Managing for Aspen — A Shared Responsibility

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Foreword

by

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The theme of the 1988 Annual Meeting of the CIF/IFC was "Forest Management — A Shared Responsibility." Discussion in the general sessions focused on the shared responsibilities of industry, government and public for all aspects of forest management.

The Forest Ecology, Silviculture and Tree Improvement, Forest Management, and Forest Economics and Policy Working Groups held a joint technical session at the annual meeting to discuss the shared responsibility of ecologists, silviculturists, managers, economists and policy makers to ensure wise management of the aspen forest resource. Until recently, this tree species was treated as a weed. Now it has gained commercial value across the country and conversion plant construction has expanded significantly to utilize this valuable forest resource.

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Ecosystems With Potential for Aspen Management¹

by

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Abstract

Much has been learned of the ecology, management, and utilization of aspen and several comprehensive reviews are available. The development of forest ecosystem classifications as a framework for intensive management has occurred mainly in the past 10 years and such site classifications are now available for British Columbia, Alberta, Saskatchewan and Ontario in areas where aspen is important. The relevance of several such ecological site classifications to aspen management in Canada is discussed.

Résumé

On connaît maintenant beaucoup mieux l'écologie, l'aménagement et l'utilisation du peuplier faux-trembles comme en font foi plusieurs des volumineuses bibliographies existantes. La mise sur pied de systèmes de classification des écosystèmes forestiers comme cadre à l'aménagement intensif s'est surtout déroulée au cours des 10 dernières années, et on dispose maintenant de telles classifications des stations pour la Colombie-Britannique, l'Alberta, la Saskatchewan et l'Ontario, dans les endroits où les peupliers faux-trembles sont une composante importante de la forêt. L'auteur examine dans quelle mesure plusieurs de ces classifications écologiques sont applicables à l'aménagement des tremblais au Canada.

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Introduction

The interest in aspen (*Populus tremuloides* Michx.) has increased greatly as aspen's potential for forest products, especially oriented strand board and pulp, is being realized. Since aspen tends to occupy the same sites as more valuable softwood species, particularly white spruce (*Picea glauca* [Moench] Voss), there is a dilemma regarding which species to manage for. Aspen's ability to naturally regenerate and grow quickly after disturbance with minimal silvicultural input (Maini 1972, Bella 1986) make it appear as an attractive alternative to white spruce as aspen markets develop.

Several biological and economic criteria will influence the decision whether to manage an ecosystem or tract of land for aspen: 1) the potential of the site to produce aspen versus other species, especially white spruce; 2) stand establishment and maintenance costs; 3) current and anticipated market value of aspen versus white spruce; 4) proximity to mills and markets; 5) consideration of other land uses such as wildlife habitat, recreation, watershed; and 6) provincial government policy on stocking standards and annual allowable cut.

Since I am an ecologist, I have left the discussion of management, silviculture and economics issues to the other members of the panel except where they bear directly on considerations that must be taken into account in managing ecosystems for aspen or other species. It will become evident that decisions on economics, silviculture and policy will be optimal only if suitability and potential of the site are considered. This paper will not review the extensive literature on aspen management and ecology, but will rather attempt to demonstrate the utility of an ecosystem classification as a sound basis for management. Excellent reviews of aspen ecology, management and utilization include Graham *et al.* (1963), Maini and Cayford (1968), USDA Forest Service (1972), Neilson and McBride (1974) and DeByle and Winokur (1985).

Aspen and Its Environment

Aspen has a very wide distribution range within Canada, commonly occurring in all provinces and territories (Hosie 1975) and most Forest Regions and Sections (Rowe 1972). Aspen, however, attains its best stand development in the Mixedwood Section (B18a) of the Boreal Forest Region (Rowe 1972). The major area of poplar inventory as shown by Fitzpatrick and Stewart (1968) and adapted by Maini (1972) is more narrowly defined (Fig. 1). The Boreal Mixedwood, the setting for this meeting, will serve as a background example for today's discussion. However, the distribution of aspen elsewhere in Canada will also be discussed with reference to its environment or site.

Climate

The climate of the Boreal Mixedwood forest section (B18a, Rowe 1972) is described briefly below because of its importance for aspen production. The Boreal Mixedwood lies within the Boreal Climatic Region of Hare and Thomas (1974). The Mixedwood has a low-energy climate with short winter and long summer days. Its climate is continental with more than half of the total precipitation occurring as summer rain (Strong and Leggatt 1981). In Alberta, the Boreal Mixedwood has a mean annual temperature of 0.5°C, 970-1 310 growing degree days (above 5°C), a mean frost-free period of 85 days, mean total precipitation of 300 mm and a moisture deficit of 190 mm (Strong and Leggatt 1981). Its climate in Saskatchewan is similar (Kabzems *et al.* 1986) except that average annual

Figure 1. Major area of poplar volume, mostly aspen, in Canada (after Maini 1972 and Fitzpatrick and Stewart 1968).

precipitation is about 400 mm. Fig. 2 from the Ecoregions working group (in press) illustrates a representative Boreal Mixedwood climate.

Soils and Parent Materials

The Boreal Mixedwood forest section will again serve as an example. The section (B18a, Rowe 1972) lies within the Interior Plains Physiographic Division of North America and includes several Physiographic Regions (Strong and Leggatt 1981). Relief is generally subdued chiefly as a result of pre-glacial erosion of the soft shale bedrock (Rowe 1972), which produced such features as the Cretaceous escarpment and associated hills in the vicinity of the Manitoba-Saskatchewan boundary. Subsequent glaciation modified the landscape resulting in the present topography characterized by rolling morainal deposits on the uplands and smoother glacio-lacustrine deposits on the lowlands (Rowe 1972). Orthic Gray Luvisols are the predominant soil subgroups on upland sites. Gleysols and Organics are common on poorly drained ground (Corns and Annas 1986).

Elsewhere in Canada, aspen commonly grows best on mesic sites with moderately-well to well-drained Luvisolic soils on morainal deposits. Base rich fine-textured deposits are preferred (Baker 1925). In northern Minnesota and Wisconsin, Kittredge (1938) found that on soils of the same textural class, aspen grew consistently and substantially better on Keewatin drift than on two other less fertile drifts. Soils under aspen forests typically have a dark Ah horizon. Aspen functions as an efficient nutrient pump and aspen leaves typically have higher nutrient contents than conifer foliage on the same site (Daubenmire 1953, Troth *et al.* 1976, Young and Carpenter 1967). Rapidly decaying aspen leaves rapidly return nutrients to the soil (Bartos and DeByle 1981, Daubenmire and Prusso 1963).

Classification of Aspen Ecosystems

Only recently in Canada has ecosystematic site classification work been done that can be used directly in managing land on which aspen is a major component. Such management-oriented forest ecosystem classifications are available for several regions of the country. Those that deal with aspen-dominated ecosystems and their management include DeLong (1988) for northern British Columbia, Corns and Annas

Figure 2. Climate of the mid-boreal subhumid ecoclimatic region (after Ecoclimatic Working Group 1989). Key to climatic diagram: a) ecoclimatic region; b) name of climatic station; c) elevation of climatic station above sea level (m); d) mean annual temperature (°C); e) number of observation years; f) mean annual precipitation (mm); g) mean daily minimum temperature of coldest month (°C); h) lowest recorded temperature (°C); i) curve of mean monthly temperature (°C); j) curve of mean monthly precipitation (mm); k) relative humid season (vertical pattern); l) months with a mean daily temperature below 0°C (black pattern); m) months with mean daily minimum temperature below 0°C (diagonal pattern); n) months with mean daily temperature above 0°C; o) division of the year (January through December, left to right, respectively).

(1986) for west-central Alberta, Kabzems *et al.* (1986) for the mixedwood section of Saskatchewan and Jones *et al.* (1983) for the Clay Belt of Ontario. Manitoba is developing a site classification system and is testing it in two pilot areas in Manitoba (Knapik *et al.* 1988). I shall briefly discuss each of these site classifications with particular emphasis on their relevance to aspen management. Vascular plant nomenclature follows Scoggan (1978).

British Columbia

DeLong's (1988) work is the most recent and classifies seral aspen and one balsam poplar ecosystem in the boreal white and black spruce zone in the Prince George forest region (Fig. 3). The DeLong (1988) field guide is in format similar to others published within the biogeoclimatic program in British

Columbia. These seral aspen ecosystems are identified with a dichotomous key and are described according to their vegetation, soil and site and distribution. Management interpretations are made for type of logging, site preparation, species choices, brush hazard, silviculture application (e.g., vegetation control, stand tending) silviculture problems (e.g., drought, excess moisture, low temperature) and productivity (site index at 100 yr.). The rotation for the optimum species (not necessarily aspen) is suggested with options where applicable for conversion to other species or conversion to rangeland or agriculture if such potential exists, and potential for wildlife habitat. The field guide is supplemented with drawings of the common plants, aids to determining slope position, soil texture, humus form, moisture regime and nutrient regime. Scattergrams of stem density, volume, and DBH versus stand age are given for the plots sampled.

It is apparent from DeLong's ecosystem data that mere presence or even dominance of aspen does not necessarily justify managing for aspen for the next rotation. Aspen occurs over a wide range of site conditions in Canada (Maini 1972) but grows well in a much narrower range of site conditions. Its

BWBScl Seral aspen ecosystem units

- 01 At - Creamy Peavine
- 02 At - Kinnikinnick
- 03 At - Soopolallie
- 04 At - Labrador Tea
- 05 At - Black Twinberry
- 06 At - Oak Fern
- 07 Ac - Cow Parsnip

Figure 3. Edatopic grid for the seral aspen ecosystems of the Prince George forest region (DeLong 1988).

Figure 4. Schematic cross section diagrams of the a) white spruce/*Viburnum/Aralia*, aspen facies and b) white spruce/*Viburnum/Rubus pubescens*, aspen facies in west central Alberta (from Corns and Annas 1986).

presence may be as much due to stand history as to site. In the Prince George forest region, aspen site index (100 yr.) ranges from 22 m on the aspen-Kinnickinnick ecosystems to 26 m on the aspen-black twinberry ecosystems. The aspen-Kinnickinnick site is subseric to submesic and occurs on coarse textured glaciofluvial parent materials, more typical of some lodgepole pine sites in British Columbia and Alberta. Lodgepole pine is the preferred species choice by DeLong (1988). On the productive, subhygric aspen-black twinberry site which normally occurs on medium to fine textured fluvial, morainal and lacustrine parent materials, aspen and balsam poplar are indicated by DeLong as preferred species with little or no site preparation. However, if conversion to white spruce is attempted, extreme competition from aspen suckers, *Calamagrostis canadensis* (Michx) Nutt. and *Epilobium angustifolium* L. can be expected. DeLong (1988) also notes that herbicide use may conflict with wildlife values.

Alberta

In Alberta, ecological site classification has been on-going since the early 1970's with the work of Lesko and Lindsay (1973). The field guide to forest ecosystems of west-central Alberta (Corns and Annas 1986) synthesizes most of the relevant earlier work including plots from the biogeoclimatic ecosystem classification program which has been the major

Alberta forest site classification effort. (Corns and Annas 1986) have described two aspen dominated ecosystems, the aspen facies of *Picea glauca/Viburnum/Aralia* and *Picea glauca/Viburnum/Rubus pubescens* (Fig. 4). The ecosystems are identified with a key and are described according to their vegetation and environment. Management interpretations are made for season of harvest, logging method, soil compaction, puddling and water erosion hazards, reforestation (including species selection, method, limitations and frost heave hazard), vegetational competition (type and severity) windthrow hazard, snowshoe hare damage hazard and productivity (mean annual increment and site index at 70 years). Successional relationships, similar associations and comments related to management are briefly discussed. Topographic relationships and 80 understory plants are illustrated. Aids to site property determinations are also given.

The *Picea glauca/Viburnum/Rubus pubescens* (aspen facies) ecosystem association is characterized by mesic moisture regime, moderately well to imperfectly drained Luvisolic soils on fine-textured morainal and lacustrine parent materials. Gross MAI averages 4.3 m³/ha/yr and SI (70 yr) averages 21 m for aspen and 18 m for white spruce. The richer and often moister *Picea glauca/Viburnum/Aralia* (aspen facies) ecosystem is characterized by a mesic moisture regime, imperfectly to well drained Luvisolic soils on fine-textured

Table 1. Ecosystems with major aspen component in the mixedwood section of Saskatchewan and some of their properties (Adapted from Kabzems *et al.* 1986)

Forest ecosystem	Drainage	Soil texture	Understory vegetation	Site quality	Rotation age	M.A.I. (m ³)	Yields (m ³ /ha)		Fire hazard ratings ¹
							At rotation	At maturity	
Populus-Rosa/ Elymus	Very rapid-rapid	Coarse	Tall shrub	111	80	1.3	100	140	1/1/8/1
Picea glauca/ Populus-Corylus	Very rapid-rapid	Coarse	Tall shrub	111	80	1.8	140	175	2/2/4/2
Populus-Corylus	Well	Moderately fine	Tall shrub Medium grass	11	70	2.8	185	210	1/1/8/1
Picea glauca/ Populus-Cornus	Well	Moderately fine	Low herb	11	75	3.1	210	240	2/2/4/2
Populus-Aralia/ Linnaea	Moderately well	Moderately fine	Medium herb	11	60	3.7	225	315	1/1/8/1
Picea glauca/ Populus-Cornus/ Mitella	Moderately well	Fine	Low herb	1	65	4.3	285	330	2/2/4/2

¹Fire hazard ratings based on a scale from 1 to 10; one (1) being very low and ten (10) being very high. The numerical description refers to the following: crown fire (cured dormant stage)/crown fire (active growing stage)/surface fire (cured dormant stage)/surface fire (active growing stage).

morainal and lacustrine parent materials. It is similar to the aspen-black twinberry ecosystem of DeLong (1988). Gross MAI averages 5.6 m³/ha/yr and SI (70 yr) averages 23 m for aspen, 21 m for white spruce and 25 m for lodgepole pine (Corns and Annas 1986). Management interpretations are similar for both ecosystems. Both will regenerate to aspen with little or no silvicultural input. Moderate site preparation to expose mineral soil prior to planting sturdy white spruce nursery stock is recommended if conversion to white spruce is desired. Site preparation and planting should be done as soon as possible following clearcut logging before dense *Calamagrostis canadensis* and other herbs and shrubs such as *Viburnum edule* (Michx.) Raf., *Lonicera involucrata* (Richards.) Banks and *Salix* spp. become abundant. The generally fine-textured soils these ecosystems occur on are easily compacted and such effects are long-lasting (Corns 1988) and so winter operations are recommended. Exposed soils are easily puddled and eroded, and frost heaving of planted seedlings can be a problem.

Aspen volumes on such stands can approach 250 m³ at rotation age (80-100 years).

Saskatchewan

In the mixedwood section of Saskatchewan, Kabzems *et al.* (1986) have described three aspen-dominated ecosystems and four others in which aspen is co-dominant with white spruce. These are distinguished on the basis of soils, drainage, texture and vegetation. Productivity in MAI and SI is given for each ecosystem as well as yield at the suggested rotation age. Comments relating to management are given including recommended species for reforestation, reforestation method and fire hazard, suggestions for logging or for white spruce release are given where appropriate. Much of the information is summarized in Table 1 from Kabzems *et al.* (1986). Productivity is lowest in the droughty *Populus-Rosa/Elymus* ecosystem which forms only marginally commercial stands, which are characterized by a scattered tall shrub understory of *Amelanchier alnifolia* Nutt. or *Corylus cornuta* Marsh. and are subject to frequent fire. Average height seldom exceeds 15 m at the rotation age of 80 to 85 years. Wood quality is poor due to fire scars and excessive rot. The *Populus-Rosa/Elymus* sites would probably support jack pine and they are useful as pasture for domestic livestock and as wildlife habitat. Productivity increases as soil texture becomes finer and drainage changes from rapid to moderately well. Aspen productivity is highest on the moderately well drained soils and in the *Populus-Aralia/*

Linnaea ecosystem of Kabzems *et al.* (1986) which is characterized by a lush mainly herbaceous understory including *Linnaea borealis* L., *Cornus canadensis* L., *Aralia nudicaulis* L., *Lathyrus ochroleucus* Hook., *Rubus pubescens* Raf. and *Viburnum edule* (Michx.) Raf. Soils are moderately coarse to moderately fine textured till on hummocky topography. Stands of this type often reach average heights of 23 m or more at an early rotation age of 60 years. At this age, MAI is 3.5 to 3.8 m³/ha/yr and total yield is 210-245 m³/ha and may exceed 315 m³/ha at 70 years. Aspen regeneration is easily obtained after clear-cutting or burning.

As soil internal drainage changes from moderately well to imperfectly drained, productivity decreases and aspen is replaced by spruce. For example the imperfectly drained *Picea glauca/Populus-Cornus/Rubus* ecosystem has a MAI of only 2.4 m³/ha/yr and stand heights of 17 to 18 m at 75 years. Site preparation is recommended on these sites and mixed spruce-aspen regeneration can be expected.

Ontario

Ontario has an ecological site classification program that has evolved from early work done by Hills. The field guide to forest ecosystems of the Clay Belt by Jones *et al.* (1983) has classified three operational groups (OGs) in which aspen is dominant or important. The OGs are landscape segments with mature forest that has an identified range of vegetation and soil conditions and probable responses to specific management prescriptions and are similar to the ecosystems of DeLong (1988) and Kabzems *et al.* (1986) and the ecosystem associations of Corns and Annas (1986). Jones *et al.* (1983) have described the vegetation and site of their operational groups and illustrated representative topographic situation, soil profiles and diagnostic plants. Aids to site property recognition and to photo interpretation and mapping of the OGs are also given. Jones *et al.* (1983) however, did not make management interpretations but rather plan to observe the results of management on the OG as time progresses. However, Pierpoint *et al.* (1984) did discuss characteristics and management implications of ecosystems with boreal hardwood components in the Clay Belt of northern Ontario. Pine hardwood or mixedwood ecosystems occur within three OGs: Diervilla (OG3), Mixedwood-herb rich (OG7) and Hardwood-*Alnus* (OG10) which occur along an environmental continuum. The relative occurrence and dominance of the major tree species in the OG3-7-10 continuum is illustrated in Fig. 5 and the

Figure 5. Forest composition trends along the OG 3-7-10 continuum (from Pierpoint *et al.* 1984).

predominant characteristics of the mineral soil are given in Table 2.

The *Diervilla* group (OG3) or "Hardwood/Mixedwood-*Vaccinium-Diervilla* — Herb Poor" is dominated by aspen but may contain jack pine, black spruce, white birch and occasionally white spruce. The understory contains about 18 species of shrubs, herbs and mosses (Pierpoint *et al.* 1984). Soils are rapidly to moderately well drained, sandy to coarse loamy Eluviated Dystric Brunisols. The dominant humus form is Fibrimor (Table 2).

The OG3 stands offer no constraints to year round use of harvesting and site preparation equipment. Plant competition with planted seedlings on OG3 is less than OGs 7 and 10 and jack pine should be considered for planting (Pierpoint *et al.* 1984). With respect to slash burning, OG3 sites may be burned without a pre-burn herbicide spray to reduce moisture-rich vegetation.

On the other end of the continuum is OG10 or "Hardwood-*Alnus*-Herb Rich" which is dominated by balsam poplar and aspen with occasional balsam fir, black spruce and white spruce. The understory is dense and diverse with often over 30 species present. Dominants are *Alnus rugosa* (Du Roi) Spreng., *Rubus ideaus* L., *Viburnum edule*, *Rubus pubescens*, and *Mitella nuda* L. (Jones *et al.* 1983). Dominant soils are imperfectly to poorly drained, fine loamy to clay textured Gleyed Eutric Brunisols (Table 2). The dominant humus form is Moder

with well decomposed Mull forms on 25% of the OG10 sites (Pierpoint *et al.* 1984).

The OG10 sites have poor trafficability in the unfrozen period with resulting problems with equipment movement, severe rutting and ponding of water. Aspen regenerates vigorously after clearcutting but if conifers are desired, planting of nursery grown white spruce should be done as soon as possible following harvesting (Pierpoint *et al.* 1984). Vegetational competition is vigorous and can be controlled by shear-blading or a combination of these treatments (Pierpoint *et al.* 1984).

The OG7 sites are intermediate between OG3 and 10 with respect to their site and management but are more similar to OG10.

The estimated quarter of a million hectares of land in the Clay Belt support mature poplar forests which are among the most highly productive sites in the Clay Belt (Pierpoint *et al.* 1984).

Discussion

There is a wealth of information on the structure, environment and productivity of aspen ecosystems in Canada. This review is not intended as a comprehensive review of Canadian aspen synecology but rather has attempted to identify and summarize aspen forest ecosystem classification studies that have addressed aspects of aspen management.

It is apparent that aspen can occur as a dominant or co-dominant species on a wide range of sites, and that there is similarity amongst the sites on which aspen occurs from British Columbia to eastern Ontario and probably beyond. It has also become evident to the developers of these site classifications that aspen productivity and stand response to logging, site preparation or regeneration practices is site dependent and predictable. Quantitative data on ecosystem response to management are however still unavailable in many areas. I believe that researchers and forest managers alike should make their research or management practices referable to the site on which they are working and use a relevant site classification where available so that site specific management interpretations may be tested, modified and finally implemented as prescriptions for more effective and more profitable management.

Table 2. Major soil characteristics of Operational Groups 3, 7 and 10 of the Clay Belt area of Ontario (Adapted from Pierpoint *et al.* 1984)

	OG 3	OG 7	OG 10
Family particle size	Sandy, coarse loamy	Fine loamy, Clayey	Fine loamy, Clayey
Drainage	Rapid-moderately well	Well-imperfect	Imperfect-poor
Depth to carbonates			
absent	60%	-	-
> 50 cm	40%	30%	10%
> 50 cm	-	70%	90%
Dominant soil subgroup	Eluviated Dystric Brunisols	Orthic Gray Luvisols	Gleyed Eutric Brunisols
Dominant humus form	Fibrimor	Fibrimor	Moder

There is still much that we do not know or understand about aspen management. Aspen and mixedwood stands are important as wildlife habitat (DeLong 1988, McNicol and Timmerman 1981) but the extent to which such sites can be managed equitably for timber, moose and songbirds is unknown. Pierpoint *et al.* (1984) have identified humus form as an area of research that requires clarification since the humus layer contains most of the roots, nutrient cycling and provides a seedbed for the next rotation. Many indications and some hard data suggest that the ecosystem or site type influences aspen morphology, reproduction, growth and yield, insect and disease effects, and succession after logging or fire. Difficult policy decisions regarding allocation of land to either white spruce or aspen production may be facilitated by considering the relative site potential for each species, rather than simply deciding on the basis of which species happens to occupy the site at present.

As forest management becomes more intensive, as public awareness and concern related to forest management increases, as markets become more competitive and when our old growth reserves have been depleted (and this is happening quicker than many of us realize), we shall be forced to understand and manage forest ecosystems. I believe we shall all benefit from such an approach that will make our woodlands operations more environmentally sound, silviculturally more effective and less costly.

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