

A review of historical literature on the pruning (formative shaping) of broadleaved trees from the sixteenth to the nineteenth century

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Abstract

This paper is a review of selected historical British literature on tree pruning from 1595 to about 1840. The authors strongly promoted the use of early pruning (formative shaping) to improve stem quality in broadleaved trees, especially in beech (*Fagus sylvatica* L.) and oak (*Quercus* spp.). They indicated that pruning was needed despite the high planting density used at that time. Most authors advocated pruning in the first year. All authors indicated that pruning should be a continuous process over a number of years. Those who examined the correct season for pruning advocated summer pruning. Some authors advised against the use of 'flush' pruning or leaving 'snags'.

Keywords: Broadleaves, historical review, formative shaping, pruning, time of pruning, leader training, stumping-back.

Introduction

As part of a research programme on formative shaping of broadleaved species at Teagasc, Kinsealy Research Centre (Bulfin and Radford 1998a&b) an extensive contemporary scientific literature review was carried out. This review highlighted references to earlier papers and books dealing with the history of broadleaved management, including early shaping and pruning practices. We have identified, located and transcribed a number of treatises and publications on this topic, written by authors from the 16th to the 19th centuries. The level of insight and skill shown by these authors was striking. It was decided to extract and publish this information to enlighten and inform, and to stir debate among those now involved in the early management of young broadleaved plantations.

There is strong evidence in the literature that significant knowledge, skill and expertise existed in previous centuries – albeit somewhat contradictory at times – in relation to broadleaf shaping and pruning. This may explain why the remnants of some very fine old broadleaved woodlands exist containing trees with good straight and clean boles.

A number of the treatises written on this subject over the centuries are reviewed below. At times these texts gave the present authors the distinct feeling that our work on formative shaping was a 'reinvention of the wheel'. The one new element that we have brought to this area of silviculture – and which encouraged us to persevere – was the application of a rigorous scientific methodology to the study of formative shaping. However, it was great encouragement to look over our shoulders – so to speak – and find corroboration of our findings from such historic sources. This paper has been written as a tribute to these early woodsmen, in an effort to highlight their contributions to silviculture and to reconnect with their expertise. If some of the comments appear somewhat stilted it may be that we have

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unconsciously adopted the authors' more courtly and circumlocutory style. The authors' exact words and spelling have been retained, as are some archaic words such as "shew" and "timeous".

In most cases it is clear from the text that the authors' discussions on pruning refer to the early shaping of young broadleaved trees. In the context of Irish broadleaf silviculture the term early pruning is more correctly referred to as formative shaping (of young broadleaves). The aim of formative shaping is to produce a single straight stem up to 3-4 m long. Many of the recommendations indicate that the authors had an intuitive grasp of tree physiology and directed their efforts to enhancing nature's own natural processes.

Timely pruning

A strong reminder on the value of timely and skilful pruning is given by Evelyn (1662) when he stated:

I shall therefore in the first Place speak of the Manual Operation of Pruning, and other Instructions as they afterwards occur... Putatio; Pruning I call all Purgation of Trees in general, from what is superfluous: The Antients found such benefit in Pruning, that they feigned a Goddess presided over it, as Arnobius tell us: And in Truth, it is in the discreet Performance of this Work, that the Improvement of our Timber and Woods does as much consist as in any Thing whatsoever. A skilful planter should therefore be early at this Work:

*Twigs of themselves never rise straight and high
And under-woods are bow'd as first they shoot
Then prune the Boughs, and Suckers from the Root*

And here it is that I am (once for all) to warn our disorderly Husband-men from coveting to let their Lops grow to an extraordinary Size before they take them off as conceiving them it furnishes them with more Wood for the fire; not considering how much gashly Wounds mortally affect the whole Body of the Tree;... In the mean while, that young Oaks prosper much in Growth, by timely Pruning,

Samuel Hayes (1794), the owner of Avondale before the Parnells, did not over-elaborate on the shaping or pruning of trees; however, he recognised the need for timely and careful pruning:

I shall not however greatly enlarge upon the subject of pruning,...it being universally admitted, that the heavy use of the knife or saw on the side branches, though prevented from being injurious by the admission of frost or rain,...whilst on the other hand the neglect of cutting off in time the ill placed luxuriant branches, permits improper boughs to take the lead, and fills the timber with unsightly knots;...

Pontey (1808) addressed doubters of early timely pruning as an effective management practice:

But, probably, the reader may ask, Will Pruning cause any deciduous tree to assume such form? The question is fair, and the answer shall be explicit. Yes, any one that will grow; provided the business be commenced in due time.

He also advanced the positive benefits of timely formative shaping or pruning on a regular basis. Such practices prevent branches from competing with the leader; therefore, the branches should not be allowed to grow so large that a knife (or nowadays a secateurs) cannot be used to remove them, when he recommended:

We next proceed to notice the consequences, or advantages of this very simple method, in order to shew whether or not it possesses the other requisites, beforementioned. In doing which, we observe, in the first place, that the real, or pretended, danger, incurred by taking off large branches, is completely done away; provided the business is begun in proper, time, namely, when a knife will perform the operation, and repeated every second or third year, till the stem is cleared to the desired height, as then the branches to be displaced must always prove somewhat small; and, therefore, when taken ...the wounds will heal very soon.

Nicol (1820) underlined the importance of early and timely pruning. The principal insight from this extract is the recommendation that pruning should start in the first year. He maintained that some of his recommendations were not recent or new and that there were well-defined principles, already established by earlier authors, with a strong emphasis on producing quality stems:

It is not, then, here pretended to set forth some new scheme of management, but to call the attention to established principles, which are well known to produce the most beneficial effects...We have shown that pruning of such trees commence at a very early period...Indeed, the right pruning of a tree, to the procuring of good, clean timber; must, in every situation, consist in a timeous and effectual removal of all competing or superfluous branches. Timely pruning is, therefore, a matter of the utmost importance...The pruning of groves of deciduous trees, must be commenced the first year after planting; and will at that time consist in removing every branch competing with the leader for the ascendancy; and thinning the smaller side shoots and twigs on the boles of the plants; leaving a sufficient number on each to promote an equal distribution of the sap over the whole plant.

A clear signal is given that close spacing has great merit in helping to produce quality stems, but he nevertheless stated that there is no substitution for early pruning:

Notwithstanding that we here fully admit the great utility of close masses for the procuring of straight clean timber, it must be obvious to every one, that, for a number of the earlier years of the forest, however extensive it may be, the plants will not feel that influence from proximity which is necessary to give them the upright tendency or direction that is so highly desirable. Hence the necessity of early pruning of forest plantations.

Main (1839) reminded his readership of the need for pruning. In a very striking and forceful manner he stated that the use of close spacing and optimum thinning regimes would not result in the production of quality timber unless some form of pruning or formative shaping is undertaken at the correct time:

It has been asserted, that no pruning at all is required in order to have good timber;

indeed, a book has been published expressly to make this declaration! But the author has failed in his proofs: for it is a well ascertained fact that clear-grained timber cannot be grown unless the tree has some kind of pruning, either by art or by accident. Accidental pruning is performed by browsing animals, as is so frequently seen in parks and forests. There the trees have usually short butts, and large branchy heads. Or, trees may be made to grow for many years very close together. In the latter case, as already has been observed, the lower boughs quickly perish and drop off by being deprived of air and light...If it be found then that timber of the first quality is produced by accident surely the same result may be accomplished by a little labour and the application of skill. And when it is understood how a tree is increased in diameter, and also how the added additions of alburnum [sapwood] may be distorted by lateral branches remaining too long where they do harm rather than good, the necessity of timely pruning will be perfectly evident.

Main (1839) went on to state that the purpose of pruning is to produce high quality stems. He strongly emphasised that if this approach is to have any real benefits on wood quality then pruning must commence when the tree is young:

This is the real and sole use of pruning forest trees, and the business can only be executed with the propriety and effect when the trees are young. Pruning an aged tree which has arrived at full form and stature can answer no good purpose; for after an irregular branch has acquired a diameter of from four to six inches, it had better be left where it is; because if cut off, the wound will never be thoroughly healed, and will remain a flaw in the timber. So that it is as much the aim of the pruner to prevent the growth of living knots which distorts the grain, as it is to hinder the formation of dead ones, which deteriorates the wood.

Main grasped the concept that large knots, whether live or dead, cause serious defects in timber. The definitive results of recent research by Shigo (1989), whereby he dissected and examined thousands of trees, have largely confirmed Main's (1839) conclusions.

Judicious pruning

Evelyn (1662) drew attention to the need to prune trees in a 'discreet' fashion and to concentrate on protecting the tree's leader:

It is by the Discreet leaving the Side-boughs in convenient Places, sparing the smaller, and taking away the bigger, that you may advance a Tree to what determined Height you desire: Thus, bring up the Leader, and when you would have that spread and break out, cut off all the Side-boughs, and especially at Midsummer, if you espy them breaking out.

Hayes (1794) was conscious of the need to ensure that plantations become well established, but he also referred to the need for skilful pruning when he stated:

...I shall offer a few observations on the management of plantations of some years standing, when the care and attention which has been bestowed on them at the time of planting, shall have produced that luxuriant growth, which, whilst it gratifies the

planter's wishes at the moment, would utterly defeat them in the end, if not skilfully directed and kept within proper bounds.

Nicol (1820) emphasised the need for judicious pruning to produce quality tree stems, but he also recognised that this objective can only be achieved if woodland owners acquired greater knowledge of the use of this technique:

But while we thus inculcate the pruning of forest trees, we would, at the same time, deprecate in the strongest terms what, in many instances, bears the name without possessing a single character of judicious pruning.

Nicol (1820) further stated:

...its abundantly evident, that pruning can never be properly, or even tolerably done, unless the proprietor understands the subject, and himself take the trouble of directing...The proportion which the top of a grove tree, from twenty years old and upwards, should occupy, is about a third part of the height of the plant; thus if the tree be thirty feet high, the top should be ten feet. But in infancy, grove trees should be feathered from the bottom upwards, keeping the tops light and spiral, something resembling a young Larch...The proportion of the tops should be gradually diminished, year by year, till about the twentieth year... In cutting, or pruning off the branches, the utmost care must be taken not to leave any stumps sticking out... It is only by this means that clean timber can be procured for the joiner...

Nicol (1820) illustrated correct and incorrect pruning methods for broadleaved trees growing in a dense stand (Figure 1).

Main (1839) contrasted the knowledge obtained from the practices of nursery management and forest establishment with that achieved using judicious and careful pruning in the management of young woodlands when he stated:

The business of raising and nursing young trees, - the best method of preparing the ground for their reception when fit to transplant - manner of transplanting - the soils most suitable for each species - together with staking and fencing - are all thoroughly understood. But the only part of the woodsman's duty which does not appear to be well defined; or at least not generally agreed upon by practical men, is relative to the necessity of carefully pruning and managing the trees during the first fifteen or twenty years of their growth.

Leader training

The earliest reference found on the use of leader training methods was by Lawson in 1597. However, the original publication is not available, but his work was reviewed by Evelyn (1662). He quoted Lawson, who recommended leader training, as follows:

The waste Boughs closely and skilfully taken away, would give us more of Fences and Fuel: and the Bulk of the Tree in Time would grow of huge length and Bigness: But here (methinks) I hear an unskilful Arborist say, that Trees have their several Forms, even by Nature;...The Oak by Nature broad, and such like. All this I grant: But grant

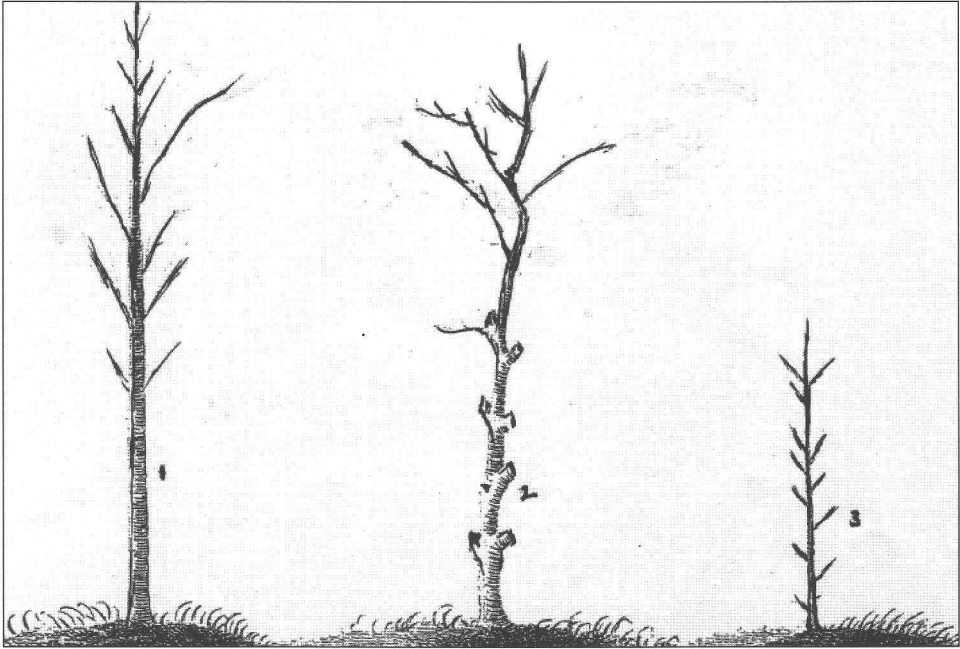


Figure 1. *Illustration of the effects of pruning practices (from Nicol 1820). The original caption is reproduced here unaltered: (1) Represents a tree in a grove or thick plantation of thirty years of age, which has been regularly and properly pruned from infancy onwards. (2) Represents a tree of the same age, on the skirts of a plantation, which has been neglected in the pruning from infancy onwards; and which is now been pruned in a way too frequently practised, is left in a state highly injurious to its health, and destructive of the soundness of its timber. (3) Represents a grove, or an ordinary plantation hardwood tree of ten years of age, clothed with a sufficient number of branches to secure the extension and enlargement of the bole.*

me also, that there is a profitable End and Use of every Tree, from which if it decline (though by Nature) yet Man by Art may (nay must) correct it... Neither let any Man ever so much as think, that it is unprofitable much less impossible, to reform any Tree of what kind soever: for (believe me) I have tried it: I can bring any Tree (beginning betime) to any form.

Lawson (1597) made a very bold claim for apical leader training, stating that he could “bring any tree to any form” if he could treat the tree while young. While we agree with the need for timely shaping, we are not so sanguine as to believe that all trees can be redeemed in this way. It may be acceptable under current forestry conditions if sixty-percent or greater of a crop could be improved at time of first shaping.

Pontey (1808) compared the importance of tree leader training to that of the invention of the plough, when he stated:

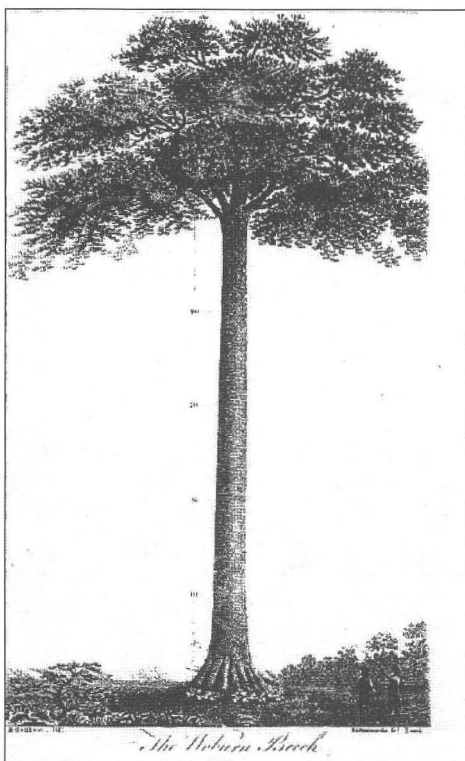
It is not said that the training of timber is of equal importance with the invention of a Plough...

If broadleaved trees are allowed to grow and mature as nature dictates, it is unlikely that they will have, clean lower stems. The benefits of using leader training to produce a clean stem to a given height are explained as follows:

Every tree with a clean stem, from four feet and upwards in length, being completely a trained one; as unassisted nature forms none of the sort. It is proved then, that such practise has been abundantly successful, so far as it has been extended; to it we are obviously indebted, for most of the good timber we possess. Surely, then, the success is a sufficient reason to extend the practice. If a tree has been benefited in a certain degree, by clearing the stem, a few feet in length, undoubtedly the same, or similar means, extended higher, would have increased the effect.

Pontey (1808) illustrated the value of apical leader training, for a particular beech (*Fagus sylvatica* L.) tree (Figure 2) that had been trained on a regular basis. This remarkable tree had a clean, cylindrical, branch free and straight stem to 15 m:

In order to give a clear idea of what may be expected from a good method of training timber...a drawing of a Beech in Woburn Park; to which the Grandfather of the



present Duke of Bedford is said to have paid very particular attention... We may observe also, that the stem is in no place either flat, or furrowed; a sufficient proof that the branches were taken off at no late period... There are several other Beech Trees in the Park, that seem little, if at all, inferior to it in weight, while in every other respect, this maintains so clear and decided a superiority, that it furnishes a decisive proof of the beneficial consequences of training timber, as the most sceptical mind require.

Nicol (1820) described the characteristics of a properly trained tree. He discussed the importance of the role of small branches and twigs in producing a well-balanced tree:

It is of importance that the tree be equally poised; and therefore if it have stronger branches on the one side than the other, they should either be removed or be shortened. Thus a properly trained tree, under twenty feet in height, should appear light and spiral from within a yard or two of the ground to the upper extremity; its stem being furnished with a moderate number of twigs and small branches, in order to detain the sap, and circulate it more

Figure 2. Pontey's (1808) illustration of a beech at Woburn park showing the beneficial effect of apical leader training.

equally through the plant.

Main (1839) fully supported the concept of prudent leader training in developing a single straight and superior stem. He advised that competing shoots or side branches should be removed carefully:

Let us suppose, again, that a similar tree is put under the care of a forester, who resolves by regulating the growth to train it into the finest and most valuable form, securing an erect and straight butt, divested of branch which by possibility could deteriorate the quality of the timber, and without checking the growth by extreme mutilation (for in his proceedings both these circumstances must be considered).

Proper pruning practice

Evelyn (1662) deplored the low quality of pruning practised in forestry, leading to the production of poor quality timber, when he stated:

For 'tis a Misery to see how our fairest Trees are defaced and mangled by unskilful Wood-men, ...As much to be reprehended are those who either begin this Work at unseasonable Times, or so maim the poor Branches, that out of Laziness, or want of Skill, they leave most of them Stubs, and instead of cutting the arms and branches close to the Bole, hack them off a Foot or two from the Body of the Tree, by which Means they become hollow and rotten, and are as so many Conduits to receive the Rain and Weather, which conveys the Wet to the very Matrix and Heart, deforming the whole Tree with many ugly Botches, which shortens its Life, and utterly mars the Timber.

About 350 years before Shigo's research work, Evelyn was aware of the correct methods of branch removal to avoid leaving stubs -to make the cut close to the bole while avoiding damage to the stem.

Pontey (1808) described in detail the principles of best pruning practice to produce good quality stems. He also illustrated the effect of pruning on stem form just after treatment (Figure 3).

Pontey considered the value of branches, their contribution to tree growth and the problem of large or disproportionate branch development. He suggested that all large branches should be removed in preference to smaller ones to ensure growth is concentrated in the leading shoot:

Consistent with above principles, there seems no difficulty, in directing a good and safe method of pruning such young trees as are intended to grow into long, clean, and straight timber. For, knowing that our business is to consolidate nature's efforts, as much as possible, to one point, we consider branches as no further useful, than as subservient to the purposes of the stem; and finding that small ones are every way preferable to such as are large, the head and stem of the plant are constantly kept light, by thinning out all the largest branches, every time the tree is pruned....It is not at all necessary to be exact, as to the quantity of such branches, provided some general ideas are attended to; such as that, the larger branches only are to be taken off, while the smaller are to remain, not upon a few feet only, but a considerable length

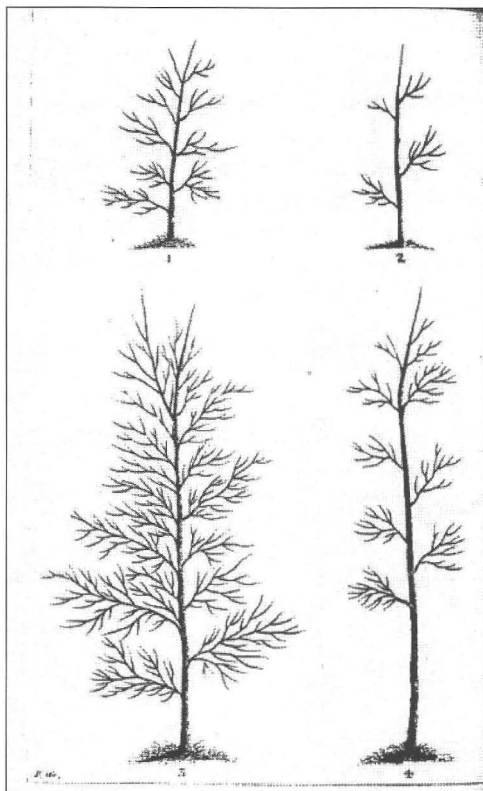


Figure 3. Illustrations of the application of the principles of best pruning practice (from Pontey 1808). Pontey explained these illustrations as follows: (1) is a tree, which has been planted small, and grown for three or four years. (2) exhibits the same figure pruned. (3) is an illustration of the same tree, three years afterwards. (4) is the same tree pruned.

down the leader, never suffering a branch to remain, that is at all likely to attract an equal quantity of sap, and, consequently, become its rival. It is unnecessary to give directions for the subsequent prunings, as the method above directed will be applicable, whether the trees are five or fifty feet in height; supposing them such as have not been previously neglected.

Pontey (1808) maintained that the correct method of pruning is easily understood and should be performed in a quick and efficient manner to provide value for money. We agree that shaping or pruning is easily understood and a matter of common sense in practice. Pontey (*op. cit.*) is extremely practical about this work when he states:

Probably, we may be here anticipated, by the reader's observing, that the means directed are exceedingly simple. Undoubtedly, they are so; and we trust too he will likewise observe, that much of their value must depend upon that circumstance. We are not to expect the nicety of Garden practice, to be introduced here; and therefore, in recommending what is useful, we have to consider how far it can be called expedient, or practicable, upon a large scale. A method, that is not at once simple, expeditious, and effectual, cannot be highly valuable, because few have the means, and fewer would find the inclination to practise it to any considerable extent.

On the problem of tree forking and choosing the preferred leader Pontey (1808) had no doubts, and recommended the following practice:

Sometimes persons are perplexed in choosing leaders for trees; - one may be the straightest, and another the strongest; - in this case, the point should be decided by considering, that we want one the most capable of attracting the sap sufficiently; for if that be done, it is of very trifling consequence, whether the leader stands only half upright, or perfectly so; as, by growing freely, it will soon cease to bend, and, therefore, we usually choose the strongest.

Nicol (1820) advocated a methodical approach to deal with many different forms of stem defects, and described a number of pruning steps that should be taken to protect the leader of the tree, when he stated:

From the importance of this subject, we beg here to repeat, that the pruning of all deciduous trees should be begun at the top, or at least those branches which are to be removed from thence should never be lost sight of. Having fixed upon what may be deemed the best shoot for a leader, or that by which the stem is most evidently to be elongated and enlarged, every other branch on the plant should be rendered subservient to it, either by removing them instantly, or by shortening them.

In dealing with stem defects such as forks he advised that the strongest and most promising shoot should be chosen:

Where a plant has branched into two or more rival stems, and there are no other very strong branches upon it, nothing more is required, than simply to lop off the weakest clean by the bole, leaving only the strongest and most promising shoot.

Competition with the leader from codominant side shoots – a common problem with ash and sycamore – was also recognised:

If three or four shoots or branches be contending for the ascendancy, they should, in like manner, be lopped off, leaving only the most promising.

On the problem of stem defects, such as multiple competing branches, large branches or whorls, Nicol (1820) made this suggestion:

It is manifest that, by removing competing branches, when they have attained perhaps half the diameter of the trunk of the tree, the grain of the timber must be abruptly broken over, and consequently, at such places, be less strong than it otherwise would have been...Is it not evident, that if these branches had been timeously checked, the greater part of the matter forming their solid contents, would have settled in the trunk itself? We have known plantations which have been carefully pruned from infancy upwards, make a better figure at twelve years of age, and each tree have more solid wood in its bole, than trees in a neglected plantation of twenty years of age...If any of the branches which have been left further down on the bole of the plant at former prunings have become very strong, or have extended their extremities far, they should either be taken clean off by the bole or be shortened at a proper distance from it; observing always to shorten at a lateral twig of considerable length.

The results of research by Shigo (1989) have shown that shaping or pruning of branches should not involve the excision of branches “clean off by the bole”. This incorrect practice is called flush pruning. He advocated that the branch collar and branch/bark ridge should not be injured, but should be protected at all times when branches are being removed. Current thinking is that such disproportionately large side branches should be removed before their individual diameters reach half that of the main stem. Nicol (1820) also advocated, in the extract quoted above, using ‘tipping’ i.e. the removal of the distal ends of large branches that are likely to compete with the leader. There is now some doubt

about the efficacy of this process, with the argument being made that these large branches might not be checked and instead they might initiate a number of lateral shoots that grow vigorously. The diameters of these large branches might then continue to expand. More research and observation need to be carried out on before conclusions are reached on the effect of tipping.

Despite the impressive published work of Pontey (1808) and Nicol (1820), it was disconcerting to learn from Main (1839) of his grave concern that pruning practices differed and there was no agreed standard. He wrote:

On this very material branch of management, many different opinions are held, as well as to the season in which it should be performed, as to the manner in which it should be executed. Some persons imagine that pruning at any stage of the growth is altogether unnecessary, while others maintain the contrary; though the latter have omitted to lay down any practical rules for performing the work except only as regards some of the regular species of the coniferae: some foresters advising all the tiers of branches to be constantly, that is, annually cut off, except three or four at the top; while others advise no branch to be dissevered...

Even in those days sawmillers were not happy with the quality of the roundwood supplied to their mills. At the time many felt that poor quality was due to the lack of pruning:

At the time when the very great complaint was made of the great quantities of defective oak timber which was constantly received and rejected in the royal and merchant's dockyard of this country, an urgent inquiry was instituted to discover the probable cause... Some persons were of opinion that the defective timber was owing to the want of pruning, as too many of the lower branches were allowed to grow, which very much distorted the grain of the stem, and if any of these branches chanced to die, they in time dropped off, leaving a hollow and rotten scar, which admitted rain and gradually extended the rottenness to the heart of the trunk.

Resulting from the sawmillers' concern about log quality many owners who had little expertise or knowledge about formative pruning, started to prune trees in a variety of ways. These practices inadvertently led to a deterioration in stem quality over time. While the instruction not to leave stubs or 'snaggs' or 'flush prune' was well aired in earlier literature, (Evelyn, 1662) the message does not seem to have spread widely, as evidenced by the destructive practice of snag-pruning mentioned by Main (1839). Furthermore, Main revealed that many foresters removed all lower branches close to the bole. In many cases this operation was carried out when the branches were large; their removal left pruning wound defects due to poor occlusion. Realising these mistakes, he came to the conclusion that tree pruning was not fully understood in all its aspects:

This idea induced many proprietors to become pruners who had done nothing of the kind before; but, fearing to injure the butt, by applying the saw too closely, they cut off the branches at the distance of two or three feet therefrom. This was called snag-pruning, and was done with the view of preserving the soundness of the trunk; for whether the snaggs lived or died the butt itself would still remain sound. In the expectation the inventors soon found their mistake; many of the unsightly stumps died back, and actually increased the injury to the butt which the pruner had laboured to avert. The snaggs

which had living spray upon them, or produced shoots after they were amputated, continued to live; but whether dead or alive when the tree was felled, their presence still indicated either distortion or dead knots in the body of the tree, and therefore that it was almost useless for planking. An improved mode of snag-pruning has been practised...called foreshortening. The object of the latter experienced forester was to prevent the lower branches of hedgerow trees spreading too far over the crops in their shade...The lower branches are cut back, but always reserving two or three secondary branchlets on their base, thus keeping the latter alive without the risk of their rotting back to injure the butt. Other foresters, seeing that a clear and handsome trunk was not obtained by snag-pruning or foreshortening, concluded that to procure long and straight boles, all the lower branches, of whatever age, should be cut off close to the trunk; [flush pruning] they knowing that the wounds, however large, would be in time covered over with new wood and bark, the whole tree would be improved in appearance and much more attractive to the eye of the buyer. While prosecuting this plan of pruning – and in some woods it was done extensively and at great expense – the projector forgot that the new wood and bark which covers the scar can never unite with its face so as to produce perfect soundness; and that certainly, when the trees so operated on came to the sawpit, a defect would be visible at every place whence a branch of any large size had been cut: Experience has proved this fact; and dealers are alive to the circumstances, always cautious of buying out of woods, which have been close-pruned, however handsome the butts may appear...This is an instance that the pruning of forest trees is not yet well understood or practised; and the consequences is, that much timber is deteriorated for want of pruning, and great numbers of trees which are healthy are much impaired in quality by the injudicious manner in which it has been performed.

Current practice is that disproportionately large branches should be removed at the earliest opportunity. (Disproportionately large branches have basal diameters at the main stem that are greater than half the diameter of the main stem at the same point.) A general rule of thumb is that such large branches should be removed before they achieve a diameter of 5 cm.

The season for pruning

Evelyn (1662) drew a distinction between old and young trees in relation to the proper time to prune, although his recommendations were not very convincing when he stated:

The proper Season for this Work, is for old Trees earlier, for young later, as a little after the Change in January or February, some say in December, the Wind in a gentle Quarter....Then shave their Locks and cut their branchy Tress, Severely now, luxuriant Boughs repress.

Pontey (1808) evidently carried out pruning in all seasons to determine the best time of the year to prune and to minimise damage to the stem of the tree. He discovered that summer was the preferred time to do this work:

In regard to the proper season for pruning, there is only one difficulty; and that is discovering the wrong one, or the particular time when trees will bleed. Considerable pains have been taken to ascertain this point, by pruning all sorts at all seasons,

repeatedly; and only two have been discovered which bleed uniformly, at certain seasons, namely, the Sycamore, and Firs, as soon as the sap begins to move. The best and safest way is, to notice, in spring-pruning, if the trees bleed, (for it never happens at other seasons;) if they do desist, till, upon trial, it be found to have ceased...As a general rule, we think summer is preferable to winter-pruning; because, in proportion as wounds are made early, they heal so much the more in the same season.

Nicol (1820) recommend that pruning of forest plantations be carried out on all tree species during the month of January with the exception of the wild cherry (*Prunus avium*):

There is no kind of forest-tree but may with propriety be pruned at this time of the year, except the Gean.

He stated that pruning might be carried out in February also, although this is not as a good time for a few species:

This work may be carried out during this month on every species of tree, excepting the Sycamore and the Birch. These, must not now receive a wound; because they bleed excessively, and sometimes die when pruned so late in the season.

He continued that all pruning should cease at the end of February and not begin again until late summer:

The pruning of no kind of forest tree should be carried on beyond this month: because every one of them, at the rising of the juices, bleeds, less or more, at recent wounds. Hence the advantage of autumn pruning above that of any other season...Pruning ought therefore to be suspended, from the end of February till the middle or end of July.

Main (1839) recommended that late spring or early summer was the most suitable time of the year to carry out pruning:

The months of April and May are the best seasons for pruning forest trees, because the wounds made by the removal of such small branches will be nearly healed over before the end of the summer; and of course no very visible knots or defects will remain in the bole when cut up for use.

It is evident that, as the centuries passed, the consensus had changed in favour of summer shaping and pruning. Results from research at Kinsealy indicate that summer shaping is most effective, up until the tree reaches about 3 m height. Thereafter, summer shaping is more difficult due to the difficulty of reaching upper branches and because the foliage obscures the view of the stem.

Annual pruning

Most authors advocate annual or regular pruning (formative shaping). As previously alluded to, Pontey (1808) encouraged the early use of:

...a knife...to be repeated every second or third year, till the stem is cleared to the desired height.

Evelyn (1662) had this to offer regarding the frequency and timing of pruning:

Young Trees may every Year be pruned, and as they grow older at longer Intervals, as at three, five, seven or sooner, that the Wounds may recover, and nothing be deformed.

Nicol (1820) suggested that woodland owners should begin pruning (formative shaping) when the trees are young. This practice should be continued on an annual or regular basis in order to produce unblemished timber:

The same attention to these will be annually required, till they arrive at maturity...To secure these advantages, it is however necessary to prune betimes, or rather to commence pruning at the infancy of the trees, and thenceforward to continue it at intervals of one, or at most two years. If the pruning of young forest trees is performed only at intervals of eight or ten years, the growth is unnecessarily thrown away, and wounds are inflicted which will ever after remain blemishes in the timber; whereas if the superfluous or competing branches had been removed annually, and before they attained a large size, the places from which they issued would be imperceptible, or at least not hurtful to the timber, when it came to the hands of the artist.

Main (1839) advised his readers to ensure, by annual inspection, that the leading shoot remains superior at all times. To achieve this objective, competing side shoots should be removed. Where multiple side shoots were present, he recommended removing some and partly removing others by “foreshortening” with a view to removing them at a later date. This practice is called ‘tipping’. However we would recommend that, where there is any doubt about a second shaping, the whole branch should be removed.

He would by an annual examination see whether the leading shoot maintained a due superiority, and that no competitor threatened to attract an undue share of the sap. If any such appeared, he would instantly displace or shorten them; so that they might not attain to more than one inch in diameter. All other size branches of a less size he would leave, as whether they lived or died they would not prove defects in the wood...This method of pruning necessarily imposes on the forester the duty of annual review, as the branches will consecutively arrive at the size at which it is advised they should be taken off; but the only difficulty will be, when three or four of the laterals [we believe this to refer to whorls] arrive at the prescribed size at the same time. In this case, if the rule be observed, the whole of these three or four branches must be removed at once; which would be, perhaps, too severe a dismemberment of the head, and probably would give a check to the whole system and counteract the very purpose of the pruner. But in such cases, the operator should be content to remove only one or two of the number closely, and foreshorten the others, to prevent their swelling to a larger size than it would be judicious either to leave or take off. These foreshortened branches with their spray, would continue to act as necessary parts of the head, and at another pruning might be removed entirely when no longer useful to the system.

Stumping-back

Stumping-back is the practice, referred to by Nicol (1820) as “heading down trees” but now commonly referred to as stumping-back (of young trees with poor stem form). This is a last-resort method to be used on trees of poor form. Its efficacy is questionable because the defect may be genetically determined. Nicol (1820) advised on the best method and recommended that the operation should be carried out in March:

It is now a proper time to examine all plantations which have been three or four years planted, to see if the hard-wood trees are in a thriving state, and such as have not begun to grow freely should be headed down to within three or four inches of the ground. The cut must be made with the pruning knife in a sloping direction, with one effort. Great care should be taken not to bend over the tree in the act of cutting. By so bending, the root may be split; a thing, which too often happens. The operation of cutting over young trees should not be performed at an earlier period of the season, because the wounded part might receive much injury from the severe weather in January and February, and the exposed shoot be thereby prevented from rising so strong and vigorous.

He referred to work carried out on this subject in France by the celebrated M. de Buffon, of the Royal Academy of Paris, in his Memorial on the Culture of Woods to the French Government, in 1742, who stated:

I have repeated this experiment so often, that I can give it as a certain fact, and the most useful practice that I know in the culture of woods.

Conclusions

It is clear from the literature reviewed that these authors and those they consulted (including professional foresters and sawmillers) had a depth of knowledge and expertise in the management of young plantations. The focus, particularly in the early period of the 19th century, was on producing high quality stems. It is possible that much of this expertise was lost at the time of the industrial revolution. The importance of growing high quality stems for industrial needs was less important because many wood products were replaced by steel. As a consequence of this technology-change, there was less emphasis on producing high quality trees so vital skills and knowledge of the techniques to manage young broadleaves was lost.

Teagasc began research on the formative shaping of young broadleaves in 1994, prompted largely by observations of the poor form of trees in a novel trial containing a mixture of ten broadleaved species. A visual ranking system, which concentrated on stem form was developed. An experiment was conducted to examine formative shaping as a means of improving stem form. Some trees were shaped regularly while others were left as untreated controls. Results to date have shown a significant increase in stem quality in the shaped trees compared with the unshaped controls (Bulfin and Radford 1998 a&b). Coincidentally, the type of stem defects identified and the remedial actions taken using formative shaping have remarkable similarities to the management techniques used by woodland managers in the early 19th century.

In the course of the research work it was speculated that the owners of the large estates must have used many skills and techniques in the past to manage young broadleaves. This

inspired us - out of curiosity - to undertake this literature review, which confirmed our speculations. A review of recent scientific literature revealed very little new information about the topic (Bulfin and Radford 1998 a&b). The information from this older literature supported the approach taken in the research now underway in Teagasc. It seems that the 'wheel is being reinvented' albeit with a contemporary scientific and statistical twist.

John Main (1839), perhaps the most perceptive woodsman, foreshadowed Gifford Pinchot, father of American forestry, who defined the objective of the US Forest Service as "The greatest good for the greatest number for the longest period" (Pinchot 1910). Main wrote:

It is the knowledge of the foregoing descriptions of the growth, which directs and sanctions the operations of the pruner in the management of young trees. His especial aim is to obtain the greatest quantity and best quality of timber on the smallest space and in the shortest time. And when all the means of judicious planting and proper culture are followed by the necessary pruning, there need be no doubt of success.

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REFERENCES

- Bulfin, M. and Radford, T. 1998a. Effect of early formative shaping on newly planted broadleaves, Part 1: Quality. *Irish Forestry* 55(2): 35-51.
- Bulfin, M. and Radford, T. 1998b. Effect of early formative shaping on newly planted broadleaves, Part 2: Height and diameter growth. *Irish Forestry* 55(2): 52-61.
- Evelyn, J. 1662. *Silva: or, a Discourse of Forest-Trees, and the Propagation of Timber in His Majesty's Dominions*: (taken from the unabridged republication of the 5th limited facsimile edition, 1979. Stobart and Son Ltd., London.
- Hayes, S. 1794. *The practical Essay on Planting, and the Management of Woods and Coppices*. William Sleater, Dame St., Dublin.
- Lawson, 1597. Quoted in Evelyn (1662): *Silva: or, a Discourse of Forest-Trees, And the Propagation of Timber in His Majesty's Dominions* (No publishers details).
- Main, J. 1839. *The Forest Planter and Pruner's Assistant*. Being A Practical Treatise on the Management of the Native and Exotic Forest Trees. W. Blatch, Brompton, London.
- Nicol, W. 1820. *The Planter's Kalendar; or the Nurseryman's & Forester's Guide*, (1st edition 1812). Archibald Constable and Company, Edinburgh.
- Pinchot, G. 1910. *The Fight For Conservation*. Doubleday, Page and Co., New York.
- Pontey, W. 1808. *The Forest Pruner; or Timber Owner's Assistant*, (2nd edition). A treatise on the training or management of British Timber Trees; whether intended for Use, Ornament, or Shelter. Printed for the Author by T. Smart, Huddersfield, England.
- Shigo, A. L., 1989. *A New Tree Biology*. Shigo and Trees Associates, 4 Denbow Road, Durham, New Hampshire 03824.