Populus granddentata Michx. Bigtooth Aspen

Salicaceae Willow family

Paul R. Laidly

Bigtooth aspen *(Populus grandidentata),* also called largetooth aspen, poplar, or popple, is a medium-sized deciduous hardwood tree of northeastern North America. It is short lived but grows rapidly, especially the first 30 years, on sandy upland soils and flood plains. Easily reproduced from seed or sucker shoots, it quickly reforests disturbed sites where it builds soil and protects seedlings of slower growing species. The soft, light-colored wood is used mostly for paper pulp. Wildlife use the foliage, twigs, and buds as food.

Habitat

Native Range

Big-tooth aspen (fig. 1) is native to northeastern and north-central United States and southeastern Canada. Its range extends from Cape Breton Island, Nova Scotia, west to southeastern Manitoba, south through Minnesota and Iowa to extreme northeastern Missouri, and east to southern Illinois, Kentucky, Virginia, and Delaware. It is also found locally in western North Carolina and northwestern Tennessee. In Canada, the greatest abundance of bigtooth aspen is in southwestern Quebec and southeastern Ontario (4).

Climate

Big-tooth aspen spans a range of climatic conditions from the marine climate along the Atlantic coast to the continental climate of Minnesota and southwestern Ontario. Summers are humid and moisture is adequate at all seasons *(4,7).*

Mean annual precipitation ranges from a low of 510 mm (20 in) on the prairie border in Manitoba to a high of 1520 mm (60 in) in the Maritime Provinces. North to south mean annual precipitation ranges from 510 to 1270 mm (20 to 50 in) with one-half or more occurring during the growing season. Mean annual snowfall exceeds 127 cm (50 in) where bigtooth aspen is most abundant and of best form. Mean annual snowfall exceeds 250 cm (100 in) in the Upper Peninsula of Michigan and the Northeast and reaches a maximum of 300 cm (120 in) in Nova Scotia (7). Areas near Lake Superior in the Upper Peninsula of Michigan often receive more than 500 cm (200 in) of snowfall.

January temperatures average -18" C (0° F) in the North and 2" C (35" F) in the South. Temperatures of –46° C (– 50" F) have been recorded at the northern limit of bigtooth aspen.

Average July temperatures range from 16" C (60" F) in the North to 26" C (78" F) in the South. Temperatures higher than 38" C (100" F) have been recorded throughout its range.

Soils and Topography

Bigtooth aspen is capable of growing on a wide range of sites but is far less adaptable than quaking aspen *(Populus tremuloides).* It is most abundant on sands, loamy sands, and light sandy loams, but it is found as a single tree or minor stand component on any soil, from rock outcrops to heavy clays. Bigtooth aspen develops best on moist, fertile sandy uplands where the depth to water table is no more than 1.5 m (5 ft), and site quality decreases rapidly as the depth to water table approaches 0.6 m (2 ft). Within this zone, a stagnant water table is much more detrimental than the lateral movement of water. Stands generally are unmerchantable if located on soils with an impermeable stratum at 0.3 m (1 ft) or less or a permeable subsoil that is dry to 1.5 m (5 ft) in the summer. Good soil aeration is essential for good growth of bigtooth aspen *(3,4,5,7).* Soils on which big-tooth aspen most commonly grow are in the orders Spodosols, Alfisols, and Inceptisols.

Although bigtooth aspen can grow at sea level and has been found at altitudes over 915 m (3,000 ft) in North Carolina, it is most abundant and develops best on flat to gently rolling terrain of floodplains or lower slopes of the uplands between 150 to 610 m (500 to 2,000 ft) in altitude.

Associated Forest Cover

Big-tooth aspen is found in pure aspen forest covers either singly or in various combinations with quaking aspen and balsam poplar *(Populus balsamifera).* Balsam poplar is a minor component of this combination on the dry-mesic sites and bigtooth aspen is a minor component on the wet-mesic sites (4).

The species is a major component of the forest cover type Aspen (Society of American Foresters Type 16) and is a minor component in the following types *(8)*:

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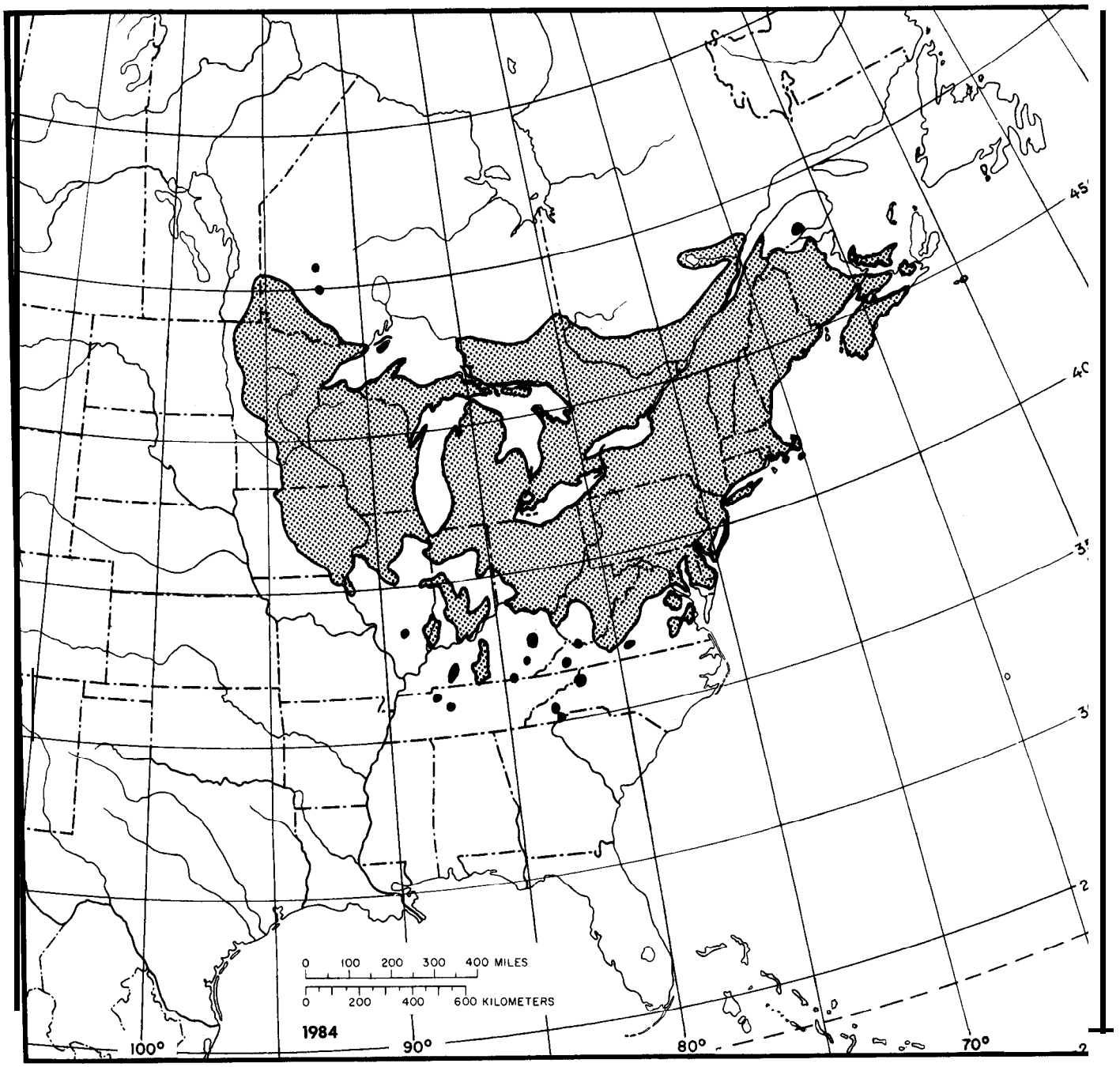

Figure *l-The native range of bigtooth aspen.*

1 Jack Pine
5 Balsam Fir
14 Northern Pin Oak
15 Red Pine
17 Pin Cherry
18 Paper Birch
19 Gray Birch-Red Maple
21 Eastern White Pine
25 Sugar Maple-Beech-Yellow Birch
32 Red Spruce
33 Red Spruce-Balsam Fir
35 Paper Birch-Red Spruce-Balsam Fir
37 Northern White-Cedar
43 Bear Oak
46 Eastern Redcedar
60 Beech-Sugar Maple
108 Red Maple

In the northern part of its range, common tree associates are quaking aspen, balsam poplar, balsam

fir *(Abies balsamea),* paper birch *(Betula papyrifera),* gray birch *(B. populifolia),* jack pine *(Pinus banksiana),* red pine *(P. resinosa),* red maple *(Acer rubrum),* and white spruce *(Picea glauca).* To the south and east, common tree associates are sugar maple *(Acer saccharum),* northern red oak *(Quercus rubra),* bur oak *(Q. macrocarpa),* northern pin oak *(Q. ellipsoidalis),* white oak *(Q. alba),* eastern white pine *(Pinus strobus),* basswood *(Tilia americana),* pin cherry *(Prunus pensylvanica),* black cherry *(P. serotina),* and sassafras *(Sassafras albidum).*

Common shrub associates are chokeberry *(Prunus virginiana),* downy serviceberry *(Amelanchier arborea),* dogwood *(Cornus* spp.), willow *(Salix* spp.), beaked hazel *(Corylus cornuta),* speckled alder *(Alnus rugosa),* highbush cranberry *(Viburnum trilobum),* American hazel *(Corylus americana),* and sweetfern *(Comptonia peregrina).* Common ground flora are blueberry *(Vaccinium* spp.), teaberry *(Gaultheria procumbens),* bracken *(Pteridium aquilinum* var. *latiusculum),* fly honeysuckle *(Lonicera canadensis),* smooth sumac *(Rhus glabra),* dwarf bush-honeysuckle *(Diervilla lonicera),* and strawberry *(Fragaria* spp.) *(4,7,8).*

Life History

Reproduction and Early Growth

Flowering and Fruiting-B&tooth aspen is normally dioecious; flowering begins at about age 10. Flowers are borne in drooping catkins, 5 to 7.5 cm (2 to 3 in) long, that are tan-colored at maturity. Bracts have 5 to 7 clefts and capsules are narrow and cone-shaped. Flowering precedes foliation and seed is dispersed before leaves are fully expanded. Female receptivity tends to begin before male pollen shed and lasts longer, but the mean dates of peak receptivity and pollen shed are closely allied. The timing of receptivity or pollen shed varies little intraclonally but varies significantly interclonally. The duration of active flowering is shorter for bigtooth aspen than for quaking aspen *(3,4,7,9).*

Air temperature seems to be the principal factor affecting the time and duration of flowering. In southern Ontario flowering occurs in late April; in southeastern lower Michigan flowering time is late April to early May; and in northern lower Michigan and northern Minnesota flowers appear in early to mid-May. Dehiscence of the capsule and seed dispersal take place about 4 weeks after flowering. Bigtooth aspen flowers, foliates, and disperses seeds about 10 days later than quaking aspen *(3,4,7).*

Seed Production and Dissemination-Seeds are pear-shaped, with a tuft of long silky hair attached to the narrow end. Good seed crops are produced every 2 or 3 years, but light seed crops are produced annually, Seeds are very light averaging approximately 5.6 million/kg (2.54 million/lb) with hair and are dispersed by wind for long distances from the parent tree (4). A single tree may produce more than 1.5 million seeds (3).

Seedling Development-Seedlings do not commonly occur in nature, in spite of extremely high production and high seed viability (more than 80 percent germination under laboratory conditions) *(3,4).* The uncommon occurrence has various causes: competition from other plants, short seed viability (2 or 3 weeks), the presence of a germination and growth inhibitor in the seed hairs, lack of moisture, high seedbed temperatures, susceptibility to fungal attack, and the chemical nature of some soils.

Germination is epigeal. Bare, moist soil is essentially for seed germination and seedling establishment. If ground moisture is adequate, seeds usually germinate in 1 to 2 days. When the seed coat is ready to rupture, a typical time table for seedling development is as follows (4):

24 h	Radical emerges from seed and contacts soil; fine hairs develop at junction of radical and hypocotyl.
48 h	Hypocotyl elongates and raises cotyledons above ground.
144 h	Cotyledons expand and shed testa; radical penentrates soil about 10 mm (0.4 in).
1 yr	Seedling is 15 to 20 cm (6 to 8 in) tall; root spread is about 15 to 25 cm (6 to 10 in) deep and as much as 40 cm (16 in) wide.
2 yr	Seedling is 30 to 60 cm (12 to 24 in) tall.
3 yr	Seedling is 90 to 120 cm (36 to 48 in) tall.

Abundant moisture can greatly increase the first year's height growth, but competition from brush and weeds can easily eliminate l-year-old seedlings.

Vegetative Reproduction-Suckering is the most common mode of reproduction. Suckers usually develop from shallow, cordlike lateral roots. These roots range from 0.5 to 11.4 cm (0.2 to 4.5 in) in diameter with the greatest proportion of suckers on roots less than 2.5 cm (1.0 in) in diameter. Sucker-bearing roots lie about 7.5 cm (3.0 in) deep in the mineral soil but can be as deep as 17.8 cm (7.0 in) *(4).* Sucker-bearing roots tend to be deeper for bigtooth aspen than for quaking aspen. Sprouts from stump and root collar are rare but develop more frequently in bigtooth than quaking aspen *(9).*

Sucker initiation is attributed to an increase in soil temperature and relief from the apical dominance effect *(3,4)*. Almost any disturbance-tree cutting, brush removal, fire, or ground scarification-can result in some degree of suckering *(2,3,5)*. Existing stands continually produce suckers but most of them are weak and die within a few years *(4,7)*.

Vegetative reproduction results in the formation of male and female clones that range from a few to several trees and occupy from 0.004 to 1.5 ha (0.01 to 3.8 acres) *(3,4)*.

Suckering ability varies significantly interclonally but no relation exists between size of clone and suckering ability. A single clone tends to exclude the invasion of other clones on a particular area, but the intermixing of "clone territories" to form a stand is common. In mixed stands of bigtooth aspen clones and quaking aspen clones, the clonal boundaries between the two species are well defined; the clonal boundaries within species are less distinct *(1,3,4,9)*.

After a stand is logged or killed by fire, suckering normally produces from 8,000 to 60,000 stems per hectare (3,200 to 24,000/acre). Age of parent stand, residual overstory, season of cutting, intensity of fire, and amount of ground scarification affect the abundance and vigor of suckers *(3,4,5,9)*. Suckers have been produced more than 30 m (100 ft) from the parent tree when invading open fields *(2)*, but 10 m (33 ft) is a more likely maximum within a stand (6). Because of the existing root system, suckers grow faster than seedlings and often reach 0.9 to 1.8 m (3 to 6 ft) in height the first year.

Reproducing bigtooth aspen from stem cuttings is difficult. However, rootability can be improved if the cuttings have expanding foliar buds or are treated with indolebutyric acid *(4,7)*. Root cuttings have a good capacity to produce suckers. Interclonal variation in rootability of cutting is large.

Sapling and Pole Stages to Maturity

Growth and Yield-Normally, mature big-tooth aspen trees (fig. 2) are 18 to 24 m (60 to 80 ft) tall and 20 to 25 cm (8 to 10 in) in d.b.h. On the best sites, bigtooth aspen can attain a height of 30 m (100 ft) at 50 to 60 years of age *(3,4,5)*. Height growth is rapid for the first 30 years and slows markedly thereafter. Quaking aspen tends to have slower height growth initially but maintains this growth longer. Stand basal area seldom exceeds 34.4 m^2/ha (150 ft^2/acre).

Empirical yields for 50-year-old bigtooth aspen in northern lower Michigan range from 100.8 m^3/ha (1,440 ft^3/acre) on site index 15 m (50 ft) sites to 296.8 m^3/ha (4,240 ft^3/acre) on site index 24 m (80 ft) sites (table 1) (5). For bigtooth aspen, site index is determined at base age 50 years. Stands begin to deteriorate from rot fungi at 40 to 45 years of age on the poor sites and at 50 to 70 years of age on the better sites. Large single cull trees more than 100 years old are found. Bigtooth aspen appears to be more resistant to disease than quaking aspen.

Figure 2—*A stand of bigtooth aspen on the Nicolet National Forest in Wisconsin.*

Rooting Habit-Suckers remain connected to parent roots even after they develop their own root system. Adventitious roots develop at the basal part of the sucker or on the parent root near the sucker base. Cordlike root connections between the sucker and parent root remain alive until one of the two trees dies *(4)*.

Bigtooth aspen's root system is shallow and wide spreading. Strong, vertical, and penetrating roots near the base of the tree, and sinker roots developing

Table l-Empirical yield table for bigtooth aspen in northern lower Michigan by age and site index[1]

Site index[2] and age (yr)	Mean height[3]	Mean d.b.h.	Basal area	Merchantable volume[4]
	m	*cm*	*m²/ha*	*m³/ha*
SI 15 m				
30	13.7	13	16.1	28.0
40	14.6	17	20.4	84.0
50	15.2	18	20.7	100.8
60	15.5	19	19.7	100.8
SI 18 m				
30	16.2	15	20.7	78.4
40	17.7	19	24.6	140.0
50	18.3	20	24.8	156.8
60	18.6	21	23.2	151.2
SI 21 m				
30	18.9	17	25.3	140.0
40	20.4	20	29.2	207.2
50	21.3	22	28.2	218.4
60	21.6	23	25.7	207.2
S124 m				
30	21.6	19	31.9	224.0
40	23.5	22	34.9	296.8
50	24.4	25	32.1	296.8
60	24.7	27	28.9	274.4
	ft	*in*	*ft²/acre*	*ft³/acre*
SI 50 ft				
30	45	5.1	70	400
40	48	6.6	89	1,200
50	50	7.1	90	1,440
60	51	7.3	86	1,440
SI 60 ft				
30	53	5.9	90	1,120
40	58	7.3	107	2,000
50	60	8.0	108	2,240
60	61	8.2	101	2,160
SI 70 ft				
30	62	6.6	110	2,000
40	67	8.0	127	2,960
50	70	8.8	123	3,120
60	71	9.2	112	2,960
SI 80 ft				
30	71	7.4	139	3,200
40	77	8.8	152	4,240
50	80	9.8	140	4,240
60	81	10.5	126	3,920

[1]All trees 1.5 cm (0.6 in) and larger in d.b.h.
[2]Height of dominants and codominants at 50 years.
[3]Dominants and codominants.
[4]Gross inside bark volume to a 10 cm (4.0 in) diameter inside bark.

from the lateral roots, provide good anchorage. Four to five well-developed lateral roots originate from the base of the tree and branch within 0.6 m (2 ft). The lateral spread of roots is usually 10 to 20 m (33 to 66 ft) under forested conditions. Bigtooth aspen's root system tends to be deeper, to be less branched, and to have fewer adventitious roots than quaking aspen's root system *(4,9)*.

Reaction to Competition-Bigtooth aspen is classed as very intolerant of shade. It cannot successfully reproduce under its own shade *(3,7)*, and seedlings must be kept free of competing brush and grasses. However, sucker growth is rapid enough to outgrow its competition. Leaving as little as 5.7 to 8.0 m²/ha (25 to 35 ft²/acre) basal area in the residual overstory can severely limit sucker initiation and growth. Severing all stems 5.0 cm (2.0 in) and larger is recommended for producing well-stocked vigorous sucker stands (5).

Mortality is very high in young sucker stands, but this acts as a natural thinning agent. Trees begin to express dominance at 7 to 10 years, and potential crop trees can often be identified by age 10. Trees die throughout the life of the stand until 620 to 1,235 stems per hectare (250 to 500/acre) remain at the end of the rotation.

Bigtooth aspen responds well to thinning for producing small saw-log and veneer material. Only well-formed, disease-resistant clones on site index 21 m (70 ft) or better areas should be considered for producing sawtimber and veneer (5).

Clearcutting is the best method for harvesting stands because the completeness of the overstory removal determines the establishment and vigor of the new stand. Rotation lengths are 30 to 40 years on the poorest sites, and 50 to 60 years on the best sites because stands deteriorate rapidly when held to greater ages. With proper harvesting and site preparation bigtooth aspen can continually occupy a site. Otherwise, it will be succeeded by the more shade-tolerant hardwood and coniferous species (3).

Damaging Agents-Bigtooth aspen is subject to a number of agents that cause damage and mortality. Fire can easily kill these thin-barked trees or reduce their growth and provide entry points for disease organisms. Hailstorms may defoliate trees and severely scar stems and provide similar entry points. Heavy thinning may subject the residual stems to sunscalding. Windthrow is not a problem but wind breakage is common at cankered and borer-infested portions of the stem.

Hypoxylon canker *(Hypoxylon mammatum)* is the most serious disease of the aspens. Trees often are girdled or subjected to wind breakage, but bigtooth aspen is much more resistant to Hypoxylon canker than quaking aspen. Heart rot *(Phellinus tremulae)* can cause serious volume loss and stand deterioration when stands are held beyond rotation age.

Ganoderma ***applanatum*** and ***Armillaria*** *mellea* can cause extensive root decay. Shepherd's crook *(Venturia macularis)* may repeatedly kill new terminal growth in young stands *(2,4,7,9)*. Clones vary greatly in resistance to disease attack and damage.

The forest tent caterpillar ***(Malacosoma*** *disstria)* and the large aspen tortrix *(Choristoneura conflictuna)* have periodically defoliated extensive areas of aspen. Populations of these insects usually persist for 2 or 3 years and then suddenly collapse. Growth loss can be substantial but few trees are killed *(2,4,7,9)*.

The poplar borer ***(Saperda*** *calcarata)* is the most serious wood borer in aspen. Extensive boring degrades large trees and subjects stems to wind breakage. Wood borers of several species can provide infection points for Hypoxylon canker and other fungi. In turn, defoliating insects may cause an increase in populations of wood borers *(2,4,7,9)*.

When their populations are high, deer and hare can heavily browse young stands. This is seldom a problem in dense stands, however, because browsing helps thin these stands. Beaver can kill large portions of stands both by flooding and by cutting trees *(2,5,9)*.

Special Uses

Typical management of aspen stands does not distinguish between bigtooth aspen and quaking aspen, and their uses are not differentiated. The aspen forests contribute significantly to maintaining other resources. It is no accident that the native range of ruffed grouse coincides with the native range of the aspens. Aspen leaves and staminate flower buds provide ruffed grouse with their most important yearlong food resource. Aspen suckers are a favored winter food of moose and are heavily browsed by white-tailed deer. Although aspen is not the most palatable browse, an abundance and wide distribution of small clearcuttings are essential for maintaining a good deer population. The bark, leaves, twigs, and branches of aspen are preferred by beaver *(2,9)*.

Because aspen is deciduous, more snow accumulates on the ground in aspen than in coniferous stands. Thus, soils are better insulated from freezing and snowmelt enters the soil rather than running overland. Because of aspen's ability to produce abundant suckers, fire-killed stands are rapidly revegetated. Similarly, aspen can be harvested on slopes without seriously affecting erosion or water quality. Aspen often is perpetuated on areas where soil stabilization poses a problem (2).

Aspen bark has been pelletizecl for supplemental cattle feed and fuel. Although the vast quantity of these pellets comes from quaking aspens bark, no distinction has been made between bigtooth aspen and quaking aspen in the pelletizing process.

Genetics

Population Differences

Recognizing the inter- and intraspecific clonal variation in aspen stands can lead to definite upgrading of the quality of aspen in growth, form, and disease resistance. In mixed stands of bigtooth aspen and quaking aspen on dry exposed sites, big-tooth aspen clones have superior growth and disease resistance *(5,6)*. The interclonal variation in rootability should be recognized when stands are established from stem and root cuttings.

Hybrids

Natural hybrids of bigtooth aspen and quaking aspen do occur, but less frequently than might be expected, because of differences in time of flowering. When hybridization occurs, it is most likely to be between male quaking aspen and female bigtooth aspen *(3,4,9)*.

The best known interspecific hybrid is ***Populus alba x P. grandidentata*** *(P. x rouleauiana* Boivin). Growth is superior to native bigtooth aspen on dry, sandy soils, but its development is maximized on fertile, moist loamy soils. Seed production and suckering are generally low and branchiness and form are poor. ***P. x canescens x P. grandidentata*** has shown good growth but poor rootability. *P.* x ***canescens x P. alba x P. grandidentata*** has shown both good growth and good rootability. Additional crosses with bigtooth aspen have been made but are generally of lower quality.

Intraspecific crosses of bigtooth aspen have been difficult to establish in plantings and have slow early growth. Bigtooth aspen has 19 pairs of chromosomes (2n=38).

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