DEPARTMENT OF FORESTRY · CANADA ·

FOREST RESEARCH BRANCH

Photo Interpretation and Forest Land Classification

by

MICHEL JURDANT

FOREST RESEARCH BRANCH CONTRIBUTION No. 634

Reprinted from

WOODLANDS REVIEW SECTION

PULP AND PAPER MAGAZINE OF CANADA

October, 1964.

PHOTO INTERPRETATION and forest land classification[1]

MICHEL JURDANT[2]

Purpose of a forest land classification

THE GREAT MAJORITY OF PEOPLE, and probably also many foresters, seem to accept Merriam Webster's definition of a "forest": "a dense growth of trees and underbrush covering a large tract of land". And yet, it does not work if one considers the silvicultural and management problems that face the contemporary forester. A biocenotic concept of the forest is certainly more scientific and probably more useful. In that perspective, to the definition above must be added that the forest results from the combined action of variable physical and biotic factors among which Major (1951) pointed the five essential ones, i.e. climate, soil parent material, relief, organisms and time.

The need for classifying forest lands has long been recognized. The divergences appear when the forest is studied as an academic object of interest or in relation to the practice of forestry. Because the kinds of classification units are established qualitatively and quantitatively by the purpose, it is primary that such a purpose be clearly defined.

The standing committee on silviculture of the Canadian Institute of Forestry recently emphasized six criteria, the recognition of which was felt fundamental to the practice of forestry in Canada. One of these is that: "Intensified silviculture and intensified forestry are one and the same thing" (Crossley, 1964). Discussing the justification of forest site classification, the committee agreed also that "forest site classification is fundamental to any silvicultural program".

The authors of the new American soil classification (Soil Survey Staff, 1960) emphasized the importance of the purpose of a classification when they wrote:

"Classifications are contrivances made by men to suit their purposes. They are not themselves truths that can be discovered. Therefore, there is no true classification; a perfect one would have no drawbacks when used for the purpose intended; the best classification is that which best serves the purpose or purposes for which it was made or for which it is to be used."

If a classification has to be developed for forested lands, the purpose should not be anything else but to facilitate forest management. Such a classification, therefore, has a practical objective and its excellence will be judged by its utility with respect to that particular end: forest management. As an illustration, and to be more concise, a good classification is that one which will enable the forester to evaluate and delineate on a map at relatively low cost areas uniform in respect to the following features:

(1) current productivity;
(2) potential productivity;
(3) natural regeneration possibilities;
(4) shrub and weed competition hazard;
(5) soil erosion hazard;
(6) soil materials for road buildings;
(7) reaction to silvicultural treatments.

Is the forest land an ecological system? What are the current trends in forest land classification? How can photointerpretation techniques be used for ecological mapping of the forests? Do the uses of these techniques influence the system of classification itself? These are the questions that will be tentatively approached in this paper.

Forest land, an ecological system

The above definition of a forest leads us to consider the forest land as an ecological system or ecosystem that is "any area of nature that includes living organisms and non-living substances interacting to

---

[1]Department of Forestry, Canada Forest Research Branch Contribution No. 634.

[2]Research Officer, For. Res. Br., Dept. of Forestry, Sillery, P.Q.

Paper presented at the Forestry Field Meeting sponsored by the Woodlands Section, Canadian Pulp and Paper Association, held at Baie Comeau, Que., September 1, 2, 3, 1964.

produce an exchange of materials between the living and non-living parts" (Odum 1961). It is, therefore, a three dimensional system in which both biotic and physical parts are homogeneous throughout. Since the Botanical Congress in Montreal in 1959, the ecosystem has been "adopted as a fundamental concept for the description, classification and investigation of forests" (Rowe, 1959).

Thus, as an ecosystem, the forest land has to be classified on the basis of significant features of both vegetation and land (soil, relief, climate).

Current trends in forest land classification

Two conscious or unconscious assumptions are usually made by all those who classify forest lands. The first is that the forest is the result of the interaction of climate, relief, parent material, living organisms (including man) and time and that wherever these factors are alike, the forest is the same. The second assumption is that we can expect similar response on sites that are similar.

In the Province of Quebec, attention has been given to Forest Site Classification by using a vegetation-centred approach. This is exemplified by the contributions of Heimburger (1941), Linteau (1955) and Lafond (1960).

So numerous are the different approaches to the problem of forest land classification that it is not intended here to present a review of these systems but rather to outline the directing concepts actually followed by most research people engaged with these problems in Canada. The trend is important because it will influence to some extent the future forest land classification. Probably the papers of Hills (1960), Lacate (1961) and Rowe (1962) best indicate the actual trend which gives as much importance to the non-living as to the living parts of the forest ecosystem. There is also a definite tendency to regionalize large territories in order to reduce geographic variation due to major changes in climate, geology and physiography. That these regions be the "site regions" of Hills (1960), the "Forest Regions" of Rowe (1959), the "Ecoregions" of Loucks (1962) or the "Bioclimatic Zones" of Krajina (1959) is not important provided that such a subdivision reduces complexity and provides us with a geographic framework in which similar responses may be expected within similar forest land units.

The most important feature of the new trend in forest land classification lies in a close integration of climate, geology, relief, soil and vegetation. All are significant attributes of a site and are used in the description, classification, mapping and evaluation of the latter. This is the only way to look for relationships between forest growth and the environment, the object of ecology.

There are various ways to classify on such a basis and it is important to note that decisions as to what sites belong together will rarely be unanimous. People classifying plants, animals or soils have exactly the same difficulties and yet their classifications are widely used. Uniformity, however, is desirable but it can be obtained only if the classification criteria are objective and not subjective. It is subjective if it proceeds from the beliefs of the classifier about sites in general. In an analysis of the logic of soil classification but which should hold also for any forest land classification, Cline (1963) developed the idea that:

"A classification system can prejudice the future. If its criteria are hypotheses without some device for constant and inescapable scrutiny in relation to fact, the hypotheses become accepted as fact. Such acceptance can mould research into patterns of the past and can limit understanding of even new experience to concepts based on knowledge of the past".

As an example, let us take the well-known Hylocomium-Oxalis forest type. The type was defined on the basis of purely floristic criteria. However, Linteau (1955) found H-0 mostly at the foot of the mountains or slightly higher on compact sandy loam glacial till in poorly-drained positions where-

at: moderately deep to deep deposits of granitic stony loamy sand consisting of basal and superglacial till.
tg: shallow deposits of granitic stony loamy sand consisting of superglacial till and colluvium. The bedrock is sufficiently close to the surface to influence tree growth
wt: water worked till with much of the fine materials removed by flowing water.
af: alluvial fan. Low cone shaped deposits of water-laid sediments with local areas of water washed till.
rt: river terrace. Water-laid sandy sediments occupying a relatively elevated position above present riverbed.
fp: recent floodplain.
gr: bedrock of igneous origin. Deposition of drift is too shallow to obscure outlines of bedrock micro-topographical features.
cf: colluvial fan. Cone shaped deposits at the foot of steep slopes and that have moved chiefly by gravity.

Fig. 1. Landform map.

as Lafond (1960) describes it on lower slopes or mountain top on sandy or gravelly soils in well-drained positions. Obviously, the type occurs on all these sites but the inference that similar responses are to be expected in all is subjective because it lies on the assumption that plant indicators always reflect features of importance to the tree and that succession and syngenetic status of a vegetation type is similar throughout all ecotopes in which it is found. It is necessary and certainly more objective to differentiate an H-O on hydromorphic humus podzol on poorly-drained washed till from a H-O on iron humus podzol on well-drained ice contact stratified drift unless there is some objective evidence that the two sites are ecologically similar. Any other attitude would prejudice the future.

The Federal Forestry Department in Quebec is actually involved in Forest Land Classification following the concept of ecosystem, the latter being defined by Rowe (1962) as: "a perceivable unit of the landscape, homogeneous both as to the form and structure of the land and as to the vegetation supported thereon." This classification of the ecosystems is based on a vegetation classification and on a soil classification within a geomorphic framework. The basic units of these three separate classifications are respectively the plant association (Braun-Blanquet, 1932), the soil series (Soil Survey Staff, 1960) and the landform, the combination of which constitutes an ecosystem type which is then a true vegetation-soil-landform unit.

The use of air photo interpretation in ecological mapping of the forests

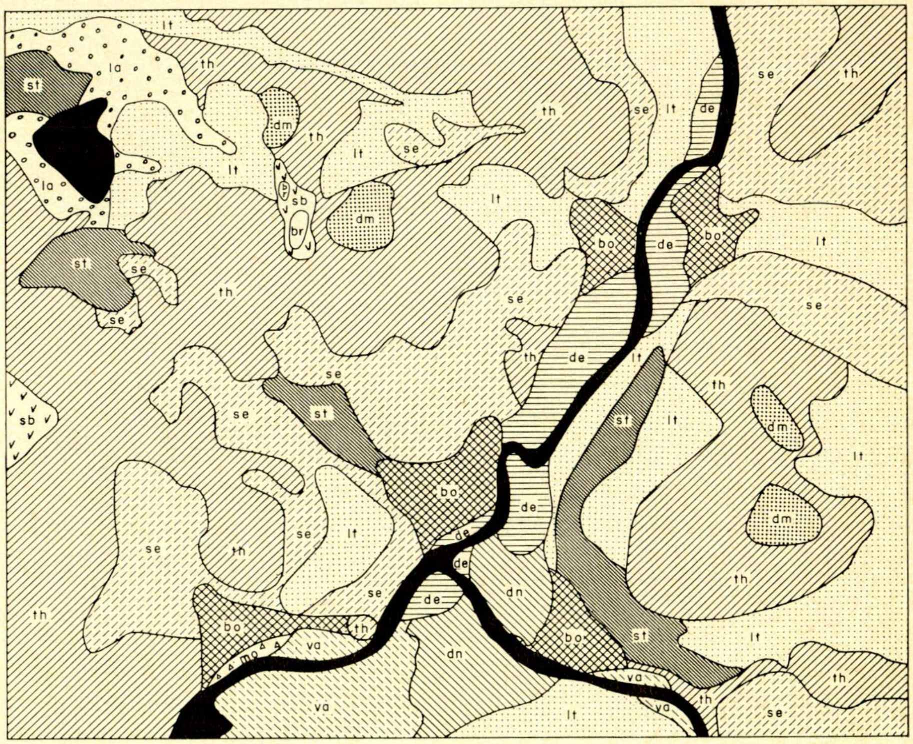
One of the most important specifications to be met before a classification system can receive the seal of approval has been defined by the standing committee on silviculture as one that "must be capable of rapid completion at a reasonable cost" (Crossley, 1964). This means that the classification units should permit the determination of units that are mappable on air photographs.

There are many features of the environment that are significant in the evaluation of a forest site. However, there is no universal answer to the question as to which are the most relevant. Consequently, in addition to the purpose of the classification itself, the techniques that are to be employed in developing the classification will influence to a large extent the kind of units that are to be established.

The features that can best be identified or inferred on aerial photographs are: tree vegetation, topography, depth of soil, stream drainage pattern, surface erosion features, soil texture, soil drainage, type of bedrock. It is evident that neither the soil profile nor the lesser vegetation can be of any use at this stage. From these first features, the landforms can be delineated relatively easily and it is within this geomorphic framework that soil and vegetation classifications can be undertaken with a maximum of efficiency. Indeed, being relatively homogeneous as to the nature of soil parent material and relief, each landform can be described in terms of its catena of soils and vegetation. Once these patterns are known, the mapping of soil series and plant associations can be undertaken.

One of the purposes of distinguishing between the forest types Hylocomium-Oxalis and Dryopteris-Oxalis proceeds from the fact that they belong to different productivity classes. But, if these types are identified and mapped on air photographs on the basis of productivity criteria, such as stand composition, crown density and tree height, what is then the use of calling them Hylocomium-Oxalis or Dryopteris-Oxalis? Would it not be easier to map the productivity classes directly?

In any interpretation work, there is always a great deal of subjectivity. However, the more stable the features to be identified, the less subjective the interpretation. As the landform characterizes the



Map symbol	Soil Series	Soil subgroup	Landform of Occurrence	Drainage Class
lt	Laurentide	orthic normorthod	at, tg, cf	well dr.
st	Stoneham	acquic normorthod	at, tg, cf	mod. well dr.
va	Valière	acquic normorthod	fp	mod. well dr.
bo	Boutet	aquic normorthod	af	mod. well dr.
dn	Des Neiges	humic normorthod	wt	well to mod. well dr.
mo	Montmorency	humic normorthod	rt	well to mod. well dr.
rb	Riv. Brûlée	humic ferraquod	wt	imperf. dr.
la	Laval	humic ferraquod	at, af	imperf. dr.
se	Séminaire	humic ferraquod	tg	imperf. dr.
sb	Ste-Brigitte	humic ferraquod	at, tg	poorly dr.
de	Decharge	histic umbraquept	fp	poorly dr.
th	Thibeault	lithic haplorthent	gr	well to mod. well dr.
dm	Demers	acquic haplorthent	gr	imperf. to poorly dr.
br	Brigitte	oligotrophic peat	gr, at, tg	very poorly dr.

Fig. 2. Soil map.

most stable features of an ecosystem, its significance as a major environment feature is to be acknowledged. Mapping of landforms on air photos is now widely used by civil engineers, geologists, agronomists and foresters and many universities offer special courses in this discipline. Perhaps the greatest single advantage of a classification system based on criteria that are both physical and biological is the possibility of mapping sites on the basis of permanent features of the forest ecosystem for which correlations, at least empirical ones, have been obtained. It allows mapping of areas where no forest cover exists or where the cover does not reflect the capability, such as after clear cutting, burning or cultivation.

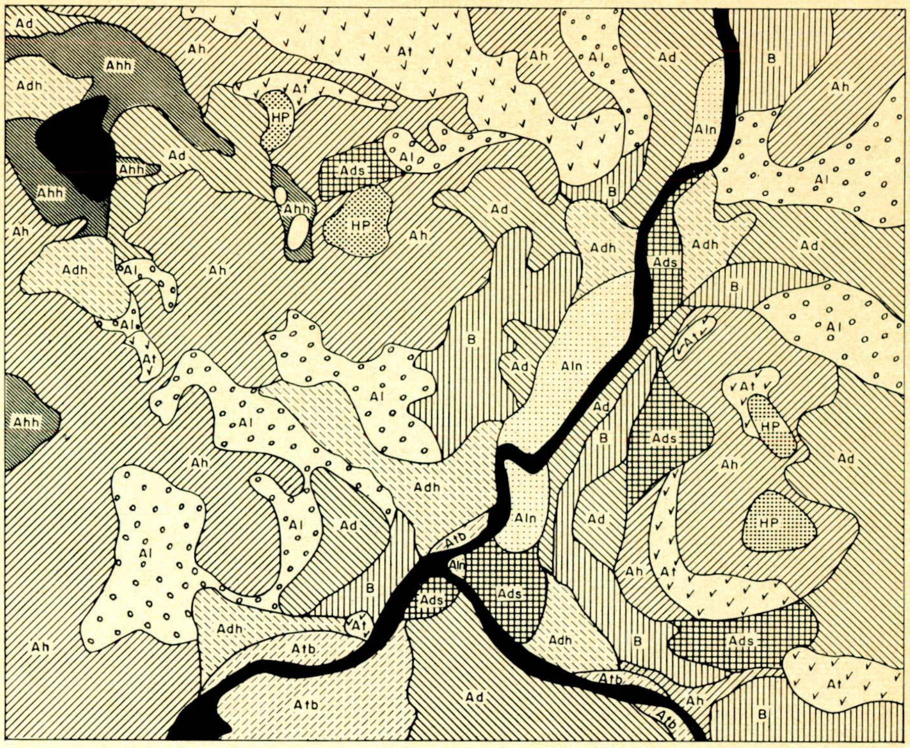
An example of forest land classification and evaluation

It is not intended to present in this paper a complete site description but rather to outline the phases pertaining to an ecological mapping of a five square mile reference area and the way in which a map may be used in assigning forest use capabilities.

The area is a portion of a 200 square miles area for which a complete land classification is almost completed. It is located along the Montmorency River in the Section Bla of the Boreal Region (Rowe, 1959). The undisturbed vegetation on well-drained loamy soils is a fir forest with an admixiure of white birch and white spruce belonging to the Fir-Dryopteris type (*Abietum dryopterietosum,* Jurdant 1964). The region is typical of the meridional part of the Laurentide National Park characterized by steeply undulating granitic bedrock covered by pleistocene deposits of various types and quaternary alluvial deposits along the larger rivers.

The landform map shown on map No. 1 served as a framework for the soil and vegetation classifications that are shown on the maps Nos. 2 and 3 respectively. Map No. 4 is the ecological synthesis of the first three ones and the mapped ecological types are true vegetation-soil-landform units.

To be useful to the practising forester, this kind of ecological information should be interpreted in terms of yield and management. This requires an evaluation of the potential production and of the regeneration capability of each ecological type.



Ad: Fir-Dryopteris type, typical variant. **Ads**: Fir-Dryopteris type, dry variant. **Adh**: Fir-Dryopteris-Hylocomium type. **Ah**: Fir-Hylocomium type, dry variant. **Ahh**: Fir-Hylocomium type, wet variant. **Al**: Fir-Lycopodium type. **Ac**: Fir-Carex type. **At**: Fir-Hypnum type. **Atb**: Fir-Yellow Birch-Hypnum type. **B**: Yellow Birch-Lycopodium type. **HP**: Black Spruce-Hypnum type. **SP**: Black Spruce-Sphagnum bog type. **Aln**: Alder swamp.

Fig. 3. Vegetation map. The vegetation units are those described by Jurdant (1964).

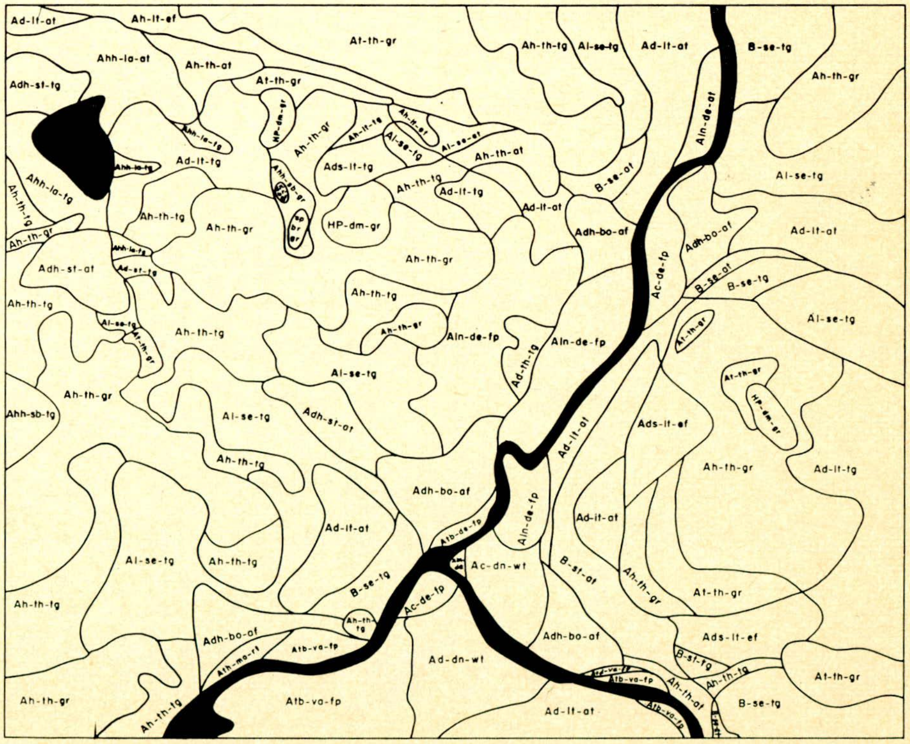


Fig. 4. Ecological map. The mapping units and symbols area combination of a vegetation type (Fig. 3), a soil type (Fig. 2) and a landform map (Fig. 1).

Map Symbol	Productivity Class	Site Index at 50 Years	Site Class
0	very high	50-59	
1	high	45-54	I
2	high-moderate	40-49	
3	moderate-high	35-44	II
4	moderate	30-39	
5	moderate-low	25-34	III
6	low	20-29	
7	very low	15-24	IV
8	extremely low	0-14	

Fig. 5. Potential productivity map.

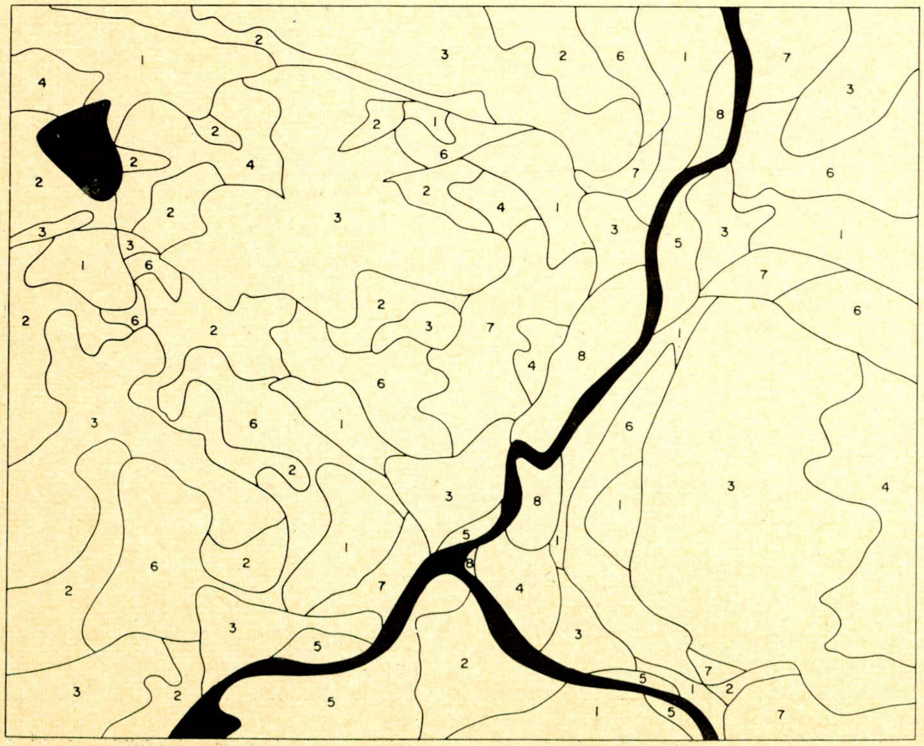


Fig. 6. Regeneration capability map.

One of the measures of productivity is site index based on a height/age relationship of the fastest growing commercial species occurring on the site. An evaluation of potential productivity on this basis is synthesized on map No. 5.

The regeneration capability for balsam fir, white spruce and black spruce has been evaluated for each ecological type by means of a regeneration survey, and a regeneration capability map (map No. 6) has been drawn. It is a measure of the competition potential of a site and of the degree of effort required to realize the potential production. It is realized that the scale adopted is comparative and does not represent any absolute figure, but the map allows the forest manager to evaluate one of the basic factors of forest production.

Map No. 7 is the Forest Use Capability map for balsam fir, white spruce and black spruce which integrates the potential productivity and the regeneration capability. With this map, the pertinent site factors found in studies of vegetation, soils and landforms are integrated into a single map whose value in terms of better forest management can scarcely be overrated. At the same time it provides the basis for proper orientation of silvicultural goals.

The basic ecological map also provides the necessary information to delineate the areas uniform in respect to erosion hazard following logging or burning (map No. 8) and to delineate the coarse material deposits for road building and surfacing.

CONCLUSION

Fundamentally, scientific forest management and sound silviculture to a large degree need an ever increasing knowledge of the relationships between the soil and the trees that grow on it. The method suggested here has not yet been put to practical use but it is in line with the actual trend in site classification and evaluation throughout

LEGEND—(Fig. 6).

Map Symbol	Class
0	very high
1	high
2	high moderate
3	moderate high
4	moderate
5	moderate low
6	low
7	very low
8	extremely low

Map Symbol	Class	Potential productivity + regeneration capability
0	very high	0
1	high	**1, 2**
2	high moderate	**3, 4**
3	moderate high	**5, 6**
4	moderate	**7, 8**
5	moderate low	**9, 10**
6	low	**11, 12**
7	very low	13. 14
8	extremely low	15, 16

Fig. 7. Forest land capability map.

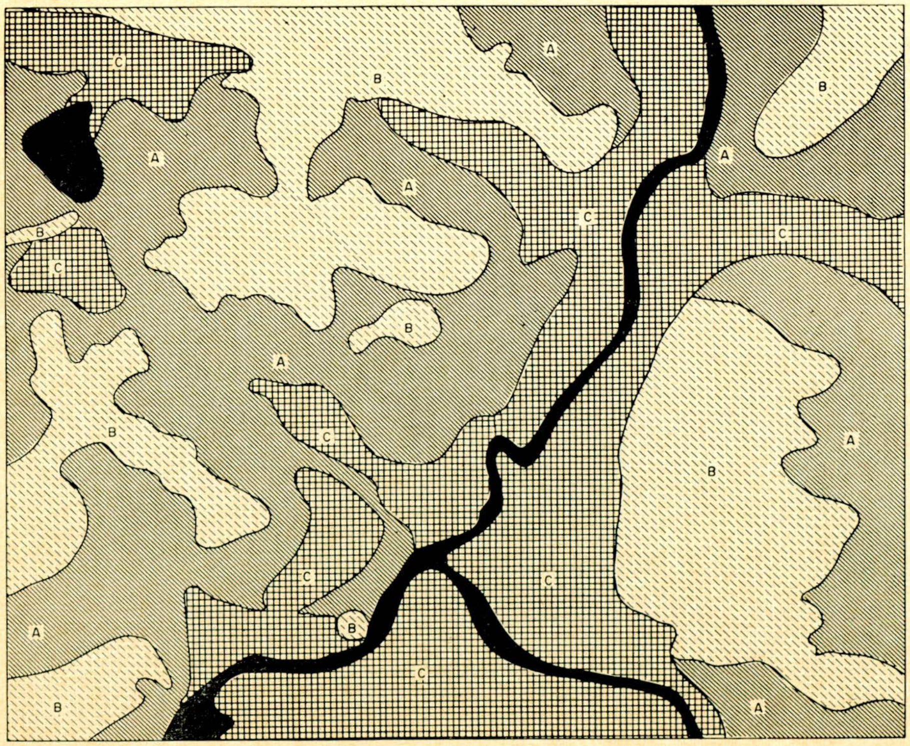


Fig. 8. Erosion symbol map.

Canada. It is not designed to give final answers in forest management because it belongs to the manager to decide what is to be done in the forest. It shows, however, that forest land classification and mapping with the aid of aerial photographs are possible only when the relationships between soil and vegetation are systematically studied within a geomorphic framework. A forest classification based solely on plant communities (either forest types or plant associations) is inadequate because plant communities as such cannot be identified on airphotos without a great deal of subjectivity which makes reliability very variable from one interpreter to the other. This does not mean that a vegetation classification is not necessary but it must be placed into correct perspective by classifying and mapping separately the landforms, the soils *and* the vegetation.

REFERENCES

BRAUN-BLANQUET J. 1932. Plant Sociology. McGraw Hill Book Co., N.Y.

CLINE, M. J. 1963. Logic of the new system of soil classifcation. *Soil Science*, Vol. 96, No. 1, pp. 17—22.

CROSSLEY, D. 1964. Report of the standing committee on silviculture. *Forestry Chronicle*, Vol. 40 No. 1, pp. 62—70.

HEIMBURGER, C. C. 1941. Forest site classification and soil investigation on Lake Edward Exp. Area. Canada Dept. of Mines and Res., Forest Res. Div., Silvic. Res. Note No. 66.

HILLS, J. A. 1960. Regional Site Research. *Forestry Chronicle*, Vol. 36, No. 4, pp. 401—423.

JURDANT, M. 1964. Carte phytosociologique et forestière de la Forêt de Montmorency. Ministère des Forêts du Canada. Publication no. 1046F.

KRAJINA, V. J. 1959. Bioclimatic zones in British Columbia. Univ. of B.C. Botan. Series No. 1, 47 p.

LACATE, D. S. 1961. A review of land type classification and mapping. *Land Economics* 37 (3) pp. 271—278.

LAFOND, A. 1960. Notes pour l'Identification des types forestiers des concessions de la Quebec North Shore Paper Co. Quebec North Shore Paper Co., Baie-Comeau, P.Q.

LINTEAU, A. 1955. Forest Site Classification of the northwestern coniferous section, Boreal Forest Region, Que. Canada, Dept. North. Affairs and Nat. Resources, For. Br. Bull. No. 118.

LEGEND—(Fig. 8).

Map Symbol	Danger of Erosion
A	high
B	moderate
C	low

LOUCKS, D. L. 1962. A forest classification for the Maritime Provinces. *Proc. of the Nova Scotian Inst. of Science*. Vol. 25, part 2, pp. 85—167.

MAJOR, J. 1951. A functional, factorial approach to plant ecology. *Ecology*, 32: 392—412.

ODUM, E. P. 1961. Fundamentals of ecology. W. B. Saunders Co.

ROWE, J. S. 1959. Forest Regions of Canada. Canada, Dept. of North. Affairs and Nat. Resources. Forestry Br. Bull. No. 123.

—— 1960. Forest ecosystem symposium final summary of opinions. *Int. Soc. for Trop. Ecology*. Vol. 1 No. 2, p. 28.

—— 1962. Soil, Site and Land classification. *Forestry Chronicle*, Vol. 38, No. 4, pp. 420—432.

SOIL SURVEY STAFF, 1960. Soil Classification. A comprehensive system. 7th Approximation. Soil Conservation Service. U.S.D.A.

●●