Silviculture of Broadleaves

Introduction

This note deals with aspects of growing and managing broadleaved woodland on a commercial basis. It is condensed from *Growing Broadleaves - Silvicultural Guidelines for Ash, Sycamore, Wild Cherry, Beech and Oak in Ireland* by Padraic M. Joyce (published by COFORD) - a comprehensive guide to the characteristics and silviculture of the five broadleaved trees most suited to Irish forestry: ash, sycamore, wild cherry, beech and oak. It covers silvicultural procedures, including tending, which is the reduction in stem numbers before commercial thinning.

Background and objectives

Not having the same degree of apical dominance as conifers, broadleaves tend to produce large and heavy branches rather than stemwood volume, and are more prone to forking of the stem. Silvicultural management aims to curb these tendencies and produce a product for which the timber trade will pay the highest price - straight, branch-free tree boles, with uniform ring widths, and diameters of > 40 cm.

Figure 1: A quality beech stand

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Wide initial spacing or pre-mature thinning will provide increased growing space for the tree crowns but at the expense of stem quality; stem form disimproves, taper increases and live branches persist, giving rise to knotty timber. In contrast, close initial spacing or late intervention improves stem form and taper: branches die earlier, remain small in diameter and are more readily shed when they die. This counters the need for artificial pruning but sacrifices crown size and stem diameter increment. In this context conifers may be planted in mixture with broadleaves to increase competition for light and to encourage greater apical growth.

Strategy

The strategy for growing broadleaves is to:

- keep the stand dense until the branches have died on the lower part of the stem to a height of 6-10 m;
- then select, mark and immediately release the potential final crop trees from competition. This procedure must be repeated at frequent intervals for the final crop trees to develop sufficiently large crowns to promote diameter growth.

Density at stand establishment

Plant at a sufficiently high density to:

- restrict lateral branch (and hence knot) diameter development;
- encourage height rather than lateral growth (see COFORD Connects Silviculture and Forest Management No 5).

Pre-thinning treatment

Keep the stand closely stocked during the pre-thinning stage, to ensure smaller lateral branches and easier shedding - a natural attribute of most broadleaves (except wild cherry). Large lateral branches will not be shed naturally for a considerable time. Where artificial pruning is necessary, it should be carried out before branch size exceeds 3 cm in diameter at the stem, to avoid exposing heartwood (*Growing Broadleaves* contains guidelines on pruning methods).

Tending and the selection of potential final crop trees

When the crop is 5-8 m tall, identify potential final crop trees. Select and remove rough branched, malformed trees (wolves) and the occasional competing dominants. Sub-dominants and suppressed trees should be retained, even if they are badly formed.

Table1: General Silvicultural Principles

Operation	What to do and how to do it	Timeframe
Formative shaping	Conducted in the early years to encourage straight stem development. Forked or otherwise malformed stems are encouraged to revert to a single leader. The shaping operation should be carried out in June-July; confined to dominants and co-dominants; on a quota of 1,000 potential final crop trees/ha (around 3 x 3 m). Hand secateurs sufficient for heights up to 3 m. Long-handled secateurs necessary at greater heights.	Begin when crop is 1-1.5 m tall. Repeat where forking is persistent to provide 6 m straight boles.
Tending	Encourage the development of 1,000 good dominants/ha as potential final crop trees. This is achieved by: • removing coarse branched, forked and deformed stems (wolf trees); • removing competing dominants, while retaining sufficient co-dominants as well as all sub-dominant and suppressed trees to promote natural pruning; • controlling species such as willow and birch and other invasive species competing in the upper canopy. Partition the area into sections by cutting racks (2-3 m wide and at right angles to planting rows) at 40-60 m intervals. Spaces between rows serve as tending paths.	When crop is 5-8 m tall - earlier for light demanders than for shade bearers.
Pruning	Maintain a sufficiently high stocking density up to a top height of 10-15 m (according to species). At this top height, tree boles should be free of live branches up to 6-8 m. If artificial pruning is necessary confine it to the 100–150 final crop trees/ha and carry out at time of their selection. Wild cherry will require pruning. The feasible limit for artificial pruning is 6 m. Above this height the operation becomes too costly.	Natural pruning preferred; otherwise prune before branches exceed 3 cm in diameter.
Under-planting	An understorey assists in natural pruning, controls weed growth, increases stand volume production and gives greater flexibility in management. It is especially used in the silviculture of oak to control the development of epicormic shoots, which reduce timber value. The species most suitable for the purpose are hornbeam and beech. There is little experience of hornbeam in Ireland. Therefore, beech is the preferred species until more information on hornbeam becomes available. Planting beech in mixture with other broad-leaved species at time of establishment is recommended only for shorter rotation (60–80 years) species. Beech is highly aggressive and tends to dominate midway through its rotation, at a time when an understorey is needed for longer rotation species. The preferred procedure is to underplant with beech after the first thinning. Subsequent thinnings should cater for the development of the understorey, as it will require some light to survive.	At establishment or after first thinning.
Control of grey squirrel	Methods of control: • Poison with warfarin - probably the most cost-effective method. Special hoppers are available, allowing access to the bait by grey squirrels only. (Not recommended in areas still containing red squirrels.) • Live trapping employs cage-traps - relatively effective but can prove laborious; periods of pre-baiting and long trapping sessions are often needed. • Shooting, alone or in combination with drey poking. The latter is more effective than straight shooting but both are dubious as measures of damage prevention. Drey poking can only be effectively carried out in late winter and early spring and is unlikely to effect a lasting reduction in numbers. Attempts to prevent damage to trees by killing squirrels in months other than April to July usually not successful.	

Figure 2: Young stand of well-managed oak

Species Characteristics in Plantations

ASH *(See Table 2)*

Growth Performance

Rapid growth in early years; current annual growth peaks around 20 years. Requires heavy thinning throughout its life to attain desired diameter growth; relatively short economic rotation.

Factors affecting growth

Death of opening buds by frost or insect larvae may lead to forking. Damage from hares and rabbits if left unprotected. Deer browse intensively on young plants and may cause heavy bark stripping of pole stage crops up to 20 cm diameter.

SYCAMORE *(See Table 3)*

Growth Performance

Reaches a height of 35 m in stands. Over the first 30 years sycamore shows excellent growth performance on suitable sites. Growth then declines and beyond 50 years of age, falls off considerably.

Table 2: Ash Silvicultural Treatment

Top height (m)	Stocking after treatment (trees/ha)	Comment
0.4-0.9	3,300	Planted at 2.0 x 1.5 m.
0.5-2.0	3,300	Vegetation management
2-3	3,000	Formative shaping – singling of forked leaders.
4-5	3,000	2nd formative shaping (if necessary).
7-8	2,100	Tending – remove 'wolves', deformed and cankered stems, but retain enough trees to encourage natural pruning.
8-10		Select and prune 200 best trees/ha to 3-4 m (if natural pruning not satisfactory); remaining live crown to equal half tree height. Favour naturally occurring compatible species (e.g. cherry, sycamore, beech, oak) to encourage species diversity.
15	490	Select 150 final crop trees/ha; prune to 6 m if necessary; thin to remove competitors.

Table 3: Sycamore Silvicultural Treatment

Top height (m)	Stocking after treatment (trees/ha)	Comment
0.4 - 0.75	4,000	Planted at 2 x 1.25 m. (2 m between rows).
0.5 - 1.0+	4,000	Vegetation management
2 – 3	3,500	Formative shaping - singling of forked leaders.
4 – 5	3,500	2nd formative shaping (if necessary).
7 – 8	2,200	Tending - remove wolves and deformed stems; in sycamore/larch mixtures remove competing larch.
12 – 14	1,000	Heavy crown thinning - option to underplant with beech or hornbeam.
15	650	Select 150 final crop trees; thin to remove competitors. Pruning may be necessary.
17 – 18	400	Thin to remove competitors to final crop stems and to release beech/hornbeam understorey.

Factors affecting growth

Both young and older sycamore are susceptible to competition from grasses which may result in complete failure of plantations. Forking is attributed to flowering of the shoot and not to frost damage. Deer browse intensively on young plants. They may cause bark stripping of pole stage crops. Particularly prone to damage by grey squirrels, often leading to encirclement and death of the upper crown.

WILD CHERRY *(See Table 4)*

Growth Performance

Grows very rapidly in youth and develops large crowns but needs careful thinning in middle age; shows good apical dominance but a poor ability for natural pruning. When planted on suitable sites it can attain 80 cm height increment in its second growing season. Annual height growth culminates between 7 and 15 years and slows appreciably between 30 and 40 years. From then on its capacity to respond to increased growing space is markedly reduced. (Because of its rapid growth and relatively short life span (70 - 80 years) it can be regarded as an ideal tree for mixtures in small woodlands, especially along the margins, where it will produce quality timber on relatively short rotations).

Factors affecting growth

Wild cherry does not grow well on exposed sites. It is vulnerable to attack by mice during the first years following planting, with damage most severe in dense grass swards. Vegetation control offers effective means of mice control as well as helping growth. Not susceptible to damage by grey squirrel but is vulnerable to fraying and browsing by deer.

Susceptible to: cherry blackfly (*Myzus cerasi*), bacterial canker (*Pseudomonas syringae*) which may kill the tree, and heart-rot, caused by both honey fungus (*Armillaria mellea*) and Fomes (*Heterobasidion annosum).*

Table 4: Wild Cherry Silvicultural Treatment

Top height (m)	Stocking after treatment (trees/ha)	Comment
0.5-1.2	2,000-4,000	Planted at 2.25 x 2 m to 2 x 1.25 m depending on size & quality.
	2,000-4,000	Vegetation management - spot application of glyphosate or treatment of 1 m strip; may also reduce frost damage.
1.5-3.0		Formative shaping - singling of forked leaders on best trees (200/ha).
ca. 5-20		Green prune between June and August when sap is flowing. Prune when branch diameter is less than 3 cm (to prevent exposure of heartwood) and to a minimum height of 6 m in several lifts. Only 80-130 final crop trees/ha to be pruned to 6 m.
6-8		Tending - remove all trees competing with 200 potential final crop trees/ha (about 7 m apart)

Table 5: Beech Silvicultural Treatment

Top height (m)	Stocking after treatment (trees/ha)	Comment
0.2 - 1.0	6,600	Planted at 2.0 x 0.75 m (2 m between rows).
0.2 - 2.0	6,600	Vegetation management, until no threat from competing vegetation.
2 - 3	6,000	Formative shaping - singling of forked leaders.
4 - 5	5,500	2nd formative shaping (if necessary).
5 - 8	2,500 - 3,000	Tending - remove wolves to encourage development of 1,000 potential crop trees/ha – allow light into stand.
10 - 11	1,900 - 2,100	Second tending - if stem form poor, or crown differentiation absent.

BEECH *(See Table 5)*

Growth Performance

Shows typical growth pattern of a climax species - height growth begins relatively slowly but continues more steadily and for longer than pioneers. Prone to coarse growth and forking with a medium ability for natural pruning. Young trees show better stem form when developing under the light shade of mature trees and may grow up perfectly straight. Branches are shed more freely if the trees are in dense stands. Beech is often outgrown by other species in the early decades but during the second half of the rotation the roles are reversed. It responds much better to crown thinning at an advanced age, and is regarded as the most flexible tree species of our forests. Beech has an economic rotation of 100-120 years.

Factors affecting growth

Under favourable growth conditions beech is windfirm, but may be damaged by summer gales or destabilised on waterlogged soils. Where occurrence of late frost is frequent, such as hollows or flat terrain, young beech should be raised only under the shelter of old stands or introduced nurse trees. Without shelter beech afforestation can lead to total failure on such sites.

Favoured by grey squirrel which may attack from the thicket stage up to 60 years of age by gnawing the bark from the stem. Browsing, fraying and bark stripping by deer can lead to serious damage where deer populations are high.

OAK *(See Table 6)*

Growth Performance

Medium natural pruning tendency. Prone to development of epicormic branches. The wood is susceptible to shake. Oaks show a rapid height growth in the early years. However, cumulative height growth is impressive only on the very best sites. Estimated economic rotations are 130 years for pedunculate and 160 years for sessile oak.

Factors affecting growth

Free of pests and diseases in Ireland, apart from oak mildew and some grey squirrel damage. Domestic livestock, rabbits, hares and deer must be excluded from newly established plantations. Two fungi that attack oak are of significance: *Polyporus sulphureus*, which causes brown cubical rot and *Stereum gausapatum*, which causes pipe rot. These enter the tree through branch stubs in which heartwood has developed. To avoid infection side branches should not be allowed to develop heartwood. This is best achieved by ensuring that branch diameter is kept small (<3 cm) by close spacing. The alternative is early and continued high pruning.

Table 6: Oak Silvicultural Treatment

Top height (m)	Stocking after treatment (trees/ha)	Comment
0.2 - 1.0	6,600	Planted at 2.0 x 0.75 m (2 m between rows).
0.2 - 2.0	6,600	Vegetation management
2 - 3	6,000	Formative shaping - singling of forked leaders.
4 - 5	5,000	2nd formative shaping (if necessary).
6 - 7	3,600	Tending - remove wolves, crooked and badly formed stems. In oak/conifer mixtures remove dominating European larch or Scots pine. Do limited pruning if natural pruning inadequate.
10 - 11	1,900 - 2,100	2nd tending (if necessary - for poor stem form or absence of crown differentiation) - in oak/conifer mixtures remove conifers.
13 - 15	1,000 - 1,300	Select about 100 final crop trees/ha. After crown thinning, underplant with beech or hornbeam.