within each unit.

Vegetation of the area is a mosaic of types, influenced by underlying rugged topography. In the north, adjoining the Boundary Waters Canoe Area (BWCA), the scenery is dominated by bedrock ridges and valleys, through which the Kawishiwi River flows. Soils are shallow. Conifers have long been an important component of the vegetation, both in mixture with deciduous species and in upland black spruce-jack pine, jack pine, and red pine stands. The central portion of the study area is dominated by aspen and birch in rough moraine country with pines and conifer wetlands on outwash. The Toimi Drumlin Field in the south once favored stands of white pine, attested by giant stumps. Following the 1937 Palo-Markham-Aurora fire, much of the western portion of this area was replanted in red pine, jack pine, and white spruce. Farther east, beyond the fire line, drumlin ridges are dominated by aspen and birch, with shrub carr in intervening swales.

Defining the plant communities

The Braun-Blanquet releve method (Shimwell, 1971) has been used to define plant communities in northwestern Minnesota (Janssen, 1967) and in north central Minnesota (Minnesota Pollution Control Agency, MPCA, 1977). The method is especially useful in studies of large areas where rapid sampling is desired. The field survey provides a visual estimate of cover and abundance for all species in all structural layers within a 200 sq m plot. In the case of the regional study, cover-abundance values for canopy species were used to group stands by cluster analysis (Orloci, 1967) into 11 major forest communities. The use of canopy species assures that clusters can be related to vegetation units detectable on aerial photos at a scale of 1:15,840. The resultant classification defines the habitat types used by the regional study in its analyses of avian (Pfanmuller, 1979) and small mammal populations (Batten, 1980).

With the exception of two community types that were not sampled quantitatively (black spruce-jack pine and ash), the communities recognized by cluster analysis of releve data were further characterized by their quantitative attributes based on data from a subset of 62 stands. Available data included tree species density and basal area, shrub species density and basas area, and herb species coverage. Voucher specimens for species encountered in the 62 quantitative sample plots are deposited at the herbarium of the University of Minnesota.

Because the cluster analysis was based on canopy data alone, the percent of total dispersion of clusters provides a measure of canopy similarity but no indication of overall floristic similarity. Jaccard's coefficient of similarity (Greig-Smith, 1964) was therefore used as an independent measure of total floristic similarity between communities (table 1).

Table 1. Jaccard's coefficient of community between communities.

	Spruce	Tamarack	Cedar	Mixed Spruce Jack Pine	Jack Pine	Red Pine	Ash	Aspen-Birch	Aspen-Birch-Fir	Mixed Conifer-Deciduous	Shrub Carr
Spruce	1.000	.406	.418	.506	.356	.267	.328	.427	.454	.476	.311
Tamarack		1.000	.335	.243	.171	.222	.336	.227	.213	.229	.323
Cedar			1.000	.370	.255	.387	.373	.356	.404	.392	.344
Mixed Spruce Jack Pine				1.000	.307	.533	.314	.473	.494	.563	.320
Jack Pine					1.000	.407	.157	.371	.378	.352	.139
Red Pine						1.000	.318	.607	.635	.575	.306
Ash							1.000	.275	.281	.343	.437
Aspen-Birch								1.000	.590	.528	.220
Aspen-Birch-Fir									1.000	.569	.219
Mixed Conifer-Deciduous										1.000	.264
Shrub Carr											1.000

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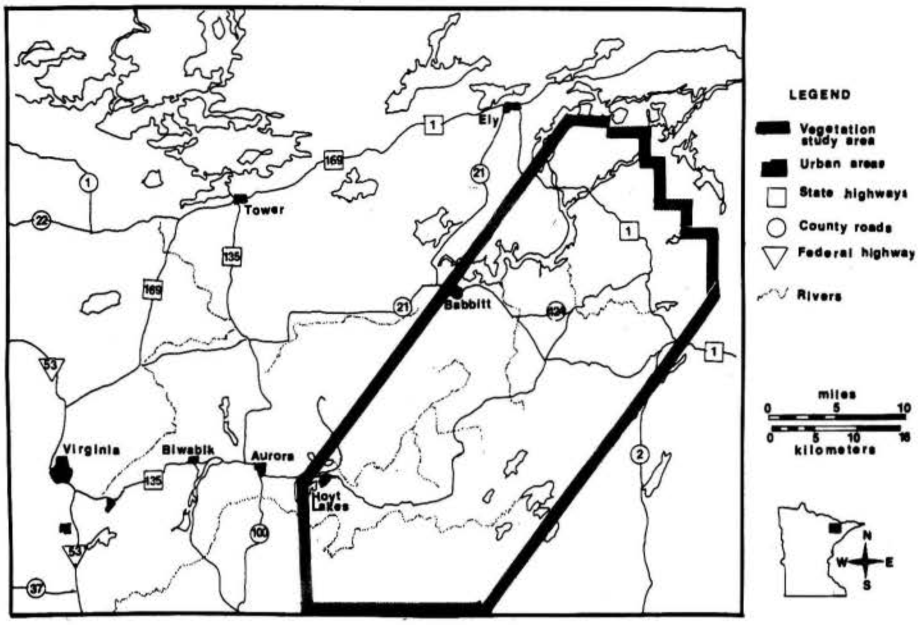
FIGURE 1 LOCATION OF VEGETATION STUDY AREA WITHIN REGIONAL COPPER-NICKEL STUDY AREA



In order better to understand the relationship of the classified communities to each other, the method of synecological coordinates (Bakuzis, 1959) was used to define the positions of communities in edaphic (moisture and nutrients) and climatic (heat and light) fields. This method makes use of reported ecological preferences of individual species to determine average stand conditions. The ecological field of an entire community is comprised of the spread of values for the individual stands within the community.

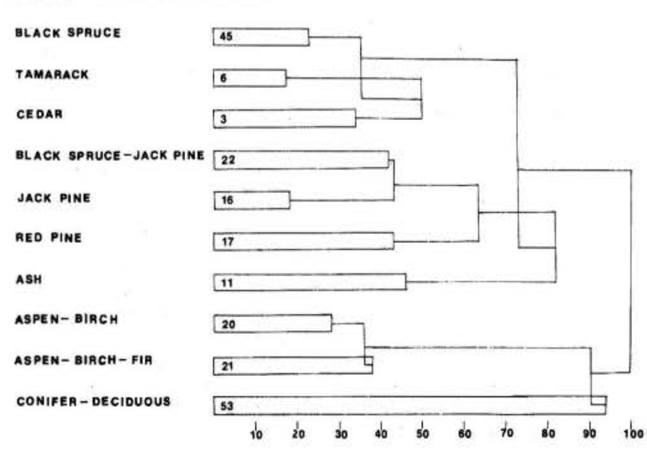
Distribution of communities charted

The summary dendrogram (figure 2) indicates the number of stands grouped in each cluster as the number within each bar. Length of the bar for each community indicates the level of dispersion which unites all stands within the community. Length of the horizontal lines connecting communities indicates the percent of total dispersion, a measure of the similarity of clusters to each other. The shorter the line, the greater the similarity between clusters. Immature stands and the shrub carr community are not included in this dendrogram because stands without trees greater than 10 m were automatically excluded from the analysis based on canopy species. These stands were classified by a separate analysis based on data from the shrub layer (Sather, 1980). As can be seen from the summary dendrogram, canopy data alone suggest that conifer bogs are more similar to each other than to other communities and more similar to conifer uplands than to deciduous uplands. Aspen-birch and aspen-birch-fir communities are more similar to each other than to the diverse conifer-deciduous community. The latter community contains stands more different from each other in proportions of dominant canopy species than the differences that exist within the entire upland continuum of deciduous and mixed communities.

Jaccard's coefficients, which take into account the shrub and herb species, indicate a slightly different set of affinities between communities. According to this measure, the red pine and aspen-birch-fir communities are most similar, with a coefficient of .635 (table 1). This similarity is probably accounted for by the high proportion of red pine plantations on sites previously occupied by aspen-birch or deciduous forest types. The great similarities between site conditions of upland communities are reaffirmed by the closely overlapping synecological spaces of the aspen-birch, aspen-birch-fir, red pine, and jack pine communities (figure 3). The mixed conifer-deciduous and black spruce-jack pine communities extend nearer the wet end of the moisture gradient, overlapping the synecological field of lowland black spruce communities. Differences between upland communities are exhibited more in their canopy composition and structural attributes than in their floristic composition. Important structural differences between communities are revealed in table 2, which summarizes selected quantitative data for all communities investigated.

The five major wetland communities recognized by cluster analysis are restricted to those with woody components. Sedge fens, which are present in the area, were sampled only in the survey and are clustered either with shrub carrs or conifer wetlands, depending on their floristic affinities as has been previously reported (Brown, 1973) high densities of leatherleaf *(Chamaedaphne calyculata)* occur in those communities with more open canopies, whereas Labrador tea *(Ledum groenlandicum)* is better developed in shadier stands. Although none of the sampled wetlands is truly ombrotrophic, receiving all of its nutrient input from rainfall, the

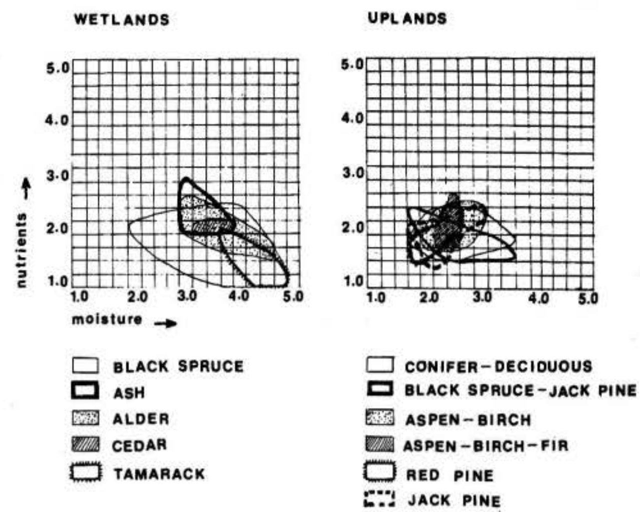
FIGURE 2 SUMMARY DENDROGRAM



highest percentage of ombrotrophic indicators (Heinselman, 1970) occurs in the tamarack community. The position of this community in synecological space, at the wet end of the field with low nutrient status, concurs with the high proportion of ombrotrophic indicators. The ash and cedar communities, which contain the highest proportion of Heinselman's (1970) minerotrophic indicators, occupy a more central position in synecological space with higher nutrient status.

The purpose of this study was the characterization of vegetation within an area likely to bear the impact of extraction of heavy metals. Potential impacts of mining were not considered in the sample design and cannot be assessed directly from the data collected. These impacts could best be understood by pursuing studies of community function in test areas where heavy metals are presently entering the ecosystem, rather than by investigation of structural and floristic characteristics. It is hoped that an understanding of the types of vegetation present in the area may serve future researchers in developing sample designs which adequately test impacts on all units of the vegetation mosaic.

FIGURE 3 DISTRIBUTION OF COMMUNITIES IN SYNECOLOGICAL SPACE



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