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Silvics and ecology in Canada

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SILVICS AND ECOLOGY IN CANADA

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ABSTRACT. — Aspens are widely distributed and grow under a wide range of ecological conditions in Canada. The most productive aspen stands in Canada are located north of the height of land where rivers flow toward Hudson Bay. Formation of clones, due to repeated vegetative propagation, is silviculturally the most significant feature of aspen stands. Clones vary in their suckering ability, phenology, growth vigour, form, and disease susceptibility. High grading of superior clones is detrimental to the future of aspen resource; clearcutting is recommended to ensure adequate regeneration and to conserve a broad genetic pool.

Poplars in Canada constitute 54 percent of all merchantable hardwoods, or about 9 percent of the total net merchantable forest resource. Of the eight poplar species native to Canada, trembling aspen and largetooth aspen are among the five suitable for commercial use (Fitzpatrick and Stewart 1968). These two aspen species, comprising approximately 80 percent of the poplar resource in Canada, occur in unmanaged stands, many of which are overmature and decadent.

In spite of the wide distribution and abundance of poplars in Canada, only 5 percent of the estimated allowable annual cut is used; this underutilization is attributed partly to easy availability of conifers in areas closer to mills and partly to certain biological features of the species. However, interest in utilization and management of aspens is increasing not only because of the expected increase in the demand for forest products but also because of the wide ecological amplitude and fast growth rate of aspen.

Various biological aspects of aspens in Canada have been described in recent reports (Maini and Cayford 1968, Shoup *et al.* 1968). This report deals with the silvics and ecology of aspens in Canada, with emphasis on the features considered significant in the management of natural stands.

TAXONOMY

Only two species of aspen belonging to Section Leuce of the genus *Populus*, namely trembling aspen and largetooth aspen, are native to Canada and the United States. Detailed taxonomic descriptions of these two aspens, which are widely distributed in Canada (fig. 1), have been presented by Maini (1968). Among poplars, these species may be easily recognized in the field by the following morphological characteristics:

Leafy Condition in Summer

1. Leaf orbicular to broadly ovate or elliptical, glandless. Buds not resinous; leafstalk, at least in upper part, flattened in vertical plane, about ¾ length of blade . . . . . . Aspens 2
Leaf narrow, lanceolate to ovate, fine-toothed. Leaf stalk about ¾ length of leaf blade, flattened on top. Buds resinous. . . . . Cottonwood and Balsam Poplar

2. Leaf coarsely sinuate-toothed; usually 10 or fewer teeth each side. Buds grayish downy. . . . . Largetooth Aspen
Leaf finely serrated to crenate; usually 15 or more teeth each side. . . . . . Trembling Aspen

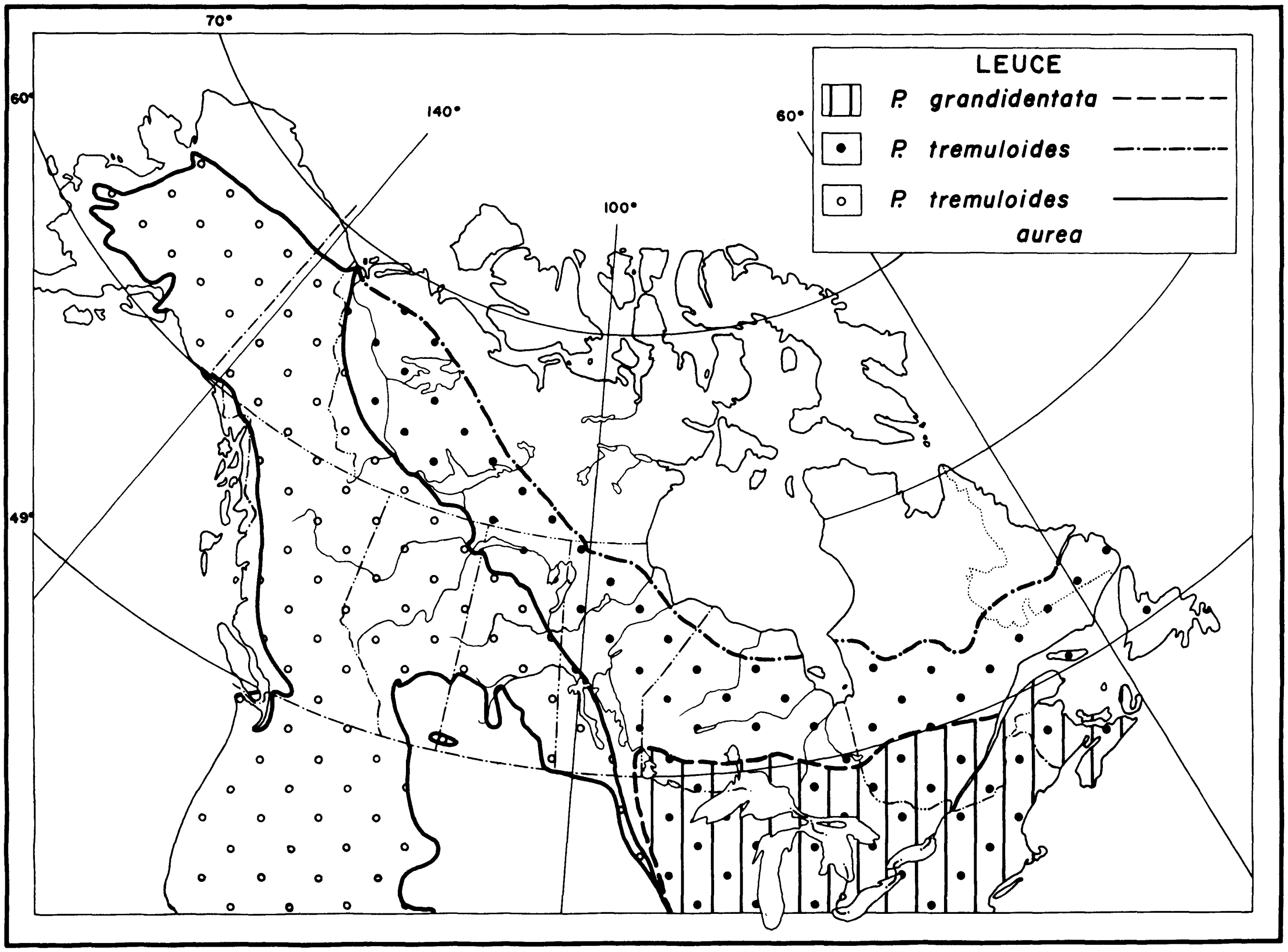

Figure 1.—*Distribution of* Populus tremuloides, P. tremuloides aurea, *and* P. grandidentata *in Canada (after Maini 1968).*

There is considerable variation in the size and shape of leaves borne on short, slow-growing lateral shoots and of leaves on vigorously growing long shoots, stem sprouts, and suckers. Only leaves borne on short shoots are reliable for species identification.

Leafless Condition in Winter

1. Buds nonresinous . . . Aspens 2
Buds resinous . . . . Cottonwoods and Balsam Poplars

2. Buds glabrous, brown, the terminal longer than the subjacent lateral bud. Smooth bark white, gray, or pale green, roots pale brown . . . . Trembling Aspen
Buds grayish downy, the terminal and subjacent lateral buds of almost equal length. Smooth bark greenish yellow; roots dark reddish brown.
. . . . Largetooth Aspen

A number of forms and varieties of trembling aspen have been reported in Canada (Maini 1968); these distinctions, however, are not made from a silvicultural viewpoint, and even the two aspen species are usually treated in similar fashion.

ECOLOGICAL LIFE HISTORY

Phenology

Aspens are normally dioecious (i.e., male and female flowers are separate and borne on different plants); some floral abnormalities, however, have been reported (Maini and Coupland 1964). Flower buds of aspens swell and extend before the leaf buds and in western Canada the female plants flower and leaf earlier than the male plants. In southern Canada, the aspens flower in early April and leaf in early May. These phenological events are delayed northwards and their timing appears to be determined by air temperature. In Ontario, flowering, leafing, and seed dispersal occur about 10 days later in largetooth aspen than in trembling aspen. The considerable variation in the phenology of different clones helps delineate various clones.

Sexual Reproduction

Aspens start flowering at about 10 years of age and mature trees produce adequate seed crops annually. Good seed crops may be expected every 2 years. During an "average year," for example, a 23-year-old, 33-feet-tall trembling aspen in southern Ontario produced 1.6 million seeds. The seeds are light (2.5 million trembling aspen seeds weigh 1 pound), pear-shaped, and have a tuft of long silky hair attached to the narrow end, enabling them to disperse over long distances. In spite of the enormous quantities of aspen seed produced annually and the ease of germination under controlled conditions (e.g., 80 to 95 percent at room temperature), establishment resulting from seeds under natural conditions is uncommon for the following reasons (Maini 1960, 1968):

1. Short seed viability.
2. The presence of a water-soluble germination and growth inhibitor in seed hair.
3. The occurrence of unfavorable moisture conditions during seed dispersal on upland sites that aspens usually inhabit.
4. The susceptibility of seedlings to high temperatures that occur on soil surface blackened by fire.
5. The susceptibility of seedlings to fungal attack.
6. The adverse influence of diurnal temperature fluctuations on initial seedling growth.
7. The unfavorable chemical nature of some substrates on which the seeds are likely to fall.

Asexual Reproduction

Rooting of aspen stem cuttings is extremely difficult and one of the major obstacles to mass multiplication of the desirable genotypes. Sprouts from stump and root collar are uncommon, although sprouts from the latter occur somewhat more frequently in largetooth aspen than in trembling aspen.

The most common mode of aspen reproduction is the formation of adventitious shoots on roots (suckers). Suckering following logging in aspen stands has been attributed to isolation-induced increase in soil temperature (Maini 1968) and to relief from the apical dominance effect.[1] Repeated vegetative reproduction of dioecious aspens has resulted in the formation of male and female clones that range from a few to several hundred trees (Maini 1968) and occupy 0.01 to 3.80 acres of land.[1] From a silvicultural viewpoint, the development of clones is perhaps the most significant biological feature of aspen stands. While a single clone may occupy a particular land surface to the exclusion of others, intermixing of clones is common.

Trembling aspen suckers are borne on roots that range from 0.2 to 2.0 inches in thickness and are located in the upper 2 inches of soil (range: 1.0 to 4.0 inches). The sucker-bearing roots on largetooth aspen range from 0.2 to 4.5 inches in thickness and penetrate to a depth of 3 inches in the mineral soil (range: 1.0 to 7.0 inches).

Although under natural conditions suckering is profuse after various types of disturbances, aging aspen stands reportedly decrease in suckering capacity. The pattern of spatial distribution of clones and the physiology and ecology of root-suckering have been studied under controlled environmental and the field conditions. The studies show a significant clonal variation in suckering capacity (fig. 2), optimum temperature for suckering, and the rate of suckering in the two species of aspen (Maini 1967), and the rootability of newly formed suckers.[1] In the controlled environment, root cuttings from clones that sprouted the most suckers produced the most large suckers. No significant correlation, however, could be established between the size of the clones (from which the root cuttings had been sampled) and the sucker growth or the rooting ability of these root cuttings; clone size was also not related to the soil moisture and the nutrient level of the various sites.[1] Considerable clonal variation in disease susceptibility has also been reported (Wall 1969). The foregoing features indicate that the natural stands of aspen are genetically and ecologically very diverse.

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[1] *Steneker, G. A. Structure, size, and development of trembling aspen (*Populus tremuloides *Michx.) clones in Manitoba. (Unpublished report, 157 p. 1972.)*

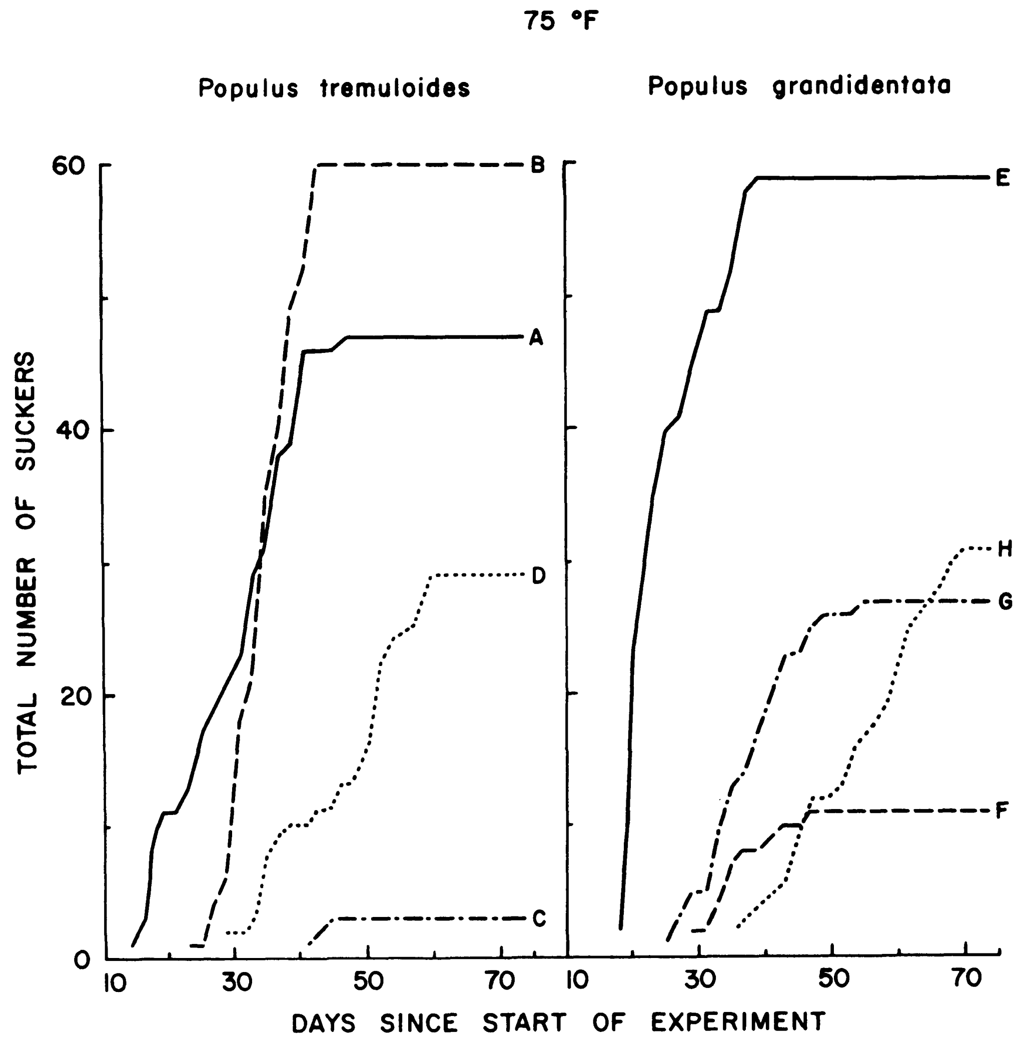

Figure 2.— *Variation in sucker formation on root cuttings obtained from four clones of* Populus tremuloides *and* P. grandidentata, *maintained at 75° F.*

EARLY GROWTH

Stem Growth

Aspens are intolerant to shade and require full sunlight for optimum growth. The suckers may originate singly or in a clump and the height of the dominant shoot in a clump increases with the number of suckers in the clump (Maini 1968). Suckers that initially have a rapid growth rate tend to maintain their dominance (Pollard 1971).

Height growth of young plants was not adversely affected when subjected to various degrees of defoliation, branch pruning, and debudding (Maini 1966, Pollard 1970); these observations suggest that a young stand of aspen suckers may be lightly browsed without any detrimental effects to the future crop.

There is considerable clonal variation in the phenology, growth rate, form, branching habit, and disease susceptibility. Studies by Vaartaja (1960) have demonstrated the occurrence of photoperiod ecotypes in trembling aspen — a feature that one would expect to occur in a widely distributed species.

Root Growth

Information on initial root growth is scanty due to the paucity of seedlings in nature. However, most new roots develop near the base of suckers and spread laterally in the upper soil layers. Trees of sucker origin can be distinguished from seedlings by a thickening that develops on the distal side of the parent root adjacent to the sucker (Maini 1968). The root system of aspens extends 40 feet or more from the stem base, that of largetooth being located a few inches deeper than that of the trembling aspen; the former is also less profusely branched and has fewer adventitious roots. Recently Zufa (1971) has successfully rooted aspen by planting succulent suckers in a suitable rooting medium maintained under high humidity.

STAND DEVELOPMENT AND MANAGEMENT

The intolerant aspens have many features characteristic of a pioneer species. However, most aspen regeneration on cutover and burned forest land is vegetative; i.e., from root suckers. The abundance of aspens in disturbed forest land, which is indicative of their ecologic significance, is determined by the proportion of aspen in the logged or burned forest and the magnitude of disturbance.

A fully stocked stand of aspen, when clearcut (or burned), produces up to 40,000 suckers per acre. However, mortality in young sucker-stands is high and by 30 years of age, the number is reduced to 1,000 to 1,500 stems; at maturity (70+ years), the stocking ranges from 300 to 400 trees per acre. Regeneration of aspen following removal of apparently pure conifer stands is usually from the roots of a few widely scattered individuals.

Aspens grow under a wide range of ecological conditions and are found associated with almost all native trees of Canada. Depending on stand history, the two aspens occur in extensive pure stands, in mixed stands of the two aspen species, in association with conifers, particularly spruce and pine, and with other hardwoods, commonly paper birch. Shrubs and herbs commonly associated with aspen and competing with aspen regeneration include *Symphoricarpos, Corylus, Alnus, Prunus, Salix, Lonicera, Vibernum* and *Pteridium* (Maini 1968).

In one investigation, the height growth of dominant trembling aspen trees was measured in 96 mature stands, located in an approximately 750-mile long south-north transect, extending from 49° and 50° N. latitude (fig. 3). In the south, height growth

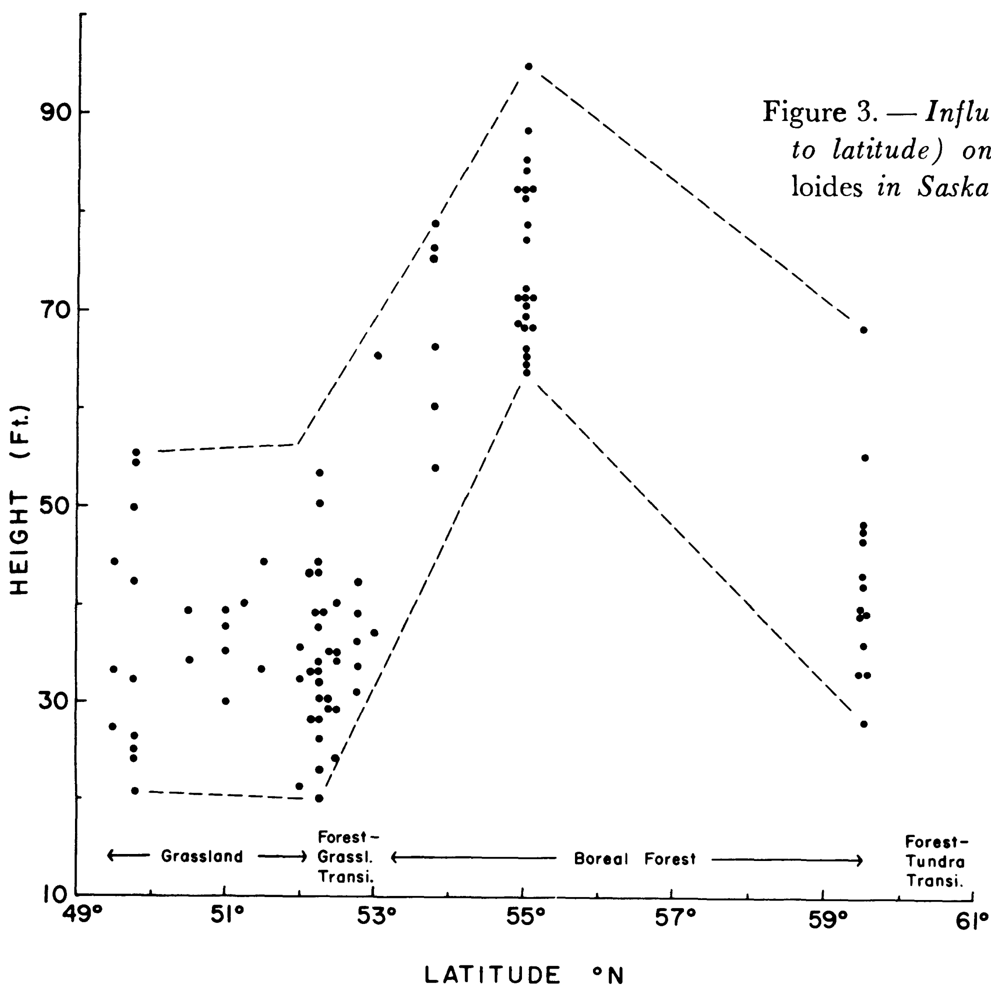

Figure 3. — *Influence of climatic gradient (as related to latitude) on height growth of* Populus tremuloides *in Saskatchewan (from Maini 1968).*

was apparently limited by inadequate moisture and in the north by unfavorable temperature and edaphic conditions. In Canada, optimum growth of trembling aspen is attained north of the height of land where rivers flow toward Hudson Bay; it is interesting to note that the "Major Poplar Area" in Canada (fig. 4) described by Fitzpatrick and Stewart (1968) also lies in this geographical region.

Several silvicultural techniques have been applied to stimulate aspen suckering and to control competition from associated vegetation. The relative effectiveness of the various treatments has been evaluated by using a "Reproductive Index" (Maini and Horton 1966). Considering the great microenvironmental variations that occur in the surface soils following disturbance in an aspen stand and the tremendous intraspecific variation in the ecologic requirements of aspens, it is not surprising that many clones continue to perpetuate in a given area. Consequently, aspens have been regarded as weed species, sometimes difficult to eliminate.

Many aspen stands are overmature and decadent. Economic considerations necessitate high grading of clones that have superior growth and low incidence of disease and other defects. This practice is expected to lower the quality of future aspen stands because these clones do not reproduce adequately under a partial canopy. And unless they produce suckers, roots of these superior aspen clones decay within 3 to 4 years after cutting, and so the inferior clones would be perpetuated when the remaining tree canopy is eventually removed by logging or natural fire. The influence of high grading on impoverishment of genepool is much more serious in species that reproduce predominantly by vegetative means than those that reproduce by seeds. Therefore, clearcutting is essential to obtain good regeneration of aspens and to conserve a broad genetic base.

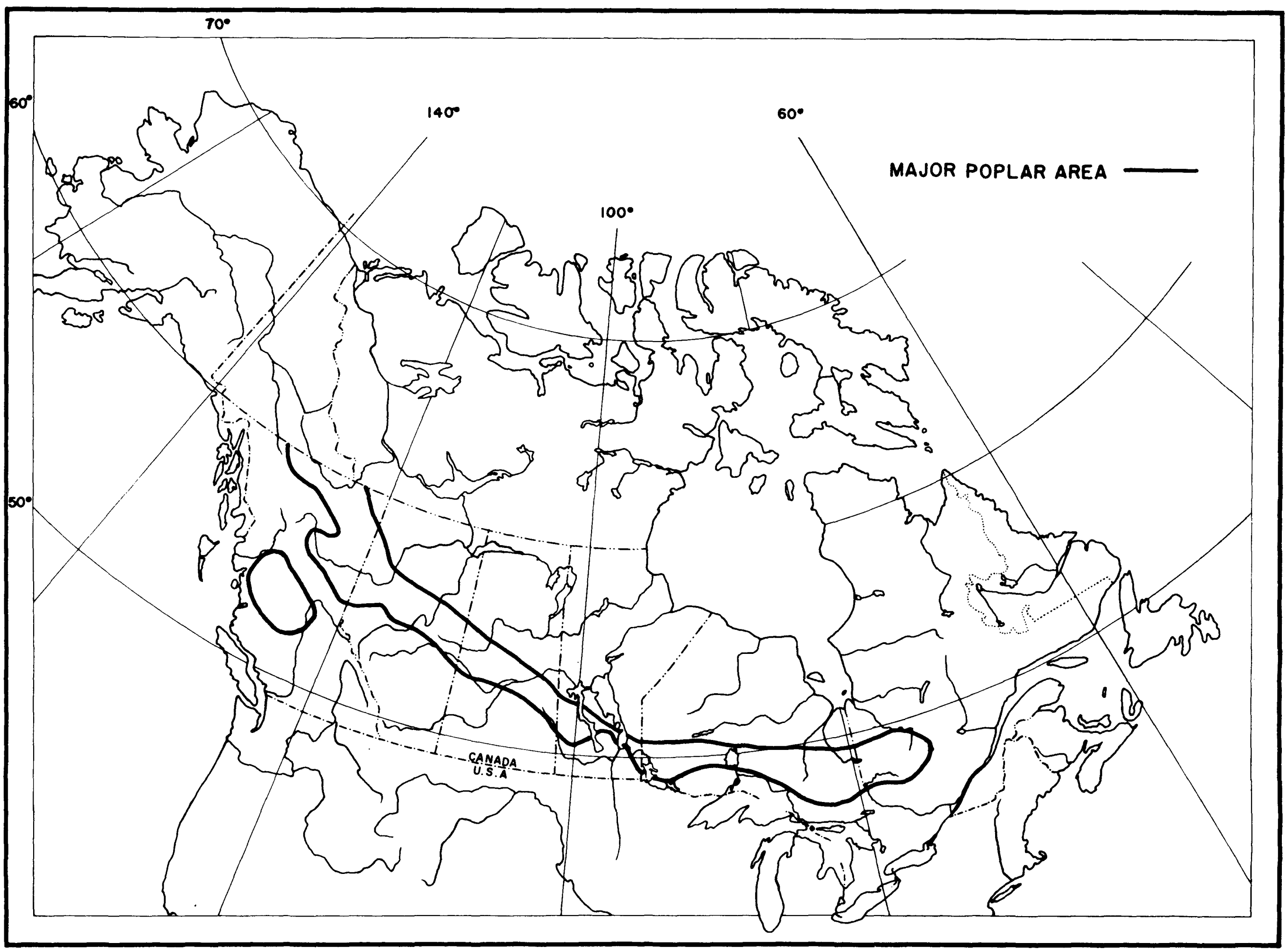

Figure 4.—*Major area of poplar volume, mostly aspens, in Canada (after Fitzpatrick and Stewart 1968).*

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