

PART 7:

SHELTERWOOD SILVICULTURE



Forest management on the Avalon Peninsula is geared much more to multiple-use than elsewhere in the Province. There are many traditional, quasi-commercial silvicultural systems suited to plantation forestry within municipal boundaries. This part describes unobtrusive silvicultural systems which can produce a virtually perpetual source of wood while preserving the integrity of the forest landscape. From a purely productive standpoint, the main advantage of shelterwood systems is that they are a good foundation upon which to establish a long-term program to refurbish forests in denuded areas.

SHELTERWOOD SILVICULTURE

In Newfoundland, even-aged, uniformly spaced coniferous monoculture is the only commercial silvicultural system being practised at an operational level. The reason is that closely spaced pure stand of fire-origin spruce is prevalent throughout the boreal biome. The more continental the climate and more benign and predictable the weather, the purer the stands of spruce. The climate of central Newfoundland, for example, is more continental in character than the coastal areas: which is why pure, even-aged fire-origin spruce predominates. In part because summer heat is much more intense in central Newfoundland due to a much higher frequency of thunder storms than elsewhere on the island. In fact, forest fire officers have dubbed central Newfoundland **lightning ally**. In recent decades fire suppression has become so effective that there is a gradual shift away from pure black spruce forest to a mixed forest mosaic with a much higher proportion of balsam fir, tamarack, birch, aspen, and balsam poplar, often with a dense, tall shrub understorey.

Pulp and paper made from black spruce is among the finest in the world. So it is understandable why we lament the shrinking base for fire-origin black spruce. But the other side of the coin is that forest productivity is bound to increase; because, as prized as black spruce is, it is the slowest growing commercial tree species in the world (which is mainly why it is so valuable). The productivity of most other tree species is much higher than black spruce - and a lot less desirable commercially. So it seems that, either by default or design, there will be an increasing dependence on faster-growing black spruce as consequence of it being part of the mixed forest. In the long run, wood processing technology and changes in markets will have changed sufficiently to avail of even the most inferior sort of wood and probably demand a wider range of species.

The case of pure stands of short-lived, unstable balsam fir stands on the Avalon Peninsula may be an aberration in the scheme of long-term ecodynamics. Regardless, of their evolution in landscape ecology, these stands are prone to a much faster rate of change by virtue of the dynamic climate and weather of the Avalon Peninsula.

While our complex forest dynamics are fraught with trials and tribulations for ecosystems managers, they are the kind of positive aspect of forest biodiversity that most European foresters can only dream of. Over centuries Europeans have developed complex sustainable silvicultural systems based on the concepts of shelterwood which in many ways mimics the biodiversity and dynamics of our natural forested landscapes. In fact, some of our own foresters have developed their own shelterwood systems along the trans-Canada highway in the St. George's area in western Newfoundland. For example, they have deliberately increased the proportion birch and aspen in the predominantly spruce-fir forest along the 'tourist corridor'. Much the same approach is encouraged to increase biodiversity and wildlife-friendly forests on the Avalon Peninsula and elsewhere in the province.

The following illustrates natural analogues of shelterwoods with the intention of raising local silvicultural concepts a notch or two by introducing traditional Scottish shelterwood systems that should be considered to ensure that plantations on the barrens get off to a good start and that the main crop tree remains reasonably wind-firm as it matures. Also, as in the example of roadside silviculture in the St. George's area, shelterwoods as a contribution to amenity woodlands, fit nicely into the demands of the multiple-use aspect of community forestry - especially in the heavily populated northeast Avalon.

Definitions of Shelterwood Systems

Clear-cutting: removal of all trees over an extensive area which is followed by natural regeneration or, where necessary, replanting

Selective cutting: The oldest system practiced in Newfoundland mainly by the sawmill industry where only choice trees are removed (also called high-grading).

Pre-commercial thinning: see note on Oceanic System

Even-aged monoculture: The standard practice for spruce plantations. Monocultures actually mimic the vast tracts of naturally-regenerated black spruce and balsam fir forests which are virtually even-aged.

Patch system: Similar to a selection system but involves cutting small groups of trees which gradually develop into a mosaic of age classes.

Coppice: Managed on a short cutting rotation between 5-20 years

Coppice-with-standards: A combination consisting of a coppice understorey and high forest overstorey. Coppice rotation is usually 10-15 years, high forest is of lightly-foliaged forest species and rotations are partial or selective cutting beginning about 60 years to 1-2 centuries and more.

2-storied high forest: Basically two age classes established by under planting old stands.

Shelterwood compartment system: The compartment involves removing commercial-sized trees in two or several irregular stages such that the first cut leaves seed trees, after regeneration is adequate and advanced enough a second cut removes the seed trees. A more gradual version in developing a shelterwood that is practised at Drumlanrig Castle in Scotland, where a canopy is broken up to allow regeneration (or planting) to develop under the canopy. This is continued through removal of more and more trees until the understorey is fully stocked. Of course, it may take many years or just a couple of thinnings – and there are many other ways, such as developing small wedges and/or strips within which the canopy may well develop to one level over time until regeneration is needed again to remove the final crop.

Shelterwood strip or wedge system: Similar to the group system, except that strips or wedges are clear-cut.

Oceanic system: Also called Early Final Selection Systems developed by Maj. General D.G. Moore on his estate in Ireland in the 1960's is designed to overcome wind-throw of even-aged coniferous plantations on exposed sites. It is based on a 30-year rotation where some trees are removed early just as the canopy is closing in (i.e., respacing). It is basically the same principle as **precommercial thinning** of natural stands used in Newfoundland.

Avalon Peninsula system: This proposed new system is recommended only for the first rotation, or earlier phases of reforesting a barren. The basic technique concentrates on planting wind-firm species mixed in with natural regeneration of shrubs and saplings to produce a series of windbreaks, preferably **Coppice-with-standard**, to protect an **Oceanic system** developed in between the strips. On an area basis the ratio of **Oceanic system** to **Coppice-with-standards** on average should be roughly 15:1 depending on exposure.

Natural Shelterwoods



On the cool, moist and fertile slopes along the coastline, birch along with balsam fir is an early colonizer of disturbed sites.



Regions like this, with an insignificant fire-history, are notable for very diverse forest landscape ecology.



Larch fulfills much the same role that birch does and tends to occupy the moist sites following wildfires.



On a slope selectively cut for fir and spruce, birch finds a useful niche in improving nutrients levels by recycling.



A complex mixture of spruce, fir, tamarack, birch and tall shrub is analogous to a traditional cultivated shelterwood.



In a natural shelterwood system, the Newfoundland blue fir is at its showiest.

Early Phase of Natural Shelterwood



Birch shelterwood with no tree-shrub understorey



An older birch shelterwood with tall-shrub understorey and a few spruce seed trees



Birch over-storey on the decline as spruce and fir begin to dominate. This could be developed into a **coppice-with-standards system**.



Shelterwood overstorey of birch, tamarack and pin cherry, with good understorey regeneration of spruce and fir. This can be developed into a combination of **coppice-with-standards and mixed shelterwood compartment systems**



Part of the pine plantation on English Cove Road located near the top of the ridge. serves as a nurse crop for a naturally regenerated balsam fir and white spruce understorey. This fits the definition of **2-storey high forest**. By contrast, outside the plantation there has been little natural regeneration of fir and spruce even before the plantation was established.

Late Phase of Natural Shelterwood



Despite the overwhelming dominance of conifers always a few birch from the shelterwood overstorey remain.



As the coniferous stands begin to collapse en masse, as they usually do, the few remaining birch will thrive.



The canopy of this birch has been rejuvenated by the collapse of the conifers harvested as standing dead-trees. Young birch have begun to recolonise the cleared area.



A wind-thrown mountain paper birch with shallow root-plate reveals a common problem in soils; i.e., a cemented subsurface layer about 15-20 cm deep which is impervious to large tree roots - thus reducing wind-firmness



Wind-firm Yellow birch virtually on the same site as the white birch.



This partially wind-thrown yellow birch is wind-firm because its large roots are drawn as the tree tips, and not broken as in other native birch

Examples of Shelterwood Silviculture



The low lying areas have natural, self-organized shelterwood compartment protecting the field. The slope is poorly regenerated spruce-fir that would benefit by introducing a **2-storey high forest system** with drought tolerant tree species



A **shelterwood** of birch and lesser amounts of white spruce and balsam fir in the context of agroforestry and tree nursery.



A very complex variation of a strip shelterwood system where mature strips are naturally regenerated, uneven-aged, mixed-species stands of birch and spruce between young compartments of planted spruce and birch coppice



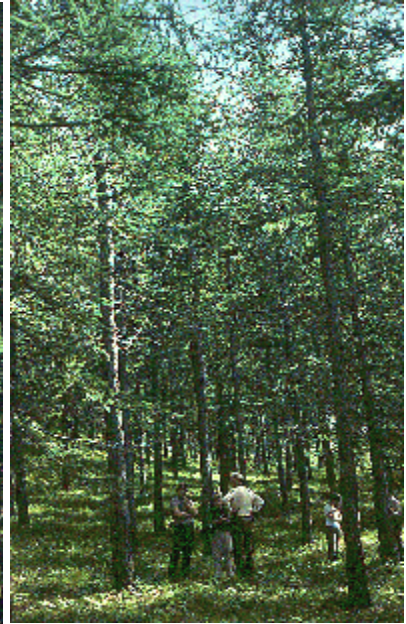
Native birch used as a shelterwood for a Norway spruce plantation on the barrens of Iceland



In addition to birch shelterwood, Alaska lupin (a leguminous plant) is also used by Icelanders to condition and fertilize the soil for tree plantations.



100 year-old Engelmann spruce in east Iceland



37 year-old larch plantation in east Iceland with a growth rate of $7 \text{ m}^3 \text{ Ha}^{-1} \text{ yr}^{-1}$.



The excellent growth of these 11-13 m tall, 15 year-old Japanese larch above Bay Bulls was greatly enhanced by the shelter and nitrogen fixing attributes of alder thickets.



Nitrogen-fixing legumes of alder



Nitrogen-fixing alder thickets and slow growing balsam fir have greatly enhanced the rapid growth of this 7 year-old naturally regenerate Sitka spruce at Trepassey



A pattern of naturally regenerated **Strip shelterwood** of alternating strips of birch and balsam fir, respectively, which developed from soil disturbance by timber extraction vehicles near Hawke's bay



The small tractor and sleigh called a 'donkey' was used to haul out the timber from strip-logging cut by hand in the 1950's in the Hawke's Bay area.



Natural regeneration on this pattern of timber extraction trails for the 'donkey' or timber jack in later years has evolved into alternating strips of birch on the trail and balsam fir between the trails like strips that can be seen in the adjacent aerial photo. The potential silvicultural system is one that is an even-aged **strip shelterwood** of birch coppice and balsam fir 'standards' on a 40 year rotation.



2-storied high forest system, starting off with naturally regenerated alder thickets mixed with spruce-fir which will eventually replace the current high storey of 15 year-old Japanese larch.



2-storey high forest system where the white spruce understorey will eventually replace the mature Japanese larch high storey.



This demonstration 25 year-old aspen **coppice-with-standards system** at Pasadena was ideal for establishing the understorey of exotic conifers.



The ultimate multipurpose, mixed species, uneven-aged **multi-storied high forest system** at Drumlanrig Castle, south Scotland. A better definition for this plantation is **Forest Garden**.

Avalon Peninsula Shelterwood System

The Avalon system is a combination of coppice-with-standards, strip- and mixed- shelterwood, high forest and oceanic system. It is designed primarily as the first step in reclaiming scrub lands, the man-made barrens and also for stabilizing forests. The primary concept is to build in wind-firmness at an early age. The first and only trial of the Avalon system was actually done in the comparatively benign location at Red Cliff, near Grand Falls.

In practice, alder thickets would be used where possible. But in the trial willow coppice was used as the primary shelterwood. The alignment of the strips should be perpendicular to the westerly wind. To improve forest stability in conifers, deep-rooted and valuable timber species such as Yellow birch (plus ash and basswood if it is a community forest) should be planted in strips along windward edges and interspersed



Avalon Peninsula system at about 6 years old. The willow strips are regarded as a temporary windbreak although it could be maintained as coppice if there is a specialty market for it. In about 10 years, the willows will be superseded by the 1st high forest species (Larch) and 15 years later the 2nd high forest storey - a mixture of Norway, white spruce and Scots pine - should have caught up by which time the larch should have reached marketable dimensions. Based on results of plantations on the Avalon, the rotation age for strip or selection cutting of larch should be 30-35 years and the others 40-45 years maximum.



Enriched soils under declining un-coppiced willow is perfect for natural regeneration of white spruce



L-R: shelter strips of willow coppice and a younger 2nd high storey of larch protecting saplings of Norway spruce, white spruce and Scots pine.



Norway spruce between the shelter strips. with 60-100 cm leader growth.

ra
n
d
o
m
ly
w
i
t
h
i
n
t
h
e
c
o
n
i
f
e
r
s

REDCLIFF SHELTERWOOD TRIALS (at 12 Years -Old)



Shelterwood of willow, larch, pine and spruce (background) and an older, conventional monoculture plantation of white spruce(foreground).



Another view of a 15 year-old conventional spruce-pine plantation (left) compared to the shelterwood system of 16 year-old willow osier (centre) and 12 year-old larch and spruce.



15 year-old spruce-pine conventional plantation



15 year-old spruce-pine conventional plantation

Willows are used as the primary shelterwood storey. They can be either harvested on 4-5 year rotation coppice, or, if it has no commercial or residential use, it will be allowed to collapse by which time regeneration of spruce or fir will colonize the willow strips. The willow shelterwood was planted in 1985 and consists of about 50 clones. It survived a wildfire in 1986 which destroyed the conventional spruce plantation established by Abitibi-Price which owns the property and encouraged the establishment of the shelterwood trial.



15 year-old osier (willow coppice) that ideally would have been coppiced at least twice.



15 year-old shelterwood coppice and 12-year-old spruce.



The same spruce as adjacent, but with a mixture of willow clones.



12 year-old Norway spruce being shaded by the willow clones with a broader branching habit.



Willow clones with a compact, narrow branching habit are preferably to restrict shading of spruce/larch.

At 12 years-old the shelterwood has almost reached the second stage in the system; i.e., the larch, and to some extent the spruce, have begun to replace the willows as the dominant shelterwood species.

At this point there is the choice of maintaining willows by coppicing, or the let it die out and be gradually replaced with natural regeneration or planted with more valuable species.



The larch and even the spruce is gradually replacing the willow as the primary shelterwood.



The gap was planted with Austrian and Scots pine which was obviously unsuited to these soils.



12 year-old Japanese or hybrid larch and spruce dominating the windward edge of the stand



Hybrid larch of reasonably good form but with a slight bole-sweep due to occupying the windward edge



Section of the shelterwood of larch, willow, Austrian pine, and white spruce.

Shelterwood Lessons From Urban Forestry

There is an unfortunate dichotomy between plantation forestry and urban forestry. Plantation forestry is usually distinguished as 'commercial' forestry. But the thriving landscaping industry associated with urban forestry is even more so. From a tree-planter's point of view, if a 'commercial' forest plantation fails, foresters can blame it on the environment - and no one gets fired. But if an urban plantation fails, the arborist doesn't eat. So there is a great deal more pressure on the arborist to consistently succeed. That is why the author of this tome is a forester, arborist and pensioner.

Humour aside, successful arboricultural plantings are in environments that are generally far worse than plantation foresters ever encounter. On a typical urban site, the soil has been stripped off, the gaps between building and along streets are wind tunnels. And then there are the vandals, dogs and cats, bikes and skidoos and mean-spirited tree-poachers. So there is a great deal of ingenuity that a good arborist has to possess to surmount innumerable difficulties over and above mere constraints of site conditions. It is not an accident nor entirely the result constant tree-care that the largest and greatest range of tree species is to be found in towns and cities. More importantly, the way that a broad range of trees is blended to create spectacular and effective miniature shelterwoods and high forest served as the basis for designing the proposed Avalon Peninsula silvicultural system.

The two adjacent photos illustrating a very complicated 15 year-old shelterwood created by the author at Pasadena, western Newfoundland is both shelterbelt and arboretum. In it there is at least 70 species and cultivars of trees. It has an appropriate balance of conifers and deciduous species to provide an attractive and effective year-round shelterbelt. The plots were laid out to accommodate a tricky pitch-n-put golf course to sharpen the author's short-iron game in slicing up through the gale-force streamlines above the canopy to the green.





Mr. Hudson, of Black Head, Conception Bay north, planted this Japanese larch 15 years ago to provide shelter for a blueberry farm..



Bowring Park is essentially a microcosm of many styles of shelterwood. It is perfect outdoor laboratory comparing many styles of natural and planted shelterwoods, monospecific plantations and high forest and their sensitivity to wind .



Waterford Hall circa 1910 surrounded mostly by farmland and clumps of naturally regenerated spruce and birch.



The urban forest adjacent to Waterford Hall as it was in the year 2000.



Severe snow drifting is as much a problem for the black spruce spinney as it is for pedestrians.



A small shelterwood consisting of only Larch, Veitch's fir and Bay willow has cured the problem of jets forming under the black spruce spinney and the associated severe snow drifting stunted spruce trees and made pedestrian miserable.

In 1996, Stirling Robertson, the author's son, established a number of shelter plantings for the City of Mount Pearl's *Environmental Forest Project*. The photos on this page illustrate some of Stirling's planting. Stirling's first of many planting projects over a 3-year period was the small-scale shelterwood system for a park in the vicinity of Babb Crescent, Mount Pearl shown in the adjacent photo.



1st growing-season results of mixed species group consisting of birch, laburnum and Norway maple standards, inter-planted with seedlings of Austrian pine, white spruce, larch, and tall flowering shrubs.



Part the same planting in the end of their 5th growing season.



Top right is a stand of naturally regenerated scrub forest of balsam fir, black spruce, tamarack interplanted with exotics; top left is mostly birch, alder and dogberry and a few spruce and balsam fir saplings also interplanted with exotics; front-left is 4 year-old Japanese larch. On the berms (middle-right) and behind that a mixed species group (see below).



Stirling Robertson's planting for a new park at City Hall. An elaborate 3 year-old mixed-species tree/shrub urban planting with a mulch of bark is the foundation for a new park at Mount Pearl's City Hall.

Below is the succession of a naturally regenerated woodland strips along part of the Trans-Canada Trailway on the old railway bed. This section is known as the Arboretum Walk which passes through Mount Pearl and east of the lower Waterford Valley. They demonstrate the kind of shelterwood strips foresters should encourage as the bulwark for reforesting man-made barrens.



This is what most of the vegetation along the trail looked like about 5 years after the railway ceased operation



10-15 years later after railway closure



About 20 years after railway closure



A different section 25 years after railway closure, now called the Arboretum Trail.



Naturally regenerated European elm, European ash, sugar maple, hybrid birch, Norway maple mixed with native white spruce, birch, and pin cherry 25 years after railway closure (this is near the beginning of the Trans-Canada Trailway)



Natural regeneration of native and exotic trees 25 years after railway close (railway bank is on the left side of the river). The photo was taken from Mile 0 of the Trans-Canada Trailway.