Extension Note

BC Journal of Ecosystems and Management

British Columbia's Northeastern Forests

Aspen Complex Stand Establishment Decision Aid

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Introduction

Aspen (*Populus tremuloides*) is the most widely distributed tree species in North America and can be found from the McKenzie Delta to northern Mexico. Its range in British Columbia is restricted to the Interior except for the east coast of Vancouver Island and along the Skeena, Kitimat, and Fraser rivers where it extends to the mouth of the river. In recent years, utilization of the species has increased dramatically, particularly in northeastern BC where aspen is the main fibre source for several OSB and veneer mills. Other aspen products include: dimension lumber, paper, molded wood composites, molding and trim, crates, pallets, pellets, chop sticks, fruit and vegetable boxes, furniture, fuel, and forage for livestock. The combined AAC for deciduous species in the Dawson Creek, Fort St. John, and Fort Nelson TSAs is almost 2 million m^3/year. In 2006, the shipment value for OSB and aspen veneer produced in BC was $2.2 billion.

Aspen can be an aggressive competitor for conifer species (particularly in the Black and White Boreal Spruce zone) but it also provides many non-timber services and is considered to be an acceptable crop tree and commercial species in a number of TSAs in the province. This Stand Establishment Decision Aid (SEDA) provides information to help forest managers in northern BC understand how to manage aspen for timber production as well as how to manage it when it is not regarded as a crop species. The following pages describe: the environmental conditions in which it is found; tree and stand regeneration; growth and yield; effects on crop trees and forest productivity; forest health considerations; management practices; and other values and benefits associated with aspen. The synopsis also includes a short list of references for further reading. For information on managing aspen in the Southern Interior of BC, see Swift and Turner (2004). Information in this document is based on a review of the pertinent literature and expert opinion.

Acknowledgements

Preparation of this decision aid was supported by the British Columbia Ministry of Forests and Range through the Forest Investment Account–Forest Science Program. We thank Craig Farnden (PhD Candidate, UBC Faculty of Forestry, craigfarnden@telus.net) for his detailed review of this SEDA.

KEYWORDS: *deciduous and mixedwood management, fibre production,* Populus tremuloides*, silviculture systems, trembling aspen, vegetation management.*

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McCulloch, L. and R. Kabzems. 2009. British Columbia's northeastern forests: Aspen Complex Stand Establishment Decision Aid. *BC Journal of Ecosystems and Management* 10(2):51–58.
www.forrex.org/publications/jem/ISS51/vol10_no2_art5.pdf

Aspen Complex – British Columbia's Northeastern Forests

Larry McCulloch

A two-cohort aspen/spruce mixedwood stand.

Aspen sites

- Aspen can occupy a wide range of sites and is a seral component in at least 77 subzones in BC.
- It is most productive on nutrient-rich, fresh-to-moist, well-drained sites (5-6/D on the edatopic grid). Soil moisture is a very important factor in the relative growth of aspen.
- Aspen does not tolerate flooding or wet, clay-textured soils that are not well oxygenated and growth on dry sites is poor. Seedlings have a low tolerance for drought.

Regeneration and development

- Aspen can be found in single- or multiple-cohort, pure or mixed-species stands, but it is shade-intolerant and will be succeeded by more shade-tolerant conifers in the absence of disturbance.
- Single-cohort stands most often occur after fire.
- The species regenerates predominantly from a clonal root system that can be centuries old and is typically much older than the above-ground stems.
- Clones are usually much smaller than 1 ha in area but can be several hectares in size. There is considerable variation amongst clones in terms of phenology, stem form, growth rates, decay, and physiological response to treatment. Flushing of adjacent clones, for example, may be as much as three weeks apart.
- The root system is wide-spreading with most lateral roots occurring within 30 cm of the soil surface. Sinker roots penetrate vertically up to 2.5 m into the soil. Distance from the parent stem is not an important factor in the ability of an aspen clone to produce suckers.
- If there are sufficient aspen stems in the original stand, suckering may be abundant in the first year following clearcutting or fire (as many as 250 000 stems/ha), but by the second year little more sprouting will occur and mortality due to intra-specific competition begins.
- Aspen can also regenerate from seed but does not regenerate well from cuttings unless they are from small root suckers.
- Trembling aspen is dioecious and one female tree can produce a million seeds or more with 95% germination capacity. Seeds have transient viability however, and must come into contact with moist mineral soil or humus within a few days of dispersal.
- Seedlings initially grow more slowly than suckers (e.g., 15 cm/year) whereas suckers can grow 100 cm or more in the first year, tapering to 30–50 cm by year three. Many first-year germinants are less than 5 cm tall, but if they have good growing conditions, they develop a large root system that will support vigorous height growth.
- Stand density has little effect on height growth in the first five years but has a dramatic influence on stem diameter.
- Full leaf area is achieved in 15–25 years, resulting in early crown closure, self thinning, and branch pruning.
- Aspen grows best with full sun but can tolerate light levels as low as 40% of full sunlight (vs. spruce which can tolerate levels as low as 10–20% of full sunlight).
- The species can regenerate in canopy gaps as small as 300 m^2, but sucker abundance and growth is better in gaps of 1000 m^2 or more. Regeneration in gaps depends on levels of competing vegetation.

Species commonly associated with aspen on its most productive sites

- **Trees:** white spruce, pine (less commonly paper birch, black cottonwood)
- **Shrubs:** black twinberry, highbush cranberry, prickly rose, saskatoon, black currant, willow, dogwood
- **Herbs and dwarf shrubs:** peavines, toadflax, calamagrostis (bluejoint), aster, tall bluebell, fireweed, coltsfoot, bedstraw

Note: Species composition varies with site and climate.

Barriers to aspen regeneration

- Cold soil temperatures (< 15°C) associated with heavy soils and/or deep duff
- Dry, sandy soils
- Overmature stands with low stem numbers and poor vigour
- Activities that compact the soil
- Heavy competition during stand initiation
- A high water table
- Frequent burning

Growth and yield

- Although aspen occurs on a wide range of conditions, it does well on a much narrower range.
- On good sites, an aspen stand at age 70 might be expected to have a basal area of 35 m^2/ha and a gross merchantable volume of about 250–300 m^3/ha.
- The age at which culmination of mean annual increment for merchantable timber (MAI) is reported to occur varies greatly depending on site quality (e.g., from 55 years on good sites to 80 years on poor sites). Site index also varies widely and within the timber harvest landbase will usually range from 15–28 m at a breast-height age of 50 years.
- Mean annual increment in northeast BC typically ranges from 1.4–2.3 m^3/ha/year, but has been reported to be as high as 5.4 m^3/ha on good sites.
- Mixedwood stands are likely to have a higher yield than either pure spruce or pure aspen stands because of differences in shade tolerance, phenology, rooting patterns, and the physical space occupied by different size canopies.
- Retaining between 1000 and 10 000 stems/ha might be expected to increase total production by about 20% relative to a pure spruce stand, but this will be at the expense of spruce merchantable volume.

Forest health

- More than 250 species of fungi and 300 insects have been recorded on aspen in North America. Most significant in terms of impact on growth and yield are: stem decay (primarily *Phellinus tremulae*), butt rot (*Armillaria ostoyae*), hypoxylon canker (*Hypoxylon mammatum*), cytospora canker, tent caterpillar, large aspen tortrix, aspen leaf miner, aspen leaf beetle, poplar borers, a number of ink and leaf spots, blights, and rusts.
- Aspen "die-back," likely related to drought conditions followed by an outbreak of forest tent caterpillar, has been a concern in Alberta where it is thought to result in stand break-up. This issue may become more prominent with climate change.
- The influence of defoliators on aspen growth depends on outbreak severity. Two years of severe defoliation causes significant reduction in radial growth but little mortality. Cases of complete leaf loss for > 4 years have resulted in 80% mortality.
- One of the key factors in terms of stand longevity and product utility is stem decay. In many stands, the pathological rotation of aspen is 50–80 years. Tree size, age, and stem defects are good indicators of decay.
- Moose, elk, and cattle can cause extensive scarring (providing entry courts for decay fungi) in mid-rotation stands.
- Snowshoe hares feed on twigs in young stands and may girdle small trees by eating the bark. Younger aspen stands (< 50 years) offer good hare habitat and this can result in extensive browsing damage on spruce if it is underplanted, especially during a hare population peak.

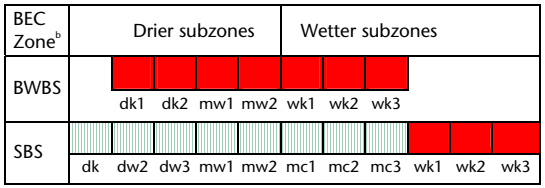
Aspen impact on conifer productivity

- An aspen overstorey can reduce light levels below those necessary for conifer survival or optimum growth.

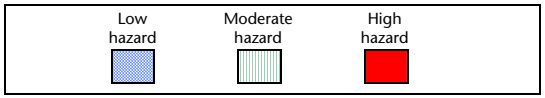
Light levels required for growth of selected conifers expressed as a percent of full sunlight

	Sw	Pl	Bl
Optimum	40–60%	100%	40%
Minimum	10–20%	60%	10%

Competition hazard rating[a]



Hazard rating key



[a] Ratings represent expert opinion. If a BEC unit is not listed, competition for light and space is not considered to be significant, although moisture competition may still occur.

[b] See Meidinger and Pojar (1991) for an explanation of Biogeoclimatic Ecosystem Classification (BEC) zone, subzone, and variant abbreviations.

- In one experiment on two sites in northeastern BC, the threshold for aspen density to have an effect on white spruce growth (up to age 17) appeared to be below 1000 stems/ha when aspen and spruce mixtures were established concomitantly after harvesting. Aspen densities above 5000 stems/ha did not result in a significantly greater reduction in height and diameter growth in spruce. Height and diameter growth reductions were 23–61% and 47–112% respectively compared to spruce grown without aspen competition. Volume production for spruce at age 70 without aspen competition was modelled to be about twice as much as spruce grown with aspen. However, in mixed aspen–spruce stands, the total productivity of both species combined was predicted to be 21% higher than in a pure spruce stand.
- In Alberta, 12 regeneration blocks were operationally treated to control aspen; five years after treatment, a 17% gain in height and 43% gain in spruce diameter were observed relative to areas with no treatment.
- Eliminating aspen from mixedwood stands that are well stocked with spruce essentially trades deciduous volume for conifer volume.
- Aspen can also beneficially influence conifer productivity, particularly juvenile stands. Examples include provision of overhead cover which reduces competition from grass, radiative frost damage, and white pine weevil incidence; increased soil organic matter content and moisture holding capacity; and more rapid nutrient cycling.

Other values of the species

As noted in the introduction, aspen wood is used to produce a variety of timber products. Aspen also provides a number of non-timber values and services.

First Nations values

- First Nations within BC have historically obtained both timber and non-timber products from aspen ecosystems.
- Aspen stands provide a broader range of hunting opportunities than available in conifer stands alone.
- When game was scarce, the cambium of mid-rotation trees was sometimes eaten to stave off starvation.
- The wood has been used for furniture, carving, cups and bowls, tent poles, drying racks, and firewood.
- The bark has been used for splints and temporary vessels, and some members of the Kaska First Nation use a green fungus growing in the cracks and crevasses of the bark on some trees as a natural insect repellent.

Habitat and biodiversity

- Aspen stands provide habitat with a wider range of understorey plants and are more attractive than conifer stands to many invertebrates, birds, and mammals. Fifty-five mammal species and 135 bird species (34 cavity nesters) are associated with western aspen forests.
- The forage value of aspen for ungulates is higher because of elevated levels of protein relative to other boreal tree species. Aspen stands provide more forage opportunities and can sustain higher levels of use than conifer stands. Aspen stands, especially suckers, are an important source of browse opportunities in the winter.
- Ruffed grouse make almost exclusive use of 6- to 12-year-old aspen groves foraging on aspen buds. Snowshoe hare graze on the twigs and the bark of small trees.
- Beaver depend on aspen for building dams and lodges, and feed on twigs and bark. It is estimated that a beaver needs about 200 aspen trees per year.

- Black bears eat catkins and new leaves in early spring.
- Many cavity-nesting birds also use aspen trees. Around Hinton, Alberta, 38 species rely on snags.
- Mice, voles, and shrews are common in older aspen stands and are an important part of the carnivore food web.
- Aspen suckers are highly nutritious and can contribute substantially to the diet of cattle; however, cattle are often deterred from entering young, dense aspen stands.
- Young aspen sprouts are a preferred forage for sheep.

Ecosystem productivity and function

- Aspen generally improves soil conditions. It has high levels of calcium and potassium in its foliage, wood, and bark relative to other northern tree species, and rates of forest floor decomposition and nutrient turnover are higher in aspen stands than pure conifer stands. Litter fall from aspen redistributes these nutrients.
- Aspen quickly reaches full leaf area (in 15–25 years) and thus quickly replenishes soil organic matter after disturbance.
- Mature aspen trees reduce frost damage to seedlings in the understorey by restricting radiant heat loss during the night and increasing air temperatures at seedling height.
- Because of its sucker-origin communal root system, aspen is mechanically stable, and its presence may increase the resistance of neighbouring conifers to windthrow. However, overtopping aspen can increase susceptibility of conifers to breakage and windthrow because conifers develop spindly stems.
- Young aspen stands are not very flammable and may act as a fire break; however, dry plant litter and fine fuels create moderately severe burning conditions in aspen stands between snowmelt and early June when vegetation growth begins. Fires in older aspen stands are characteristically low-intensity.
- Rapid initial growth means rapid carbon sequestration; however, aspen is not as secure as conifers as a long-term carbon reservoir because it recycles faster and aspen products have a shorter lifespan.
- Aspen can slow the spread of root diseases in mixed stands because it is immune to *Phellinus weirii* and more resistant to *Armillaria ostoyae* than most conifers.

Management considerations

Aspen is regarded as both a crop tree and a competitor for conifers. The following text outlines two broadly different approaches for managing the aspen resource at the stand level—when the objective is to manage for aspen or mixedwood, and when the objective is to manage for conifers. At the stand level, these two approaches may be mutually exclusive but at the landscape level, both types of objectives can be achieved.

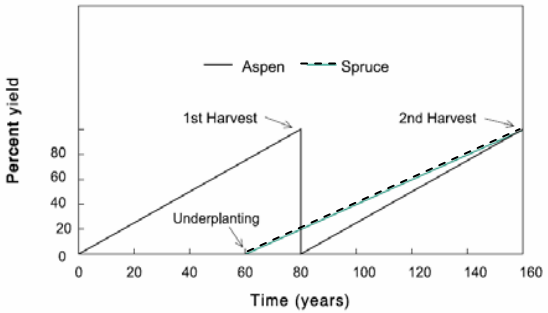
Landscape-level considerations

- Successful management of aspen ecosystems starts with a good understanding of the range of natural variation in forested ecosystems in the area, knowing which structural elements and processes are critical to the maintenance of ecological function, some insight into the likely impacts of climate change, and a clear idea of desired future forest condition.
- Carefully considered objectives at the landscape level must be formulated for biodiversity targets, timber production targets, non-timber resource values, and resource management costs before decisions can be made at the stand level.
- Landscape-level planning should include identification of priority areas for aspen harvest. These might include older stands that should be harvested before decay levels become an economic deterrent.

Silviculture systems

Aspen or mixedwood objective

- Choosing to promote aspen regeneration implies that a market for aspen products exists, or is expected to exist, or that non-timber objectives for the stand are more important than timber objectives.
- The silviculture system chosen will depend in part on existing stand conditions. Pure aspen stands and mixed-species stands, whether they are single- or multiple-cohort, are generally suitable for aspen regeneration. Avoid trying to regenerate aspen on excessively wet or dry sites.
- The highest levels of aspen regeneration and early growth will be achieved when an aspen or mixedwood stand is clearcut, stimulating maximum sucker regeneration. There must be a sufficient number of reasonably well-distributed mature aspen stems in the original stand to ensure adequate regeneration (at least 9 m^2/ha of basal area).
- Stands with high calamagrostis occupancy are not good candidates for clearcutting to stimulate aspen regeneration. One study suggested that if there is one bluejoint clone per m^2 prior to harvest, bluejoint dominance after harvest is highly likely.
- A number of other silviculture systems can also be employed. For example: creation of a single-storied mix of aspen and conifers; creation and management of a two-storied mix of aspen and shade-tolerant conifers (similar to some shelterwood systems); and creation of a mosaic of discrete patches of aspen and conifers (see Comeau et al. 2005 for a more thorough discussion of this topic).
- In patchy stands where conifers and aspen are not well mixed or where gaps in stocking exist, discrete patches of both species could be encouraged.
- Light levels in small gaps (0.1 ha) may be too low for optimum growth of shade-intolerant species, but smaller gaps prevent large increases in shrub and herb cover; vegetation competition in larger gaps can be too high to achieve sufficient regeneration.
- In general, growth of tree species in northern BC increases rapidly with gap sizes up to about 0.1 ha. Larger gaps (0.5 ha) do not show any advantage over smaller gaps in terms of regeneration. Abundant aspen regeneration (2000 stems/ha) has been found in gaps as small as 400 m^2 in NE Ontario.
- In mixedwood stands, openings less than 0.1 ha will minimize brush development.
- With a strip approach, it has been found that light availability is less than 20% in 5-m-wide strips unless they are oriented north–south. If a uniform shelterwood is chosen, basal area retention exceeding about 13 m^2/ha will favour conifers over aspen. In 40–60-year-old aspen stands, 60% light availability can be achieved when aspen basal area is 8 m^2/ha. If regenerating aspen, a 0.4 ha minimum opening size is recommended.



Schematic showing the proposed management regime for spruce planted under pure aspen stands. (Source: DeLong 1997)

- Stands with a suitable number of acceptable understorey spruce or balsam, or mid-rotation aspen stands (30–60 years of age) that could be underplanted with spruce, are very suitable for mixedwood management.
- Aspen stands that are good candidates for under-planting have canopies dense enough to restrict growth of understorey vegetation (about 1200 stems/ha or 20–35 m^2 of basal area/ha) but still allow about 20% of full sunlight to reach the ground.
- When aspen is under-planted with spruce, the aspen would be harvested at 60–80 years of age once the spruce has grown sufficiently tall to stay ahead of aspen suckers (a height of ~4 m). The spruce would be subsequently harvested at about age 80, and then the area could be replanted with spruce or, depending on management objectives and condition and abundance of aspen, left to grow as a single-cohort aspen stand.
- Rotation length will depend on site quality and product objectives. For sawn lumber products, rotation in northeastern BC may be 70–90 years, whereas for OSB and fibre products, rotations of 40–60 years may be more appropriate. In deciding on stand rotation, it may be helpful to use the Mixedwood Growth Model (an individual-tree, distance-independent model developed at the University of Alberta for mixedwood stands) to explore culmination ages and tree sizes.
- In areas where stem decay is common, a shorter rotation (50 or 60 years) may be warranted.
- In general, the least-cost management solution will be to manage along successional pathways, emulating natural processes and disturbances.

Conifer objective

- A conifer-dominated stand can be produced from any existing condition, but costs will increase dramatically in some stand types. Stands with > 20% conifer are best suited for mixedwood management.
- Stands that will be difficult to manage for conifers include pure aspen stands and mixedwood stands with low levels of acceptable advance conifer regeneration and high brush potential. Stands with high levels of tomentosus root disease may also be better suited to aspen regeneration.
- Where the objective is to grow a single-cohort pine stand, clearcutting is the most appropriate silviculture system leaving fewer than 8 m^2 of residual aspen basal area/ha (about 10–20% aspen cover). If aspen basal area is less than 8 m^2/ha in the original stand, mature aspen trees should not be cut unless they impede operations or are a safety hazard. Cutting will stimulate suckering and may increase brush levels.
- When the objective is to grow a single- or multiple-cohort stand of spruce, clearcutting, shelterwood, and selection systems are all possible, depending on existing stand structure.

Harvesting practices

Aspen or mixedwood objective

- Avoid leaving more than 35–50 mature aspen stems/ha if managing for aspen regeneration (less than ~20% cover).
- Winter harvesting is preferable on soils sensitive to compaction to avoid damaging clonal root systems.
- Aspen cut or damaged during harvesting produce prolific root suckers. Even aspen that remain undamaged will produce suckers as the root system is stimulated by the increased heat and light on the forest floor. Suckers resulting from excessively damaged root systems can be less vigorous.
- Winter harvesting can result in more aspen suckers than spring harvesting but this is generally not critical to regeneration success.
- Avoid leaving log decks or debris piles on areas to be regenerated during the growing season following felling. Burning piles on areas to be regenerated will inhibit aspen regeneration.

Aspen conversion

- Producing a single-cohort conifer stand from a pure aspen or mixedwood stand is possible but costs are high and success rates are low on sites well suited to aspen growth.
- One scenario that has been effective is to girdle mature aspen 2–4 years prior to clearcutting, use mechanical site preparation to create suitable microsites, plant conifers, and treat any resprouting aspen with herbicides.
- When mature aspen are girdled and the overstorey retained, death will occur within about 4 years and suckering will be minimal.
- Underplanting conifers, however, is generally less expensive, has higher success rates, and better emulates natural succession patterns.

Conifer objective

- In mixedwood stands, consider girdling aspen 2–3 years prior to harvest to reduce aspen competition for the next crop.
- Residual overstorey aspen cover of 20–30% during stand establishment will benefit spruce by reducing radiative frost damage, reducing brush development, reducing incidence of white pine weevil, and maintaining higher organic matter content in soils. Higher levels of overstorey can be retained but optimum spruce growth may not be achieved.
- Protecting existing understorey conifer stocking reduces regeneration costs, reduces time to free growing, shortens time to rotation, and maintains a higher level of ecosystem productivity.
- Deciduous stands with at least 1000 reasonably distributed conifers/ha in the understorey are good candidates for understorey protection. Up to half the conifer regeneration could be lost due to skid trails and blowdown, although typical losses range from 10–20% (except along roads and processing areas where it is higher). Added harvesting costs may be as much as \$4.00/m^3.

Tactics for protecting understorey conifers

- Ideal sites for this approach are those where there are about 1500 reasonably well-distributed healthy, acceptable Sx trees/ha, 3–6 m tall, 15–50 years old, not on a hilltop or excessively wet site, occupying > 50% of an area at least 5 ha in size.
- Survey the proposed block prior to harvest to identify patches of conifer stocking.
- Flag major skid trails; restrict skidding to designated trails and/or use a highly motivated and skilled crew.
- Keep trail development to a minimum (< 5m wide) and locate trails in voids, undesirable understorey, or overly dense patches where possible. The objective is to optimize the trail network to facilitate harvesting while minimizing loss of desirable spruce stocking.
- Fall trees into designated trails or gaps.
- Process at the stump if hand falling.
- Bunch logs in the direction of skidding.
- Avoid harvesting in patches where sufficient high-quality understorey conifers already exist.
- Leave rub trees or high stumps at skid corners.
- Skid to landings rather than the roadside to avoid a dispersed skid trail pattern.
- Ensure adequate site supervision during operations, especially in early stages of harvesting.

Site Preparation

Aspen or mixedwood objective

- Shrub and grass competition can reduce aspen regeneration. Any harvesting or site preparation activities that improve soil warming and reduce competing vegetation will benefit suckering and subsequent growth.
- Brush blades used in piling slash or uprooting vegetation may stimulate suckering by severing aspen roots and increasing soil warming.
- Avoid activities that cause soil compaction.
- Broadcast burning stimulates root suckers but repeated burning eventually results in fewer suckers with low vigour. Burning piles will kill all sucker root stock under them. If burning to reduce slash or encourage grazing opportunities, it is best done during the dormant season for better stimulation of aspen suckers.
- Mineral soil exposure provides a favourable seedbed; however, establishing aspen from seed is uncommon.

Conifer objective

- If herbicides (glyphosate) are used as a site preparation technique, application is best conducted the second year after harvesting when trees are taller and not hidden by other vegetation.
- Site scarification after suckers have completed one season of growth may reduce subsequent vigour and number of suckers on most sites, but exercise caution to avoid soil compaction and displacement.
- Burning and grass/legume seeding followed by sheep grazing could potentially provide a number of benefits, including nitrogen fixation, erosion reduction, suppression of other forms of competing vegetation, and increased forage supply. Sheep grazing would not be suitable if aspen were considered to be a crop tree.

Regeneration practices

Aspen or mixedwood objective

- Aspen regeneration is normally achieved by suckering and, therefore, it is the stems that are cut that produce the next crop rather than those that are left.
- Though it's not recommended, if regenerating aspen from seed or by planting seedlings, there must be no soil moisture deficit at establishment. Mineral soil exposure is also required to establish an aspen crop by natural seed-in.
- Where aspen is considered an acceptable species, sucker stocking the first year after establishment should be > 15 000 stems/ha (30 000 sph is ideal), 10 000–30 000 sph by year 10, and 5000 sph by age 20 for pulp and OSB products. Fewer trees are required at age 20 for sawlog or veneer production.
- Retaining acceptable advance regeneration is the best way to ensure a merchantable conifer component in a regenerated mixedwood stand.
- Intimate admixtures of young aspen and spruce are common at the regeneration stage, but admixtures with pine are not normally encouraged because pine is shade intolerant. There has been relatively little research in this area, however, and further experimentation with retaining higher levels of aspen in association with pine could be considered. Specific stocking standards for deciduous species in multi-cohort stands have not been developed.
- In BC, deciduous species are currently considered acceptable on some sites (see BC Ministry of Forests and Range 2007). There is also provision in the *Forest and Range Practices Act* to submit stocking standards that deviate from the reference guide in a Forest Stewardship Plan as well as an initiative to develop a Provincial Tree Species Selection Reference System that will provide current knowledge on tree species selection and stocking requirements that will help better inform any new standards proposed in a Forest Stewardship Plan.

Conifer objective

- If under-planting spruce in a mixedwood stand, plant 1400–1800 sph. The best timing for this is approximately 25 years prior to the expected aspen harvest. Stand basal area should be < 35 m^2/ha.
- Avoid under-planting next to disturbed areas if the hare population is peaking.
- On most sites where aspen is a prominent component of the stand, larger-caliper planting stock is appropriate.

Plantation maintenance

Aspen or mixedwood objective

- One of the principal advantages of promoting and utilizing aspen is that it is a low-maintenance species. Often, the only management intervention required is to harvest an existing stand at the appropriate time. Normally, the species regenerates abundantly, exhibits early rapid growth, self-thins quickly, grows reasonably straight with early natural pruning, and advances through stand structural stages more quickly than conifer species.

- Most management activities are associated with harvesting and site preparation practices; however, in circumstances where investment in treatment is warranted, aspen responds well to thinning and fertilization (where nutrients are limiting). Although the economics are questionable, thinning is best conducted at age 10 or when stand dbh is about 5 cm. The objective would be to improve aspen diameter growth (when lumber or peeler products are foreseen), improve understorey conifer growth, enhance browse, and remove undesirable ramets.
- In some studies, there has been an increase in *Hypoxylon* canker in thinned stands.
- Control of tent caterpillar and aspen tortrix by chemical means or *Bacillus thuringiensis* (Bt) has been practiced in some areas. If chemical or biological controls are contemplated, a good understanding of insect population dynamics is mandatory. Active intervention to control insect outbreaks in aspen stands has not been considered necessary to date in British Columbia.

Conifer objective

- Where conifer timber production is the primary management objective, brushing to control aspen competition can be an effective tool to maximize conifer growth.
- If aspen regeneration is dense in a single-cohort, mixedwood stand, cutting all aspen stems when conifers are less than about 3–4 m tall is not effective because of rapid resprouting and growth. A fivefold increase in sprouts can be expected. Thinning of aspen stems in stages (to 5000 sph when dominant stems are 1.5 m tall, and to 1000 sph when dominant aspen are 3 m tall) would minimize sprouting from cut stumps.
- Girdling of stems can be as effective as herbicides but it does not act as quickly (two or more years are often needed), it is more expensive than broadcast herbicide methods, and it does not necessarily eliminate subsequent suckering in young stands.
- Hand-breaking in June or July when competing vegetation is mostly aspen provides some control and results in less resprouting because the broken stem does not completely eliminate the transport of auxin from stem to roots.
- Glyphosate and triclopyr have both proven to be effective in killing aspen stems when applied to foliage or cut stumps; however, not enough herbicide is translocated to kill other untreated stems in a clone. Foliar treatments using glyphosate at a rate of 2.4–3.0 kg/ha have provided good to excellent control of aspen.
- When the objective is to manage for conifers, it is important to clearly state acceptable levels for deciduous species (spatial pattern and stems or basal area/ha). Spot treatments around conifers can be effective and may have other ecological benefits, but the objective in retaining deciduous trees should be clearly articulated.
- Depending on conifer species and age, varying densities of aspen within the stand are acceptable and even desirable. With spruce, light levels should be maintained at 40–60% of full sunlight, and with pine, light levels should be > 60%.
- Overtopping trees (~8 m^2 of aspen basal area per ha) will reduce light levels to below 60% of full sunlight.
- During establishment phases, ensuring that there are < 1000 young aspen stems/ha should provide sufficient light levels for conifer height growth as the stand matures, although diameter growth may be affected.
- Treatment will not be effective unless conifers have the ability to respond to release (e.g., spruce with 10 cm leader growth, 60% live crown, and at least three nodes worth of branches).
- Whenever brush control is undertaken, a shift in vegetation patterns can be expected with significantly increased levels of non-target or unaffected species.
- If herbicides are used, untreated patches should be left to maintain some wildlife habitat.

Livestock and wildlife considerations

- Aspen stands can be a good source of secondary forage for livestock.
- Extremely dense stands of aspen are not attractive to livestock. Spacing aspen to 5000 sph at age 5 to accelerate stand development has resulted in a level of cattle utilization that is similar to use under mature aspen.
- In trials in the Peace region, aspen cutblocks seeded with forage could be grazed by livestock for up to five years without substantially harming the aspen regeneration; however, under operational conditions, damage to aspen can be severe.
- In areas of high cattle use, avoid leaving stumps at a height that may damage a cow's udder during brushing treatments. One option is to cut the aspen stem part or all of the way through within 10 cm of the ground and then push the tree over, laying all downed aspen in the same direction to allow for cattle movement.
- Aspen management should emulate natural conditions in terms of the size and age of stands and structural elements within them if wildlife values are to be maintained. Examples include: retaining some large snags and green standing trees, protecting understorey conifers, retaining coarse woody debris, deliberately creating debris piles, and maintaining some understorey vegetation.
- Where cutblock sizes are > 4 ha, biodiversity can be improved by leaving islands of mature trees with a minimum size of 0.2 ha.
- Buffers around wetlands should be maintained to provide nesting habitat and cover.
- Aspen and willow within 30 m of streams or lake shores are critical for beaver.

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ARTICLE RECEIVED: September 9, 2008

ARTICLE ACCEPTED: March 31, 2009

Production of this article was funded, in part, by the British Columbia Ministry of Forests and Range through the Forest Investment Account–Forest Science Program.

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Test Your Knowledge . . .

British Columbia's northeastern forests: Aspen Complex Stand Establishment Decision Aid

How well can you recall some of the main messages in the preceding Extension Note?
Test your knowledge by answering the following questions. Answers are at the bottom of the page.

1. Aspen grows best on:
   - A) dry, rich sites
   - B) moist, well-drained sites
   - C) wet, clay-textured soils

2. When aspen is considered to be a crop species, how much aspen should be left when harvesting a brush-prone, mixedwood stand?
   - A) < 40 mature aspen per hectare
   - B) 30–40% aspen cover
   - C) 10–20 m^2 of aspen basal area
   - D) All of the above

3. Which stand is best suited to conifer management?
   - A) A patchy aspen stand with large canopy gaps and rich, well-drained soils
   - B) A young stand (< 10 years old) with abundant aspen and spruce regeneration
   - C) A 70-year-old aspen stand in which 50% of the area is stocked with 5-m-tall spruce

4. Name two wildlife species that are highly dependent on aspen.

Answers

1. B 2. A 3. C 4. beaver and ruffed grouse