



» Silvicultural Guidelines for the Tending and Thinning of Broadleaves

Recommendations for the tending and thinning of:

Ash, Sycamore, Alder, Norway Maple, Oak (pure),
Oak with conifer nurse, Beech (pure) and
Beech with conifer nurse

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Contents

Introduction	01	Thinning	14
Tending	02	What is thinning?	14
What is tending?	02	Why thin?	14
Why tend?	03	When to thin?	14
When to tend?	03	How to thin	14
Selecting Potential Crop Trees (PCTs)	04	1st Thinning recommendations	15
Criteria for selection	04	Ash / Sycamore / Norway Maple / Alder	15
Disease free	04	Pure Oak	16
Good stem form	04	Oak / Conifer Mixture	17
Good vigour	04	Pure Beech	18
Distribution	04	Beech / Conifer Mixture	19
Marking trees	05	Health and Safety	20
Why mark trees?	05	Tending and Thinning	20
The procedure for marking (i.e. 2-stick method)	05	High Pruning	20
High pruning	06	Thinning Control Plots	21
Why prune?	06	What are Thinning Control Plots?	21
How to prune	06	Why are they needed?	21
Pruning steps	06	How to establish Thinning Control Plots	21
Pruning equipment	07	Felling licences	23
Tending recommendations	08	Requirements	23
Ash / Sycamore / Norway Maple / Alder	08	Procedure for application	23
- (initial stocking = 2,500 stems/ha)	08	Record keeping	23
- (initial stocking = 3,300 stems/ha)	09	Appendices	24
Pure Oak	10	Appendix I – How to measure tree height	25
Oak / Conifer Mixture	10	Appendix II – Illustrations of the 2-stick method of marking trees	27
Pure Beech	11	Appendix III – Summary Table	30
Beech / Conifer Mixture	11		
Notes on ash	12		
Selection of hurley butts	12		
Notes on alder	13		
Notes on conifer nurses	13		

Introduction

Currently around 30% of the annual afforestation area in Ireland is broadleaves. However, this has not always been the case. The advent of attractive grants and premium payments for establishing broadleaves in the early 1990s led to a significant increase in broadleaf planting during the last 15 years (Figure 1), the majority of which was established on farmers' land.

Figure 2 illustrates the plantation age profile of the main broadleaf species used in forestry. Whilst the majority of the oak and beech forests are 50+ years old, the other broadleaf species of ash, sycamore, alder and birch have a much younger age profile. Early management priorities of these grant-aided broadleaf plantations had been on establishment, weed control, and formative shaping. Some of the earliest of these plantings are now at the stage where tending and thinning interventions are required to maintain the quality and productivity of the crop.

Tending and thinning operations provide growing space for the remainder of the crop and may also reduce disease incidence within the plantation. Tending and thinning operations are essential investments for the future of the crop. Due to the higher variability of both stem growth and quality of broadleaves, their management must be treated differently to that of conifers, with an emphasis on favouring high quality, vigorous stems. This publication provides guidelines for the tending and thinning of ash, alder, sycamore, Norway maple, oak and beech. Some silvicultural procedures to follow during these operations are also provided.

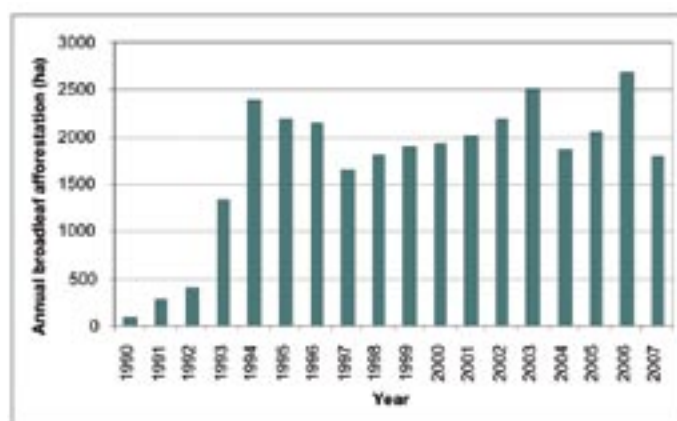


Figure 1. Annual broadleaf afforestation, 1990-2007 inclusive (Forest Service statistics, 2008)

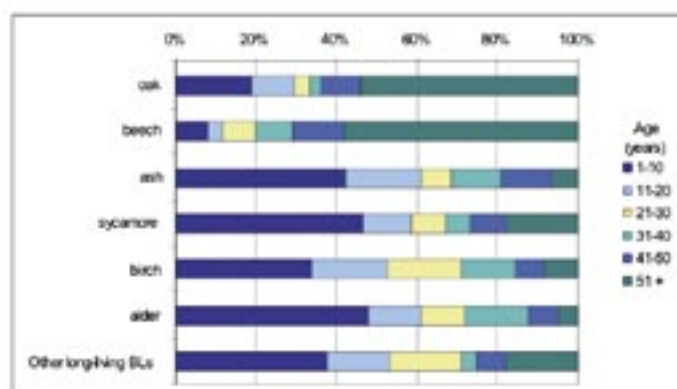


Figure 2. Age structure of the broadleaf forest estate (National Forest Inventory 2007)

Tending

What is tending?

The tending operation readies the plantation for future management operations by removing a number of less-favoured trees.

It involves:

- » the identification and marking of trees with superior form and vigour from which the final crop will later be chosen (PCTs – Potential Crop Trees);
- » the removal of competing conifer nurses;
- » the removal of competitors to the PCTs;
- » the removal of diseased trees;
- » the removal of overly-large, malformed trees (wolves); and
- » the creation of access routes (racks) within plantation blocks for future operations.



Figure 3. Ash plantation before (top) and after (bottom) tending. Note the increased amount of light after tending due to the reduction in canopy cover.

Why tend?

Tending can potentially improve the health of a plantation. It facilitates future management operations by providing access with the provision of racks and concentrating management on those trees that will benefit from it the most. Diameter growth of selected stems will increase due to reduced competition (see Table 1 below).

Table 1. Teagasc research findings from 2m x 1.5m ash tending trial, Co. Kilkenny, tended 10 years after planting (8m top height).

	Untended	Tended	Heavy tended
Diameter at 1.3m height* 5 years after tending (cm)	11.1	11.6	12.2
Volume of 1m length log (m ³)	0.0097	0.0106	0.0117
Percentage increased volume per 1m log due to tending	-	9%	21%

* Diameter at Breast Height (DBH)

When to tend?

Tending is carried out at different times depending on the species concerned and the growth rate. It is normally carried out when the average height of broadleaves reaches approximately 8m.

Table 2. Minimum height to carry out tending operation

	Ash / Sycamore / Norway Maple / Alder	Pure oak	Oak mixture	Pure beech	Beech mixture
Height (m)	8	8 - 10*	8 - 10	7 - 8*	7 - 8

* Select 600 PCTs and high prune as required

**When tending and thinning wear appropriate personal protection equipment.
Observe proper Health and Safety guidelines when using a power saw. Never work on your own.**

Selecting Potential Crop Trees (PCTs)

Criteria for selection

The careful selection of Potential Crop Trees (PCT) is highly recommended for all future management. Future thinning operations will release the PCTs from competition with the result that they maintain their growth rates, increase their diameter and reduce the time until final harvest. The number of PCTs selected is greater than the number of final crop trees required at final harvest so that:

1. there remains a choice of trees to select from;
2. high quality later thinnings can be harvested;
3. there is reduced risk of unforeseen circumstances affecting a chosen final crop tree (e.g. disease, stem breakage).

There are four main criteria used in selecting Potential Crop Trees:

- » Disease free
- » Good stem form
- » Good vigour
- » Distribution

Disease free

Diseased stems should not be selected as PCTs and should be removed during tending or thinning operations with due regard to site conditions.

Good stem form

Potential Crop Trees are **the best trees selected from what is available**. Potential Crop Trees must have relatively good stem form. The aim is to select stems that have 6m of straight defect-free log. However, in the vast majority of cases this is not achievable. Therefore, if 6m is not achievable, then 5m of straight, defect-free log should be aimed for, then 4m, etc. The log length should have no forks and no branches with a diameter larger than half the stem diameter at the point of branching. The length of log needn't necessarily begin at the base of the tree but can start part way up the stem if, for example, there is a defect at the base of the stem.



Figure 4. Canker on ash

Good vigour

The growth rate of the tree is also important. A tree that has very good stem form but has slow growth will take longer to reach the size required at final harvest. If it is subject to strong competition before thinning it may also never react to being released from competition.

Distribution

It is normal to find that the quality of the trees within a plantation varies, dependent on whereabouts within the plantation is being considered. However, the number of Potential Crop Trees should not all be concentrated in the "good quality" areas of the plantation. Instead the distribution of PCTs should be the same throughout the plantation but their relative quality may differ. For example, the "good quality" area of the plantation may have PCTs with 5m log length whilst the "poorer quality" area may have PCTs with 4m log length.

Whilst the ideal scenario is to have the Potential Crop Trees equally spaced throughout the plantation, this never happens. It should be remembered that PCTs are just that; **Potential** Crop Trees. For most of the species discussed here, approximately 100 final crop trees are required at the end of the rotation. The final crop trees will be selected from the PCTs during later thinning operations. Therefore the majority of the PCTs will be removed during subsequent thinning operations and provide high quality thinnings and enhanced income.

Marking trees

Why mark trees?

Marking the PCTs concentrates the mind on why tending and thinning is being carried out. Permanently marking the PCTs also saves time during later operations because the trees to be favoured are easily identifiable and do not require selecting again. Marking the PCTs also identifies them as trees to take particular care of during management operations, thereby reducing accidental damage from felling, extraction etc. An additional benefit of permanently marking the PCTs is so that future management can continue to favour them.

Marking trees to be removed (competitors, diseased and wolves) ensures that the trees intended to be removed are actually removed.

The procedure for marking (i.e. 2-stick method)

When selecting PCTs, it is very important to view the tree from 2 sides at right-angles from each other. Stem defects can often be missed if the tree is only viewed from one direction.

The diagrams in Appendix II illustrate the 2-stick method for marking PCTs of different crops. This procedure is a useful technique with which to begin the marking process until you have got your eye in. After a short time marking trees using this method,

you will be able to do it without using the two sticks and just walk down the rows marking the trees as you go. It is worthwhile occasionally checking the number of PCTs that you have marked by subsequently placing the two sticks as below and counting the number of PCTs marked between them.

PCTs should be marked with a ring of paint so that it is visible from all directions. In addition a line of paint should be applied vertically on one side of the stem, extending from ground-level to 30 – 40 cm height. This additional mark will enable the identification of any PCTs mistakenly removed during tending or thinning operations. Specialist permanent tree-marking paint is available in a variety of colours but white household undercoat paints with a titanium base are equally as suitable.

Trees to be removed can either be marked on three sides with paint spots of a different colour than that used for the PCTs, or by slashing the bark (blazing) using an axe, a billhook or a scribe. It should be noted that if blazing is to be used to mark thinnings that the thinning operation should be carried out within a few weeks as the blaze becomes less visible with time.

When PCTs are being selected for a 1st thinning operation they should be selected from those already marked prior to tending being carried out. The number of PCTs required at 1st thinning is less than that required at tending. Any PCT selected at tending that is no longer required as a PCT at 1st thinning should be marked using a different colour paint over the existing paint.



Figure 5. Tree marking paint (left) and a scribe (right)

High pruning

Why prune?

- » To improve tree stem quality
- » To reduce “knotty core” width
- » To remove forks and disproportionate large branches
- » To produce clean knot-free timber up to at least 6 metres

How to prune

When removing branches it is most important to identify two key features on the tree stem:

1. The Branch Collar - usually a swelling around the base of the branch where it joins the main stem
2. The Branch Bark Ridge (BBR) - identified as a raised ridge of rougher bark that develops in the branch crotch and runs downward at an angle to the main stem.

These are part of the tree’s defence mechanism. It is important to avoid injury or damage that can lead to disease. Avoid “flush cuts” that remove the branch collar. Also avoid leaving “stubs”.

Flush cuts and stubs prolong the healing process and can increase the likelihood of disease incidence and wood discolouration. Pruning tools should always be kept clean and sharp to ensure a good clean smooth cut. Never allow branches to grow greater than 5 cm in basal diameter. A large branch generally has a basal diameter at least half the size of the main stem.

Pruning steps

There are three steps in standard large branch pruning:

1. The first step is to make a deep cut underneath the branch at about 30 cm up the branch
2. The second step is to move up the branch and make a second cut completely through the branch from above. This prevents snapping and tearing of the stem when the branch falls.
3. The third step is the final pruning cut which should be at a slight angle away from the main stem just outside the collar and the BBR (see Figure 6). Care should be taken to ensure that the bark does not tear when the remainder of the branch comes away from the main stem.

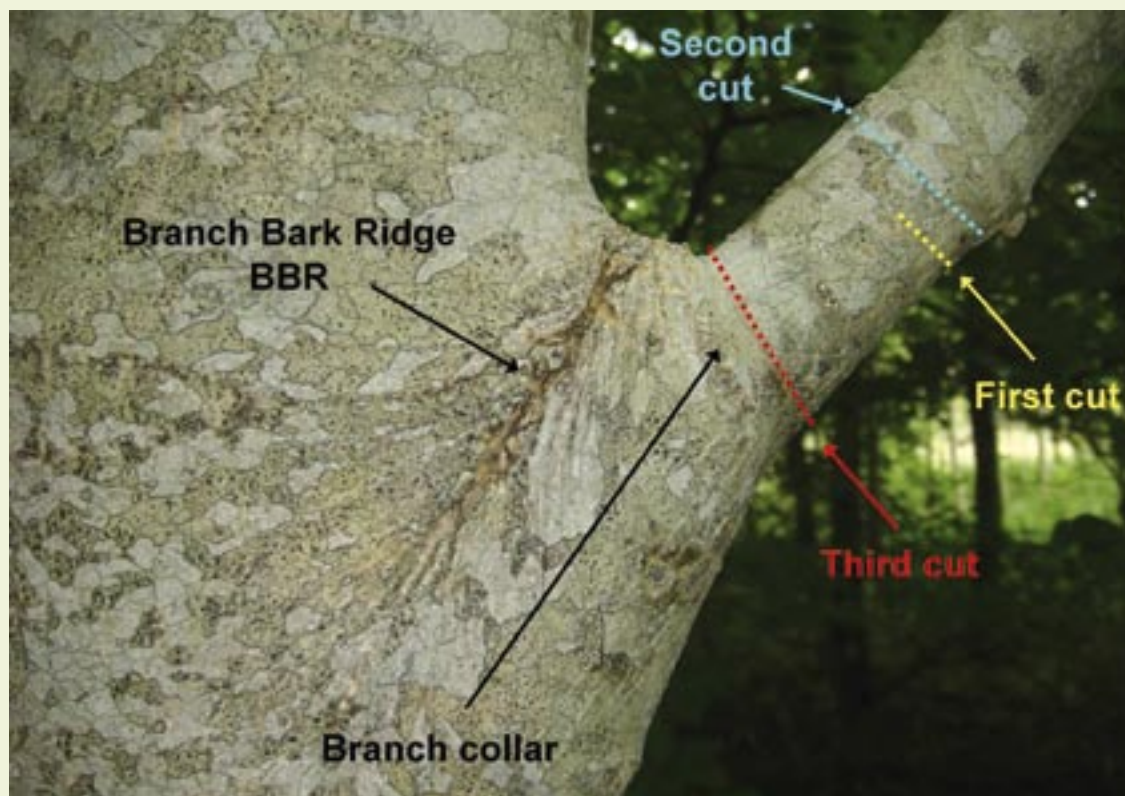


Figure 6. The 3-cut method of pruning a large branch



Figure 7. Secateurs, loppers and pruning saw (left) and telescopic pruning saw (right)

Pruning equipment

Equipment such as secateurs, loppers and handsaws can be used to prune branches up to approximately 3m. There is a wide range of telescopic pruning equipment available for pruning stems up to 6 metres such as special hand-saws with curved blades, small power saws and loppers.

It is important to ensure that all pruning equipment is sharp and properly adjusted to give a clean cut. To minimise risk of disease infection when carrying out pruning operations, it is essential that all pruning

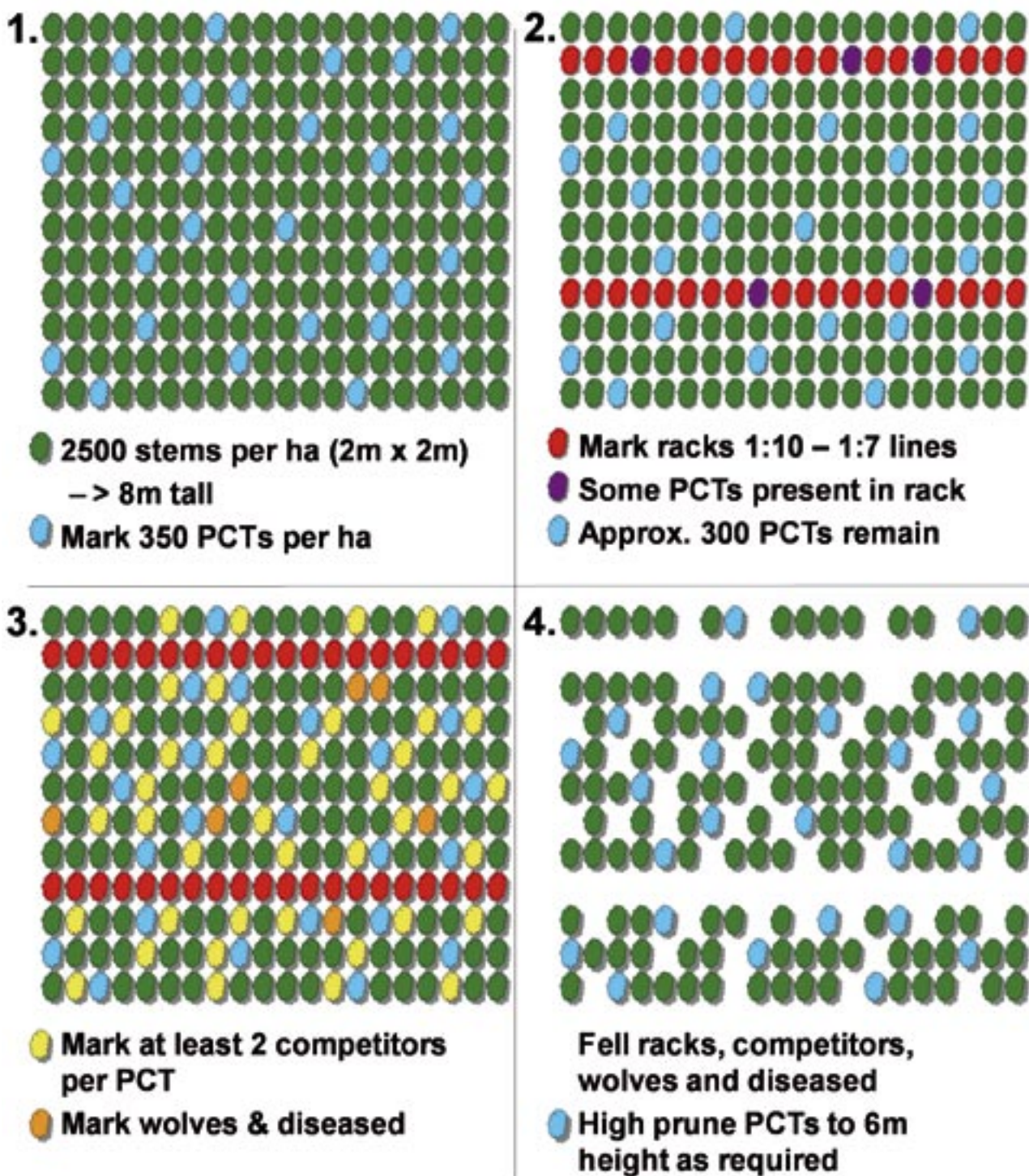
equipment is frequently disinfected with a 70% alcohol solution or by using household anti-bacterial cleaner. When cleaning pruning equipment, ensure that the blades are free from debris and dirt so that the disinfectant can reach all of the cutting surfaces. It is important to wipe off excess disinfectant from the surfaces to prevent damaging the trees. A longer soaking in disinfectant may be required for pruning equipment that no longer has smooth cutting surfaces. The older the equipment is, the more likely that the surfaces have become pitted and can harbour disease-causing microbes that can be unaffected by quick sterilization. This is especially true of canker-causing organisms.

Tending Recommendations

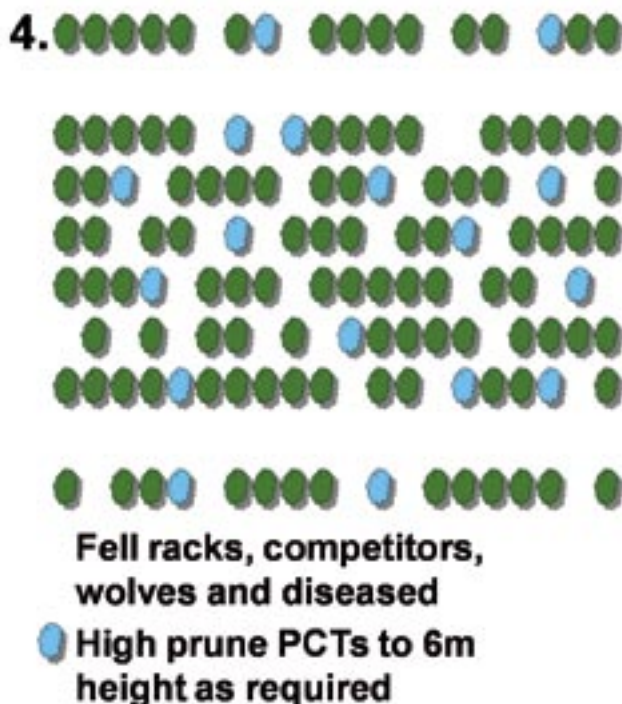
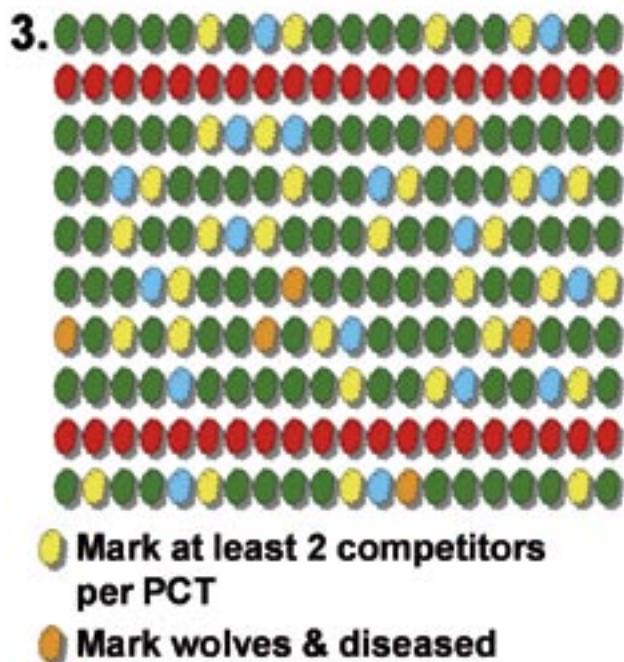
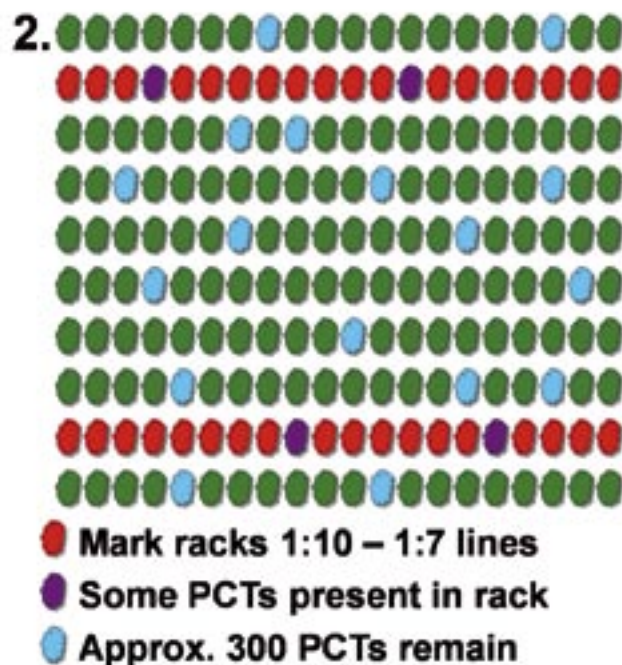
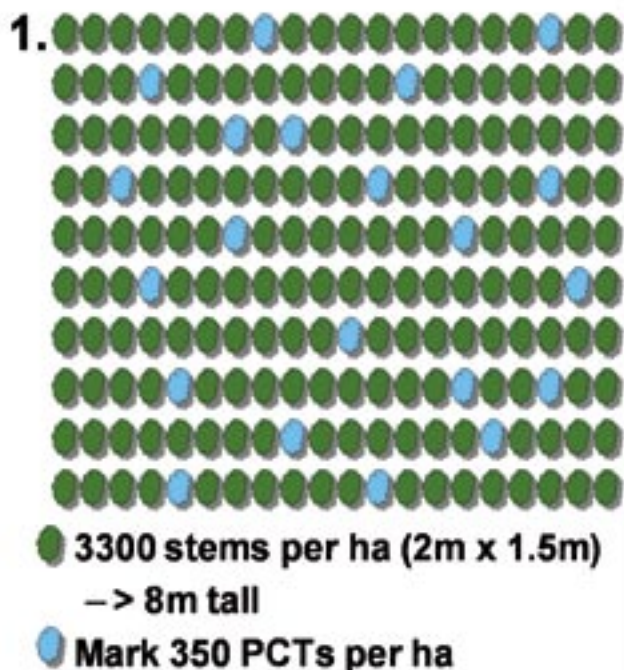
There are different tending recommendations for the different species, initial stocking and for broadleaf/conifer mixtures. The recommendations are illustrated below. Thinning control plots should be established after the trees have been marked and prior to felling. See the section regarding thinning control plots (page 21).

Ash / Sycamore / Norway Maple / Alder Tending Recommendations

(initial stocking = 2,500 stems /ha)



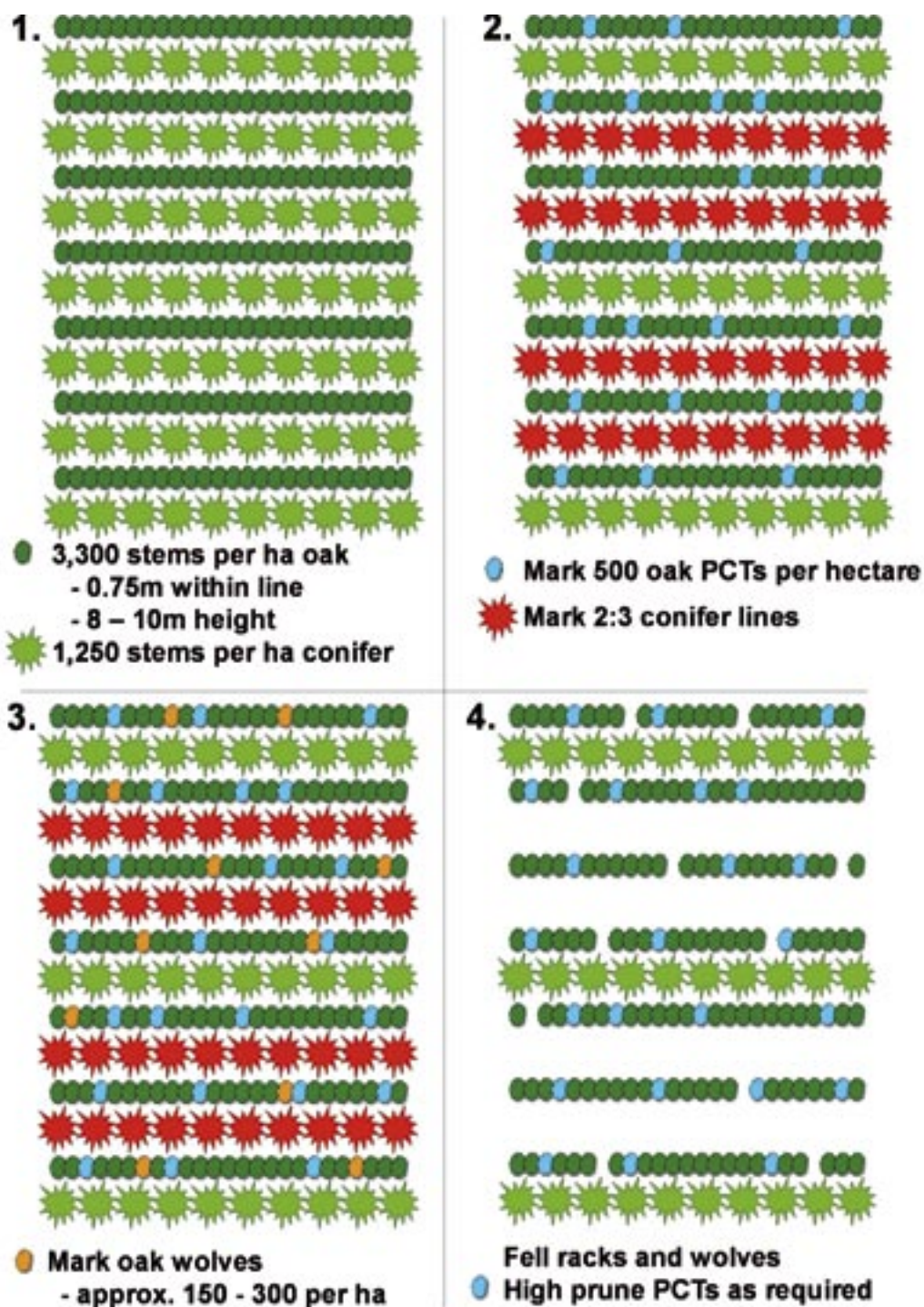
Ash / Sycamore / Norway Maple / Alder Tending Recommendations (initial stocking = 3,300 stems /ha)



Pure Oak Tending Recommendations

No tending is necessary in pure oak plantations irrespective of initial stocking density. However, it is beneficial to identify and mark approximately 600 PCTs per hectare and high prune them as required to increase future quality log length.

Oak / Conifer Mixture Tending Recommendations

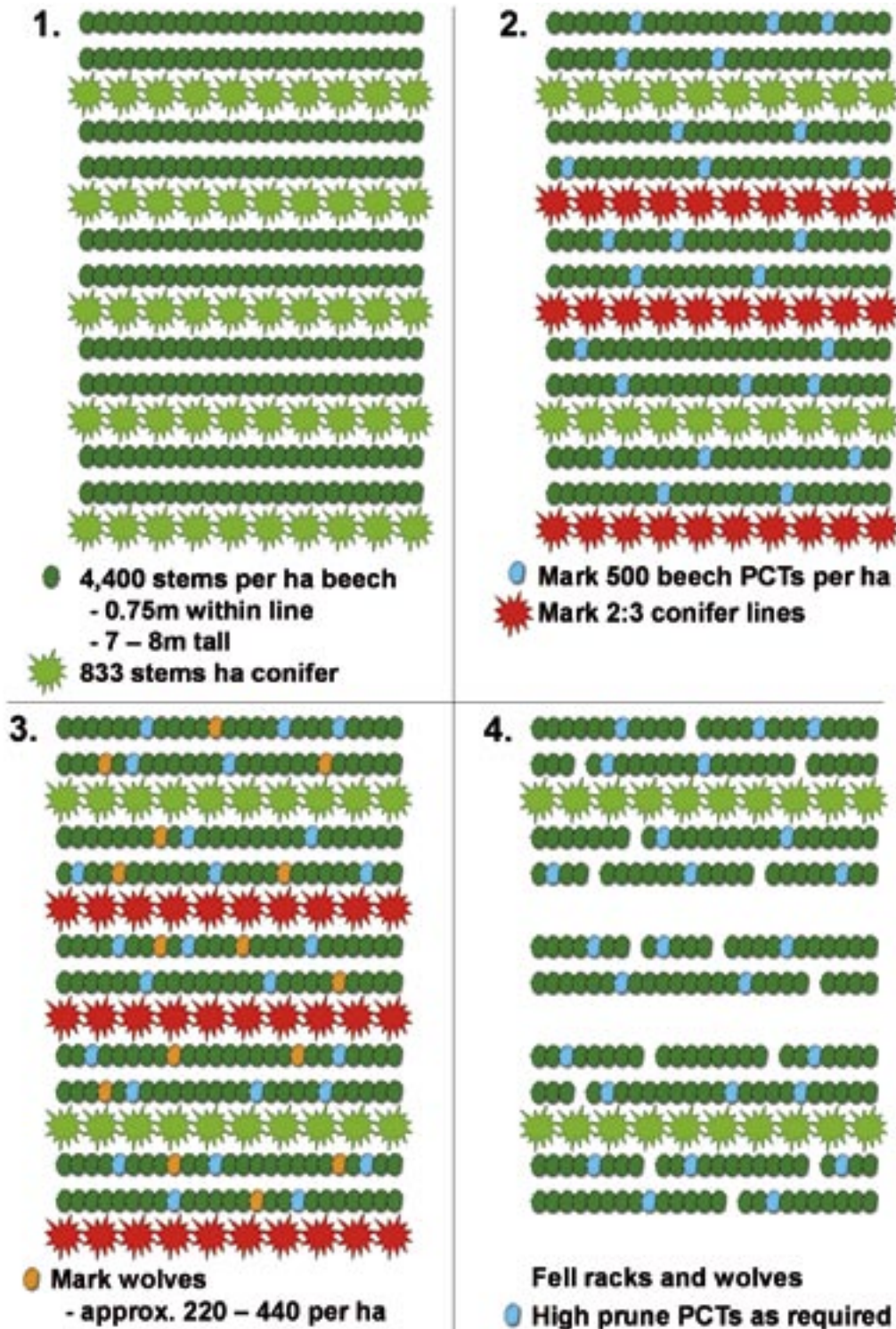


In addition to the above, if any of the conifer nurses are competing with the oak they should also be removed during the tending operation.

Pure Beech Tending Recommendations

No tending is necessary in pure beech plantations irrespective of initial stocking density. However, it is beneficial to identify and mark approximately 600 PCTs per hectare and high prune them as required to increase future quality log length.

Beech / Conifer Mixture Tending Recommendations



In addition to the above, if any of the conifer nurses are competing with the beech they should also be removed during the tending operation.

Notes on ash

Whilst the focus of management in ash plantations should be on the provision of future sawlog, hurley butts can also be selected and released from competition during a tending operation. They should not constitute part of the selected 350 PCTs. Occasionally a hurley butt stem and a PCT may be strongly competing with each other. If no other stem can be selected as a PCT then the hurley butt should be removed to release the PCT from competition. However, if another nearby stem meets the criteria of a PCT, this can be selected as a PCT and the original one removed, releasing the hurley butt from competition.

Selection of hurley butts

A hurley butt must have good root buttressing, ensuring that the grain of the wood will follow the curve of the bas and maintain its strength. The first 1.3m of stem must also be straight and defect free. Stems matching these criteria and 30cm diameter at 1.3m height are suitable for hurley production, although smaller diameter butts are sometimes accepted. When tending operations are carried out in ash, it is possible to select stems with the required stem form that will have potential for producing a hurley butt in the future once the diameter has grown to sufficient size. These selected stems should be released from competition to ensure their continued rapid growth.



Figure 8. Felled hurley butts and the final product



Figure 9. A well-managed, high quality ash stand

Notes on alder

The number of PCTs included in the recommendations above for alder are the absolute minimum required. Ideally more PCTs should be selected. This is because alder tends to have a relatively small crown and is shorter-lived than other broadleaf species. Therefore there can be more stems per hectare at final harvest than the other species. The more PCTs that can be selected during the tending phase in alder the greater the choice there will be for crop trees later in the rotation.

Notes on conifer nurses

Conifer nurse species such as Scot's pine and European larch are often used in the establishment of oak and beech. Their main function is to provide shelter and improve the growth and quality of the broadleaf crop species. The management of the plantation should always favour the broadleaf species and the nurse species should never be allowed to hinder its growth.

When the nurse species begins to suppress the broadleaf crop, the nurse must be removed to allow the broadleaf species to continue its growth. This may require the removal of complete lines of the nurse species or only the removal of individual stems.

Thinning

What is thinning?

Thinning is the removal of a number of trees from a plantation to reduce competition and provide increased room into which the remaining trees can extend their canopies and grow faster.

Why thin?

Thinning occurs naturally in all broadleaf woodlands but in a haphazard fashion. By carrying out thinning operations, the best quality trees can be selected and favoured. Thinning increases the amount of light and space available to the remaining trees. It will increase the stem volume of these favoured trees over time, reduce the time to final felling, and may provide an interim income.

When to thin?

Thinning should be carried out when canopy competition occurs between trees. This can begin at different times depending on species, initial stocking, and growth rates.

How to thin

Tending and thinning in broadleaves are often carried out with a chainsaw, rather than a harvesting machine, thereby lessening possible damage to the remaining crop during the felling process. Racks are often established in the tending operation to provide suitable access routes to enable extraction of later thinnings by forwarder if required. Extraction by quad bike with a skidder or trailer is possible in small areas during early thinnings.



Figure 10. Extraction of broadleaf thinnings by a forwarder

Table 3. Minimum height to carry out 1st thinning operation

	Ash / Sycamore / Norway Maple / Alder	Oak	Oak mixture	Beech	Beech mixture
Height (m)	12 – 15	10 – 12	10 – 12	12 – 15	12 – 15



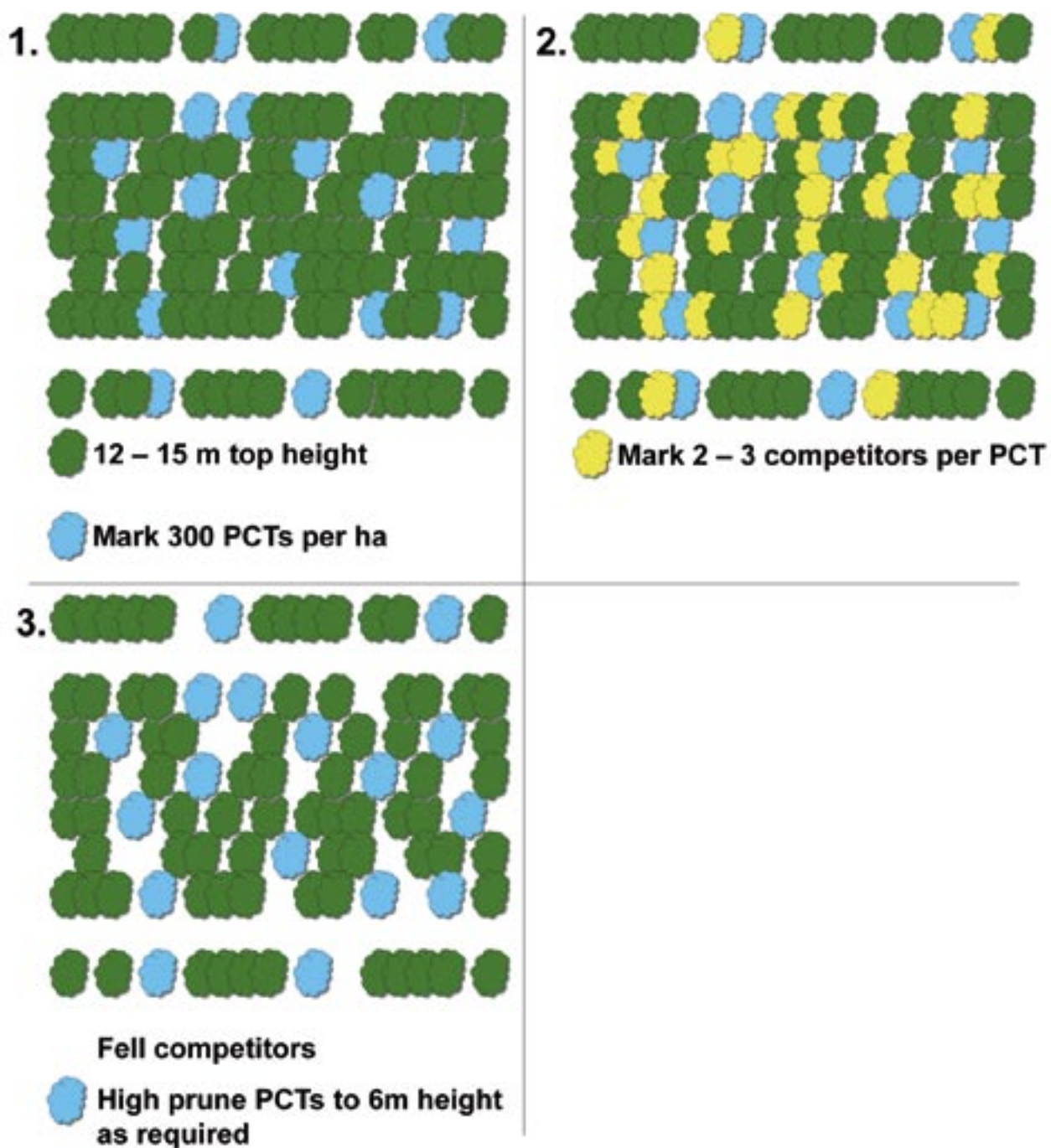
Figure 11. Extraction of broadleaf thinnings by quad using a skidder (left) or a trailer (right)

1st Thinning Recommendations

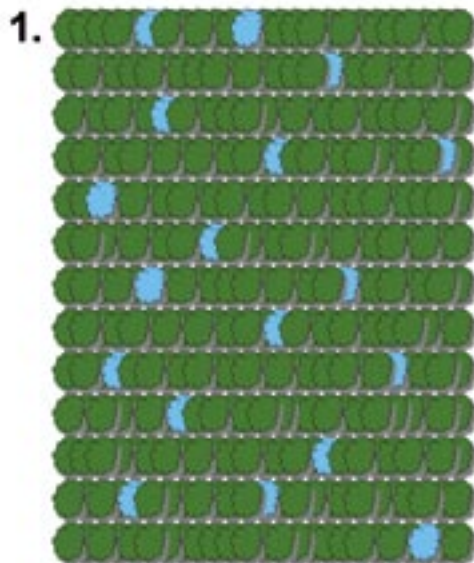
There are different thinning recommendations for the different species, initial stocking and for broadleaf/conifer mixtures. The recommendations are illustrated below. Thinning control plots should be established after the trees have been marked and prior to felling. See the section regarding thinning control plots (page 21).

Ash / Sycamore / Norway Maple / Alder 1st Thinning Recommendations

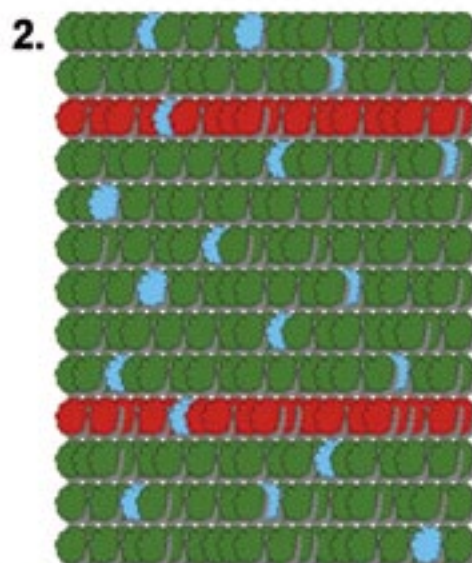
The following recommendation for 1st thinning of ash, sycamore, Norway maple and alder can be applied to plantations with initial stocking of 2,500 and 3,300 stems /ha.



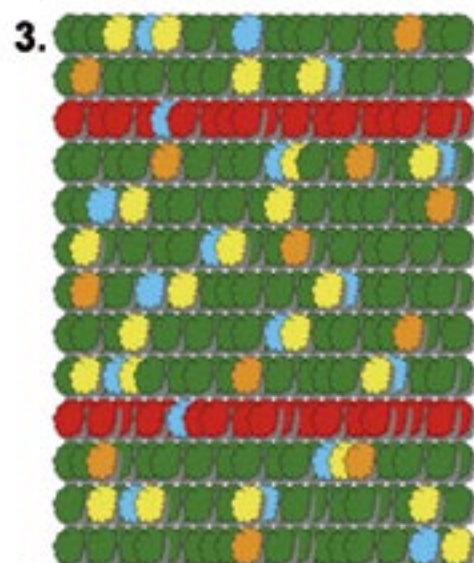
Pure Oak 1st Thinning Recommendations



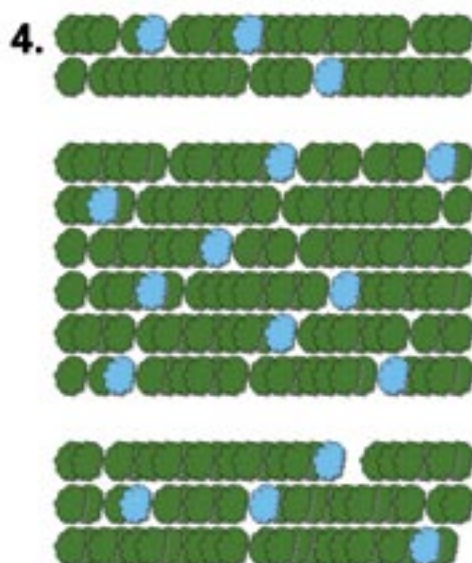
- 6,600 stems per ha
 - 2m x 0.75m
 - 10 – 12m tall
- Mark 400 PCTs per ha



- Mark racks 1:7 – 1:10 lines

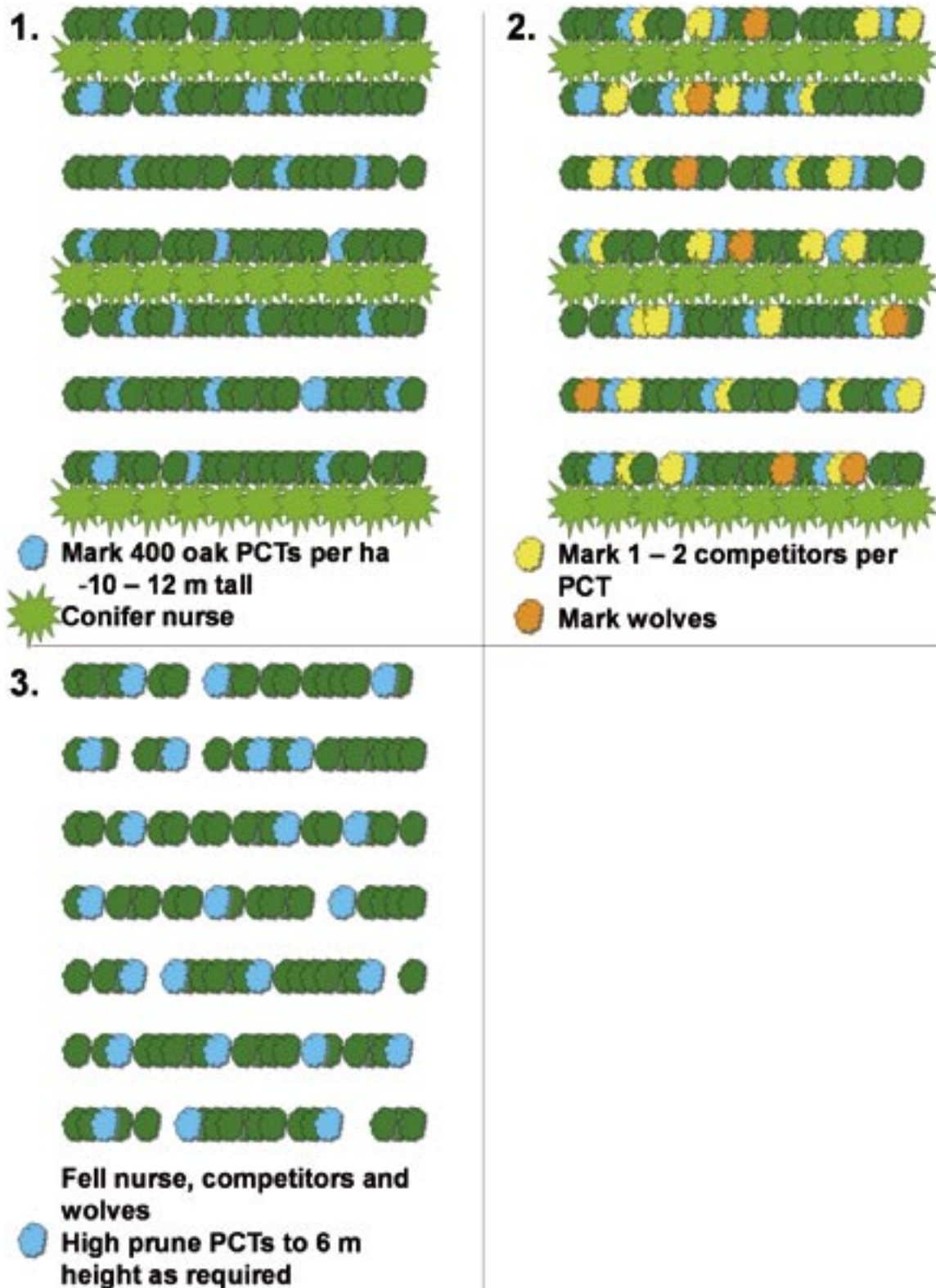


- Mark 1 – 2 competitors per PCT
- Mark wolves

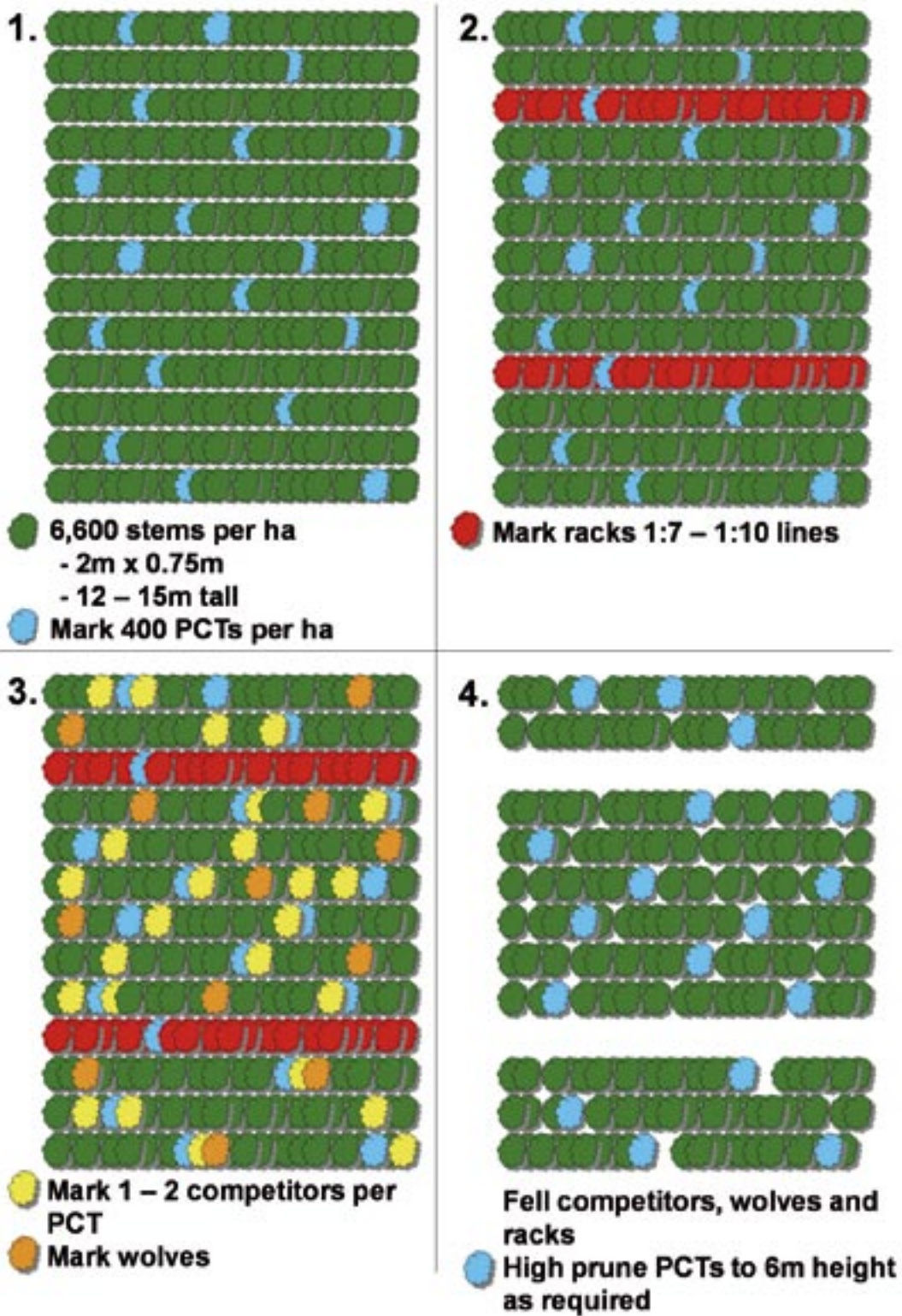


- Fell racks, competitors and wolves
- High prune PCTs to 6m height as required

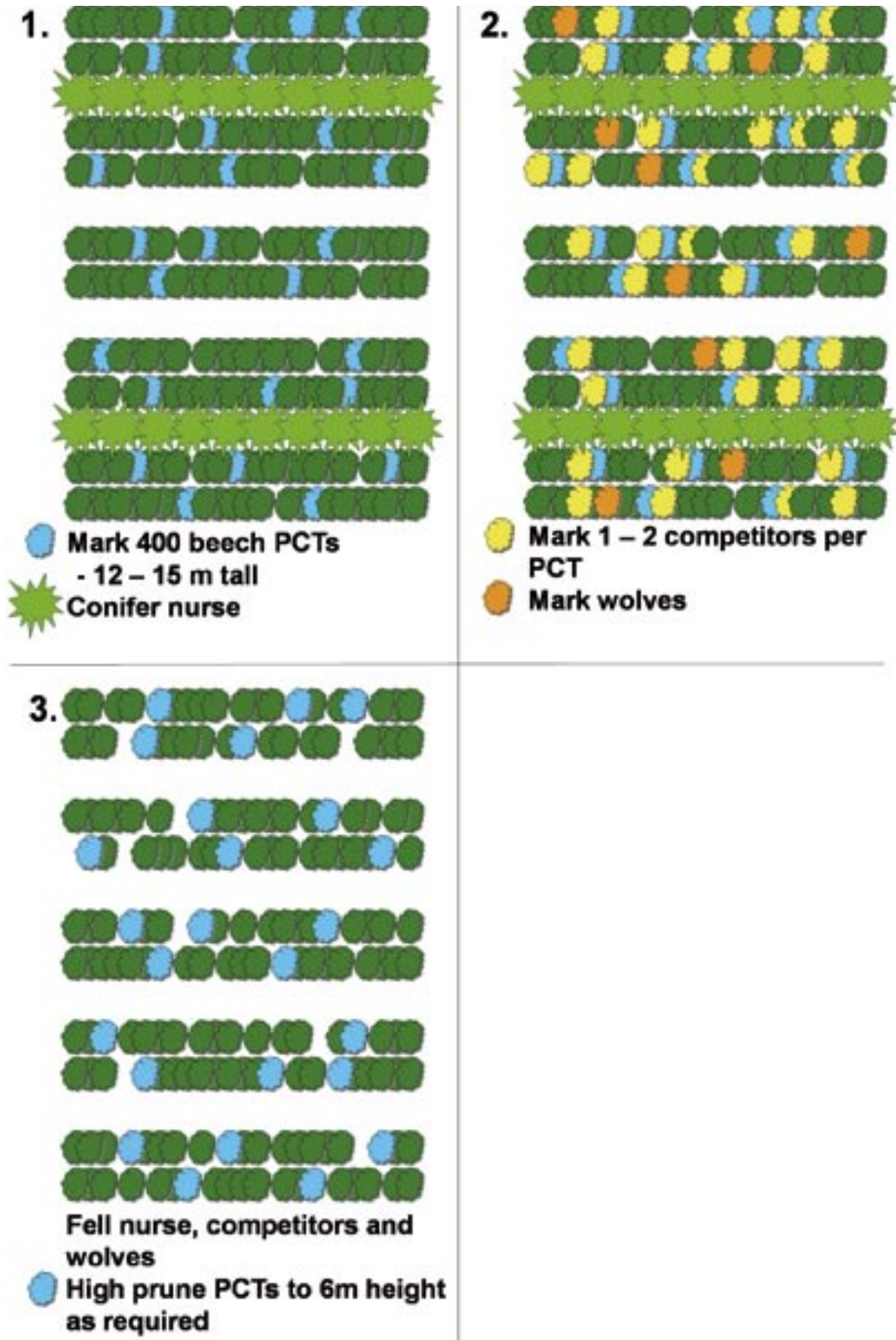
Oak / Conifer Mixture 1st Thinning Recommendations



Pure Beech 1st Thinning Recommendations



Beech / Conifer Mixture 1st Thinning Recommendations



Health and Safety

Tending and Thinning

Forest owners should have public liability insurance. It is also essential that all workers in forestry operations have adequate insurance and certified training. Courses on the safe use of chainsaws are available from Teagasc's Ballyhaise College, Coillte and other certified private training providers.



Figure 12. Appropriate safety equipment should be worn

Suitable Personal Protection Equipment (PPE) should be worn at all times. For example, high-visibility vest, hardhat with visor, etc. Appropriate PPE should be worn if chainsaws are being used (e.g. chainsaw gloves, chainsaw trousers and chainsaw safety boots). Adequate signage should also be provided, especially if the plantation is frequented by the general public. **Never work alone!**

High Pruning

The use of appropriate safety equipment when high pruning is essential. Hardhats and eye protection should be worn. Appropriate personal protection equipment should be worn if a powersaw is being used. Teagasc provides short courses on correct pruning techniques.

Thinning Control Plots

What are Thinning Control Plots?

A Thinning Control Plot is a permanently marked plot that represents the surrounding area of similar plantation. Typically they measure 20 m x 20 m (0.04 ha). Thinning Control Plots for beech mixture are 20 m x 18 m (0.036 ha).

Why are they needed?

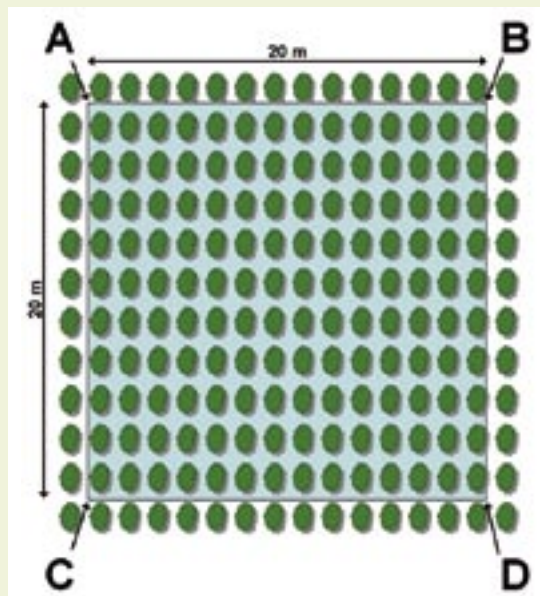
Thinning Control Plots allow you to check that the correct amount of PCTs have been marked (see Table 4) and can be used to provide an estimate of the volume of thinnings harvested.

How to establish Thinning Control Plots

Thinning Control Plots should be established after the PCTs and trees to be removed have been marked, but before any trees have been felled.

The number of Thinning Control Plots required will depend on the variability of the crop and the area involved. The minimum should be 1 Thinning Control Plot per hectare. However, if there is great variability in the crop, 2 or 3 plots per hectare may be required to provide a more accurate assessment of the plantation. The following procedure is for all broadleaves including oak/conifer mixture. The procedure to follow for beech/conifer mixture is overpage.

1. Starting between two rows, place a stick (A)
2. Measure 20 m from the stick up between the two rows
3. Place another stick at this point (B)
4. Starting at point A again, measure 20 m at right angles from the line A-B
5. Place another stick at this point (C)
6. Measure 20 m from C at right angles from A-C
7. Place another stick at this point (D)
8. Measure from D to B. The distance should be 20 m
9. Replace the sticks at points A, B, C and D with permanent posts



If a Thinning Control Plot is required in beech mixture, the following procedure should be used:

1. Starting between two beech rows, place a stick (A)
2. Measure 20 m from the stick up between the two rows
3. Place another stick at this point (B)
4. Starting at point A again, measure 18 m at right angles from the line A-B
5. Place another stick at this point (C)
6. Measure 20 m from C at right angles from A-C
7. Place another stick at this point (D)
8. Measure from D to B. The distance should be 18 m
9. Replace the sticks at points A, B, C and D with permanent posts

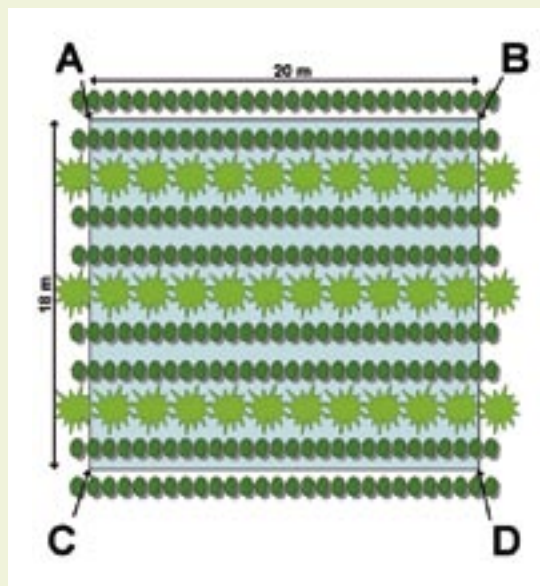


Table 4. Number of PCTs required at Tending and 1st Thinning for different broadleaf plantation types

Plantaton type	Operation	PCTs required per ha	PCTs required in Thinning Control Plot
Ash / Sycamore / Norway Maple / Alder	Tending	350	14
	1st Thinning	300	12
Pure Oak or Beech	Tending	600	24
	1st Thinning	400	16
Oak / Conifer Mixture	Tending	500	20
	1st Thinning	400	16
Beech / Conifer Mixture	Tending	500	19
	1st Thinning	400	15

Felling licences

Requirements

Forest owners are required by law to obtain a Felling Licence prior to felling any trees. There are two types of felling licence available:

1. General Felling Licence
2. Limited Felling Licence

A General Felling Licence can be applied for from the Forest Service. It is normally issued for a period of 2 – 5 years, although this may be extended to 10 years in exceptional cases. A management plan is required prior to application of a General Felling Licence.

A Limited Felling Licence can be applied for from the Gardai. It is issued for a period of 2 years. No management plan is required prior to applying for a Limited Felling Licence.

Procedure for application

Felling Licence application forms can be requested from the Forest Service, Johnstown Castle Estate, Co. Wexford or downloaded from the Forest Service website (<http://www.agriculture.gov.ie/forestry/>) or from the Teagasc forestry website (<http://www.teagasc.ie/forestry>). Limited Felling Licence application forms are also available from any Garda Station.

Completed applications should be returned to:

The Felling Section
Department of Agriculture, Fisheries & Food
Johnstown Castle Estate
Co. Wexford

Completed Limited Felling Licence application forms can also be returned to any Garda Station.

Tending and thinning **must not** be carried out until a Felling Licence has been confirmed. Any breaches of the Felling Licence legislation can result in penalties being applied.

Record keeping

It is recommended that a folder be kept containing Felling Licences and other silvicultural records related to a plantation such as:

- » Date of tending and thinning
- » Number of Potential Crop Trees
- » Contractors (if any) used for silvicultural operations
- » Date of pruning operations and number of stems pruned
- » Costs of silvicultural operations
- » Advisor / Consultant site visit reports
- » Photos of the plantation before, during, and after silvicultural operations
- » Value of any timber sold

The records may be important in the future sale of the crop because they will provide evidence of the silvicultural management of the plantation and the potential for added value that this management will generate.



» Appendices



Appendix I – How to measure tree height

Tree height can be measured accurately with special, but expensive, equipment, such as an hypsometer (see Figure 13), a clinometer, or height measuring poles. However, tree height can be estimated reasonably accurately using the method described below.



Figure 13. An hypsometer, used for measuring tree height

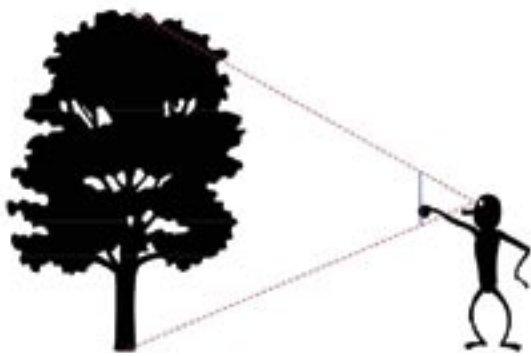
A simple method of measuring tree height



Break a straight stick such that, whilst holding one end between your index finger and thumb, the other end is next to your eye with your head erect. Your arm should be outstretched and at right-angles from your body (see accompanying photos)



Figure 14. Measuring a stick for use in estimation of tree height



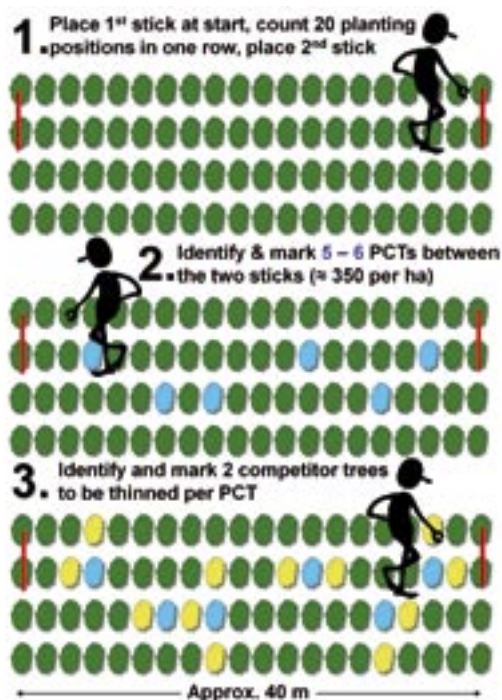
Holding your stick vertically at arm's length and keeping your head still, walk forwards or backwards until the top and base of the tree align with the top and base of your stick.



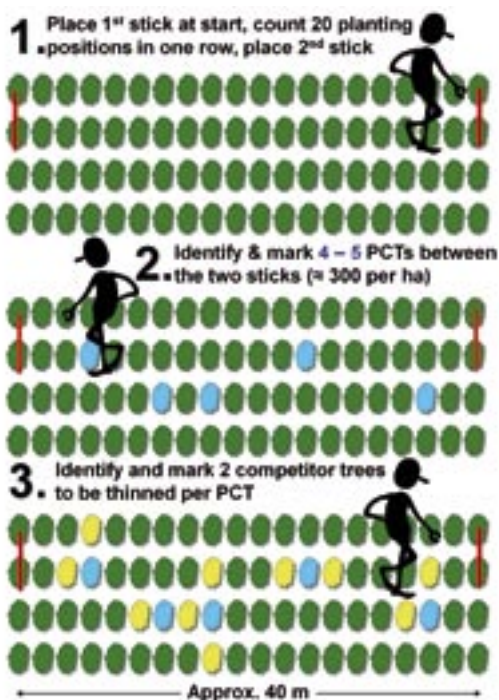
Pace or measure the distance from where you are standing to the base of the tree. This is equal to the height of the tree.

Appendix II – Illustrations of the 2-stick method of marking trees

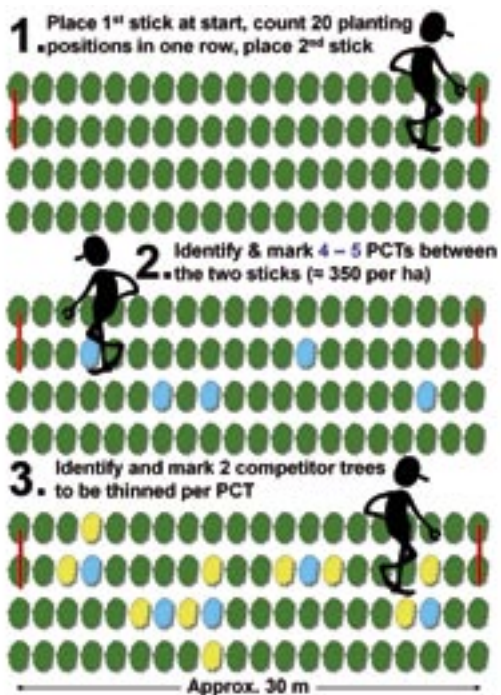
Ash/Sycamore/Maple/Alder 2,500 - Tending



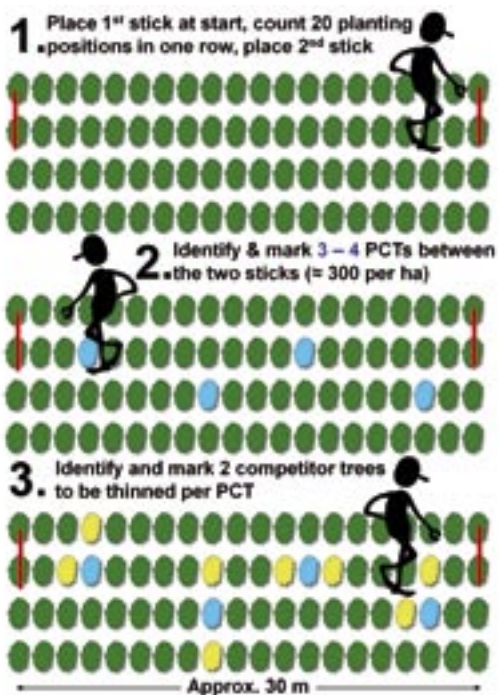
Ash/Sycamore/Maple/Alder 2,500 - 1st Thinning



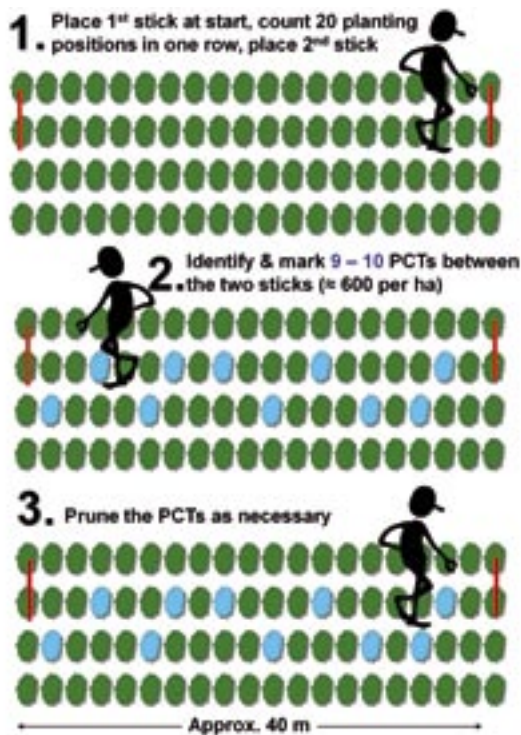
Ash/Sycamore/Maple/Alder 3,300 - Tending



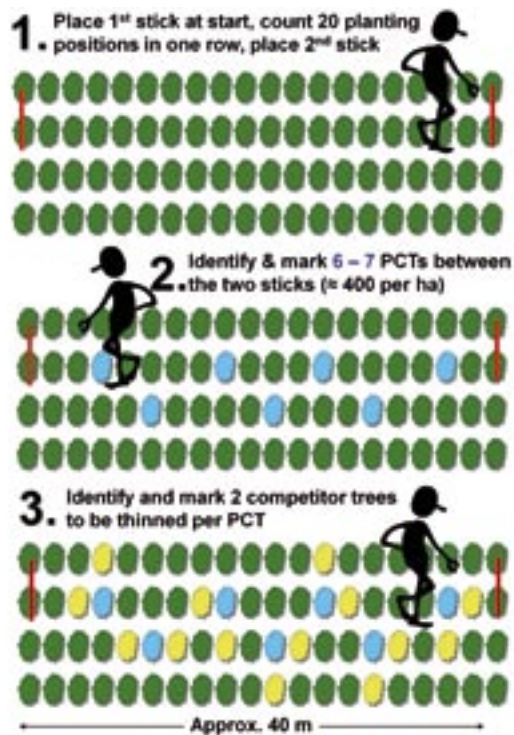
Ash/Sycamore/Maple/Alder 3,300 - 1st Thinning



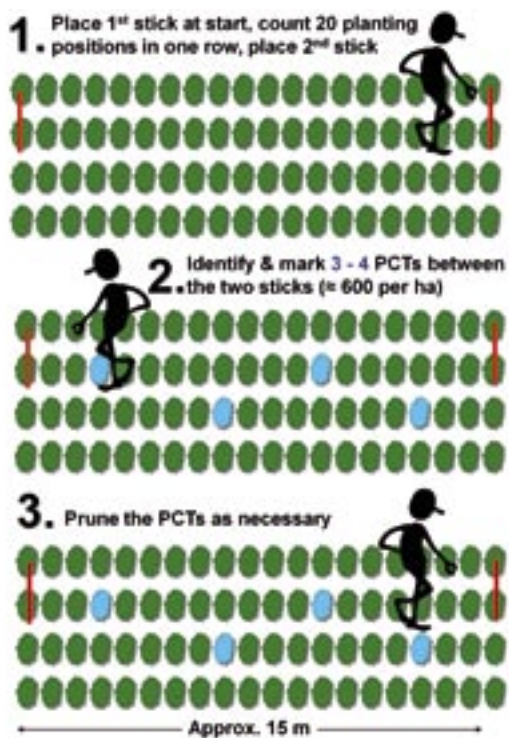
Pure Oak/Beech 2,500 - Tending



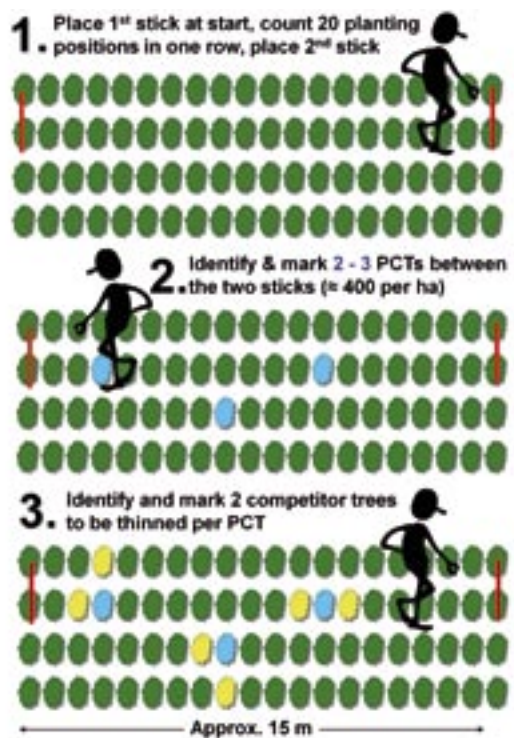
Pure Oak/Beech 2,500 - 1st Thin



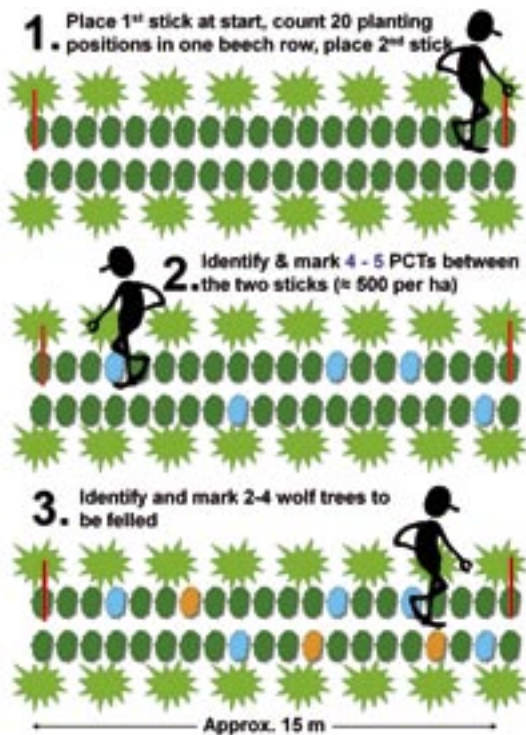
Pure Oak/Beech 6,600 - Tending



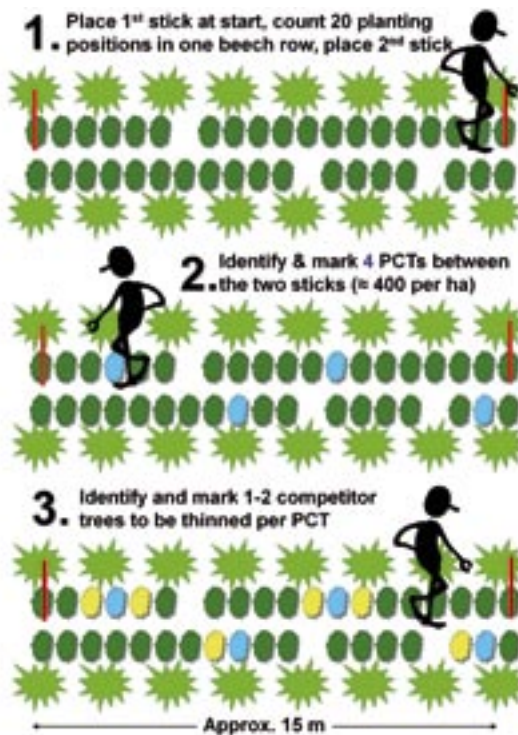
Pure Oak/Beech 6,600 - 1st Thin



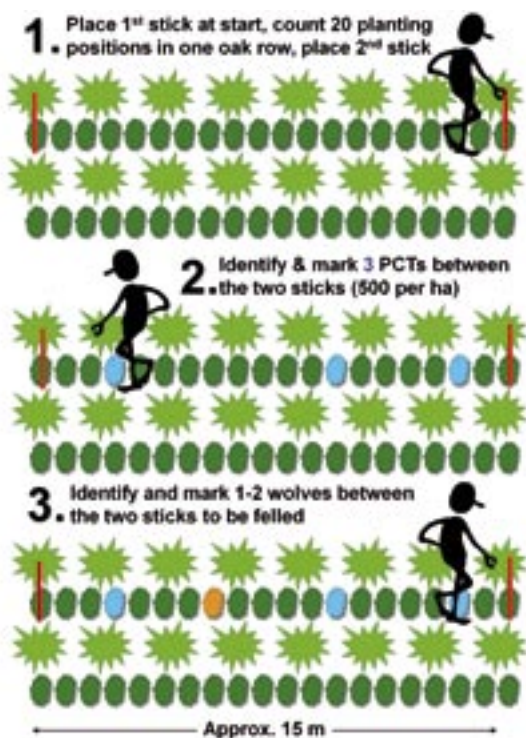
Beech mixture - Tending



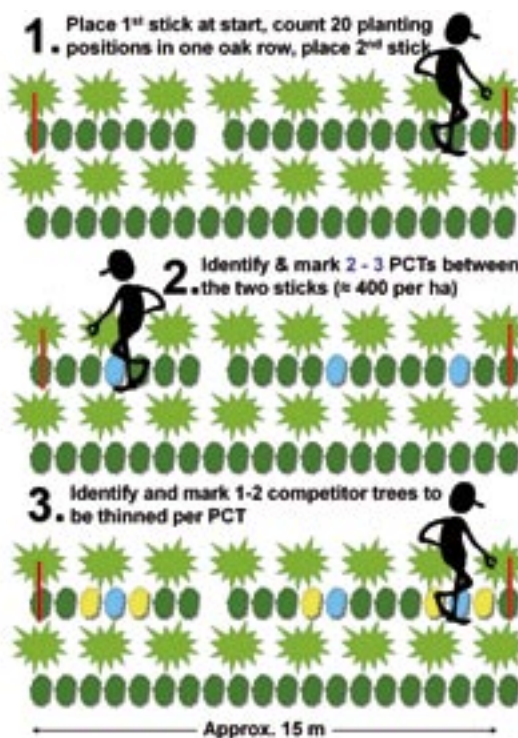
Beech mixture - 1st Thin



Oak mixture - Tending



Oak mixture - 1st Thin



Appendix III – Summary table

Plantaton type	Operation	Height (m)	PCTs required per ha	PCTs required in Thinning Control
				Plot
Ash / Sycamore / Norway Maple / Alder	Tending	8	350	14
	1st Thinning	12 - 15	300	12
Pure Oak	Tending	8 - 10	600	24
	1st Thinning	10 - 12	400	16
Oak / Conifer Mixture	Tending	8 - 10	500	20
	1st Thinning	10 - 12	400	16
Pure Beech	Tending	7 - 8	600	24
	1st Thinning	12 - 15	400	16
Beech / Conifer Mixture	Tending	7 - 8	500	19
	1st Thinning	12 - 15	400	15



For all your forestry advice and training needs

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