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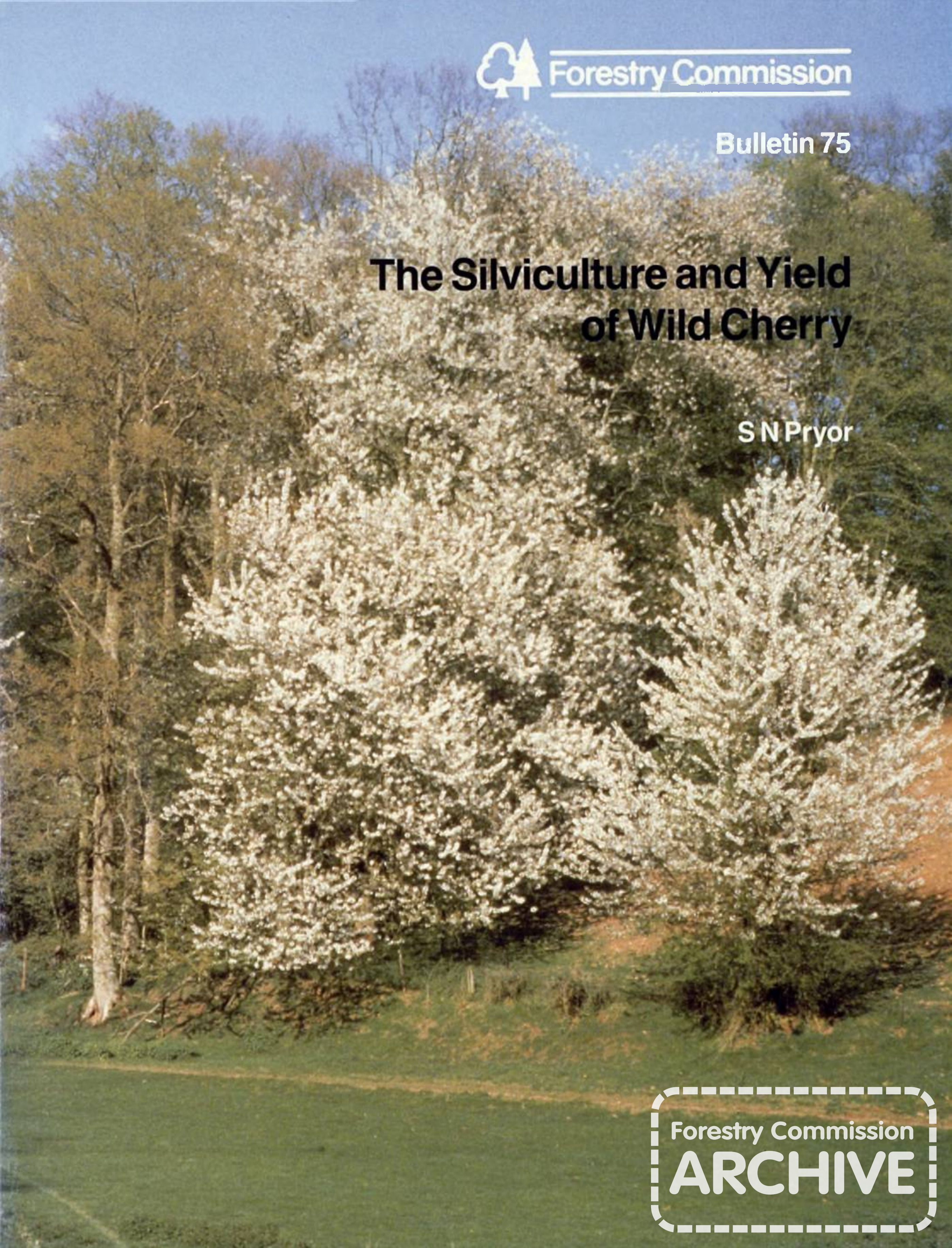

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The Silviculture and Yield of Wild Cherry

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FRONT COVER:

'Lovliest of trees, the cherry now
Is hung with bloom along the bough
And stands about the woodland ride
Wearing white for Eastertide.'

From 'A Shropshire Lad' by A. E. Housman, 1896.

Contents

The Silviculture and Yield of Wild Cherry

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Summary

The silvicultural characteristics of *Prunus avium* L. are described, based on a study in which over 40 stands throughout Britain were visited. Cherry naturally regenerates freely, and is rapid to establish when planted. Exposed sites should be avoided; shallow and poorly-drained soils give poor growth. Cherry is immune to damage by the grey squirrel but is very susceptible to browsing and fraying by deer. Pruning and heavy regular thinnings are recommended. Height and diameter growth is rapid, volume yield is high, and rotations of 65-75 years are feasible. Three yield tables have been produced from growth functions, with maximum mean annual increment values of 4.9–9.1 m^3 ha^{-1}. The attractive timber has good working properties and is much in demand. Heart-rot and green stain are the most serious timber defects.

Introduction

Interest in cherry as a forest species, in addition to its role as an amenity species, has increased in the last decade. This interest has been stimulated by the high value of the timber and by the observation that, in the first part of its life at least, cherry can grow very fast. Despite this interest, and the increasing amount of cherry being planted, knowledge of the silvicultural characteristics of the species is limited. Published accounts are confined to a small number of continental papers and there are no indications of the yields that can be obtained. A study of the silvicultural characteristics and potential yield of this species was therefore carried out by the author during 1983-84.

The first problem was finding enough stands of even-aged cherry as most areas of cherry are mixed, uneven-aged stands, or avenue and perimeter plantings. Over 40 stands, both planted and natural, were eventually located and visited. This is probably a high proportion of the total number of such uniform stands of cherry in Britain. Mensurational data were recorded at each site: height, diameter, stocking and stand volume. Site characteristics – topography, soil type and vegetation – were also assessed. This information, along with comments from owners, managers, and timber merchants, has been combined with previously published information to produce the following account of cherry.

Biology

Taxonomy

The genus *Prunus* (Rosaceae) contains several native species, many introduced ornamental species, and the parents of many commercially important cultivars, including plums, almonds and fruiting cherries. *Prunus avium* L. is normally called the wild cherry or gean, but is also known as the mazzard or merry tree. The name bird cherry, somewhat confusingly, is normally reserved for *Prunus padus* L., a small tree of northern Britain. Full descriptions of the distinguishing features of *Prunus avium* are given in publications by Bean (1950) and Mitchell (1974).

Several continental authors (Hrynkiewicz-Sudnik, 1968, in Bulgaria; M'Yakushko and M'Yakushko, 1971, in the Ukraine; Beck, 1977, in Germany; and Masset, 1979, in France) describe different races and subspecies of *P. avium*, mostly distinguished on the basis of fruit colour and taste, and leaf and bark characteristics. However, no subspecies or divisions of the species are generally recognised, and in Britain, although variation has been noted, no attempt at describing subspecies has been made. One can expect the usual taxonomic complexity associated with species which can reproduce vegetatively, with reduced variation between trees within a stand or wood, but with greater differences apparent between trees in different woods.

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Distribution

The natural range of *P. avium* includes the whole of Europe as far north as Scandinavia and extends into western Asia and north Africa. It occurs naturally throughout Britain but is less common in the northern part of Scotland. It is essentially a lowland species but its regional distribution is 'strangely patchy' (Rackham, 1980). It is seldom found above 300 m in Britain, although Beck (1977) reports that it occurs as high as 1000 m in the Black Forest of Germany.

The present study was concerned with locating and measuring stands of cherry and could not extend to a survey of the natural distribution of the species in Britain. Peterken (1981) gave the frequency of occurrence of cherry in each of his stand types. This information showed that cherry was most frequently found on the calcareous sites (mostly stand groups 1–4 and 8C), which included soils which are 'light' to 'heavy' and 'dry' to 'moist'. However, it was also recorded in the stand types occurring on mildly acidic soils (8D and 3A) and in several stand types which were too acid for ash (5B, 6C, 8A and 9B). The distribution of sample stands located during this study certainly confirmed that cherry is most frequent on soils overlying calcareous parent material, particularly on the Sussex and Wiltshire Downs, the Chilterns and the Cotswolds.

In Britain cherry is typically found singly, or in small groups, scattered through mixed broadleaved woodland; and only occasionally does it become the dominant tree over larger areas. In Belgium it was seen in exactly the same situations. It is noticeable in this country, and in Belgium (Thill, 1975), that cherry is very frequently found on the wood margins. Rackham (1980) suggests that this may be due to the slightly more favourable soil conditions which are found on the banks at the boundaries of the wood. But the woodmen of the past, as much as the planners of today, must have valued its beautiful blossom and may thus have spared, or even encouraged, such marginal trees. The higher light intensity at woodland edges would also aid the establishment of this light demanding species. Cherry is surprisingly uncommon as a hedgerow tree, considering its suckering habit and its attractive blossom.

Cherry has occasionally been planted, especially from the 1950s onwards, and plantations can be found in most regions of Britain. They were usually planted for amenity reasons, and tend to be small (less than a hectare) and prominently situated in the landscape. Although its timber has long been recognised as useful and valuable, until recently it has only rarely been planted with timber production as the main aim.

Establishment

Natural regeneration

Cherry trees start flowering and setting viable fruit at an early age, often under 10 years old, and good seed crops occur every 1 to 3 years (Gordon and Rowe, 1982). The seed is disseminated by birds, especially blackbirds, thrushes, starlings and jays. Turcek (1968) studied the spread of seed from an individual tree and found that the vast majority of seed remained within 50 m of the parent tree. A small proportion is obviously taken much further and hence cherry has been called the 'wandering tree'. Seeds usually lie dormant for 9 to 12 months before germinating. Beck (1977) suggests that this dormancy is induced by blastocoline released from the fruit flesh left on the stone. He reports the natural germination percentage to be 30–50 per cent, but Gordon and Rowe (1982) give the germination percentage in nursery conditions as 77 per cent.

Thill (1975) and Beck (1977) state that cherry coppices well, but in the stands visited coppice stools and shoots were noticeably infrequent. It obviously can produce shoots and was occasionally seen to do so in abundance. It may be that size of stump or the time of year of cutting is critical, or simply that coppice shoots normally die rapidly through shading and browsing.

Cherry is renowned for its capacity to produce sucker shoots and, as Evelyn (1679) notes, it is "apt to put forth from the roots ... especially if you fell lusty trees". The crops of natural regeneration that were seen appeared to be a mixture of seedlings and suckers, but without uprooting all the plants the relative importance of these two methods of regeneration could not be assessed. Garfitt (1983) suggests that crops of cherry could be established by planting 30–120 mother trees per hectare and waiting 15 years, by which time a complete crop of straight, clean suckers will have become established. Although suckers were observed up to 10 m from a parent, such a spread in this short period of time could not be relied upon. At several sites where mature cherries had recently been felled the number of suckers which appeared was disappointing; certainly more research is needed on the factors which stimulate suckering.

Seedlings and suckers are relatively shade tolerant for their first few years. In fact, providing there is some side-light, saplings and even poles will often continue to grow straight up into the crown of over-topping trees. However, height growth rates are impeded, and any overstorey should ideally be removed when the natural regeneration is 3 to 5 years old.

Natural regeneration often tends to be unevenly distributed, but seedlings and suckers can be transplanted in the forest, preferably when they are less than 1 m tall. Two fine stands at Ugley, Bishops Stortford, were seen which had been established in this manner. It was also noticeable in many stands that cherry seedlings and/or suckers were less frequent directly under the cherry canopy, tending to be much more numerous under the canopy of other adjacent hardwood species and in nearby open areas.

Seed source and vegetative propagation

Most of the cherry seed used in Britain in recent years has come from the Continent. However, cherry is not subject to the EEC regulations on the registration of seed stands. There is thus no guarantee of the origin of the seed used by nurseries, and given that most plantings are considered to be for 'amenity', timber quality and stem form are unlikely to have been amongst the selection criteria for seed stands. Freedom of the seed stand from infection by seed-borne viruses would also be desirable, but at present is not enforced. In an attempt to improve this situation several stands have been selected which are, phenotypically at least, above average. In conjunction with the Forestry Commission and the Department of Forestry, University College of North Wales, Bangor, seed has been collected from these stands.

Workers at Orléans, France, have had some success in vegetatively propagating cherry (Riffaud, 1980; Cornu and Chaix, 1982). *In vitro* bud culture was found to be the most successful technique. However, in the immediate future we must rely on seed and it is therefore essential to improve the quality of our own seed sources.

Planting

Cherry's strong apical dominance and relatively weak phototropic tendencies, result in a high proportion of the planted stems developing and retaining a single straight leader. Initial stocking can therefore be lower than is usually recommended for other broadleaves and spacings as wide as 3 x 3 m (110 per ha) are probably sufficient to provide a full stocking of potentially good stems. However, such wide spacing does lead to heavy branching, and pruning is essential. Where cherry is planted on old woodland sites coppice regrowth and hardwood natural regeneration can be allowed to form a matrix nurse around the widely spaced cherries. The cherry will usually grow sufficiently fast to avoid being smothered by the coppice, and the competition prevents heavy branching and promotes the growth of a vigorous leader.

Both the take and early growth of planted cherry is generally well above average for hardwoods, thereby making it a cheap crop to establish. This vigour also makes it a useful species with which to beat-up plantations of other hardwoods as it will usually catch up with the older trees, and not prolong the weeding period.

Cherry transplants are particularly sensitive to weed competition and Davies (1984, 1987) has shown that full weed control can more than double early height growth. Careful weeding, and hence good height growth, in the first 2 years will often make subsequent weed control unnecessary.

An underplanting and establishment experiment, set up by the author, produced the following information on the early growth of cherry transplants. Firstly, the cherry was taller and had a greater basal diameter after two growing seasons than any of the other species (oak, beech and ash). Secondly, cherry was very shade tolerant and unlike all the other species showed no reduction in height growth, even under an oak canopy with a basal area of $18\,m^2\,ha^{-1}$. Thirdly, cherry showed a good response to tree shelters with a four-fold increase in height growth. Tuley (1983) similarly found excellent growth of cherry in shelters. In fact, cherry transplants are normally out of the top of 1.2 m shelters at the end of the first growing season. However, as the growth of cherry unprotected by shelters is very rapid anyway, many growers consider shelters unnecessary for this species. In areas with a high deer population, however, shelters are desirable for protection rather than for the stimulation of growth.

Stand Treatment and Silvicultural Characteristics

Pruning

Cherry is unusual amongst broadleaved species in having most of its side branches arranged in annual whorls. Although these branches soon die when shaded, they are retained for many years after their death. Not only does this result in dead knots being incorporated into the timber, but it also probably contributes to the formation of the nodal swellings which are often seen on cherry stems. If high quality timber is to be produced, then pruning of final crop trees is essential. This should be done to at least 5 m in two or three stages.

Once branches are large enough to contain heartwood, their removal or death will give decay fungi direct access to the heartwood of the tree. Branches should therefore be removed before they contain heartwood, which usually means when less than 3 cm in diameter. The resulting small wounds will heal fairly rapidly. Thill (personal communication) suggests that gum secretion will be minimised by waiting until the branches have died, through shading, before removing them. Unless stands are very dense this will usually mean that the branches have become too large and will contain heartwood.

Epicormic shoots are infrequent on cherry, but if an over-dense crop of cherry is heavily thinned, epicormic shoots will often appear. Provided a crop is reasonably well thinned, pruning will be needed no more than two or three times in its life. If only about 200 final-crop trees per hectare are pruned, then it is obviously only a small financial investment, yet it will usually more than double the value of the final crop of timber.

Thinning

Although young cherry trees are shade tolerant, the species is essentially a 'pioneer', and becomes much more light-demanding with age. It is particularly intolerant of lateral competition and in unthinned stands diameter growth is severely restricted, and the crowns of even the dominants suffer dieback. Recovery of the crowns from such suppression is fairly rapid in younger stands, but in stands over 40 years old it is slow and often only partial. Thinnings should therefore be sufficiently heavy and regular to ensure that the crowns of the final crop trees are unimpeded, and will remain so until the next thinning.

Cherry is a short-lived tree, and liability to windthrow and heart-rot increase markedly with age. Heavy thinnings are recommended to enable large diameters to be produced as soon as possible. Under-thinning can result in dieback of both roots and crowns, and leads to longer rotations, all of which increase the likelihood of heart-rot. For cherry, a very good relationship was found between the diameter of a tree's crown and the diameter of its stem at breast height (see Figure 1). Dawkins (1963) has shown that such a good linear relationship is typical of 'intolerant' or light-demanding species, and that a more shade-tolerant species would not show such a clear relationship. The practical meaning of this is that if, by contact with neighbouring crowns, a tree's crown is limited in size, then the diameter of its stem will be correspondingly restricted.

The equation given in Figure 1, relating stem and crown diameters, can be used to calculate the expected crown diameter for any given stem diameter. Alternatively if stand mean diameter is known, then stand mean crown diameter can be predicted. The number of stems per hectare corresponding to various levels of canopy closure percentage can then be estimated. These are presented for a range of stand mean diameters in Table 1. In order to obtain good diameter growth it is suggested that the stocking is never allowed to rise above the values corresponding to 100 per cent canopy closure. If a

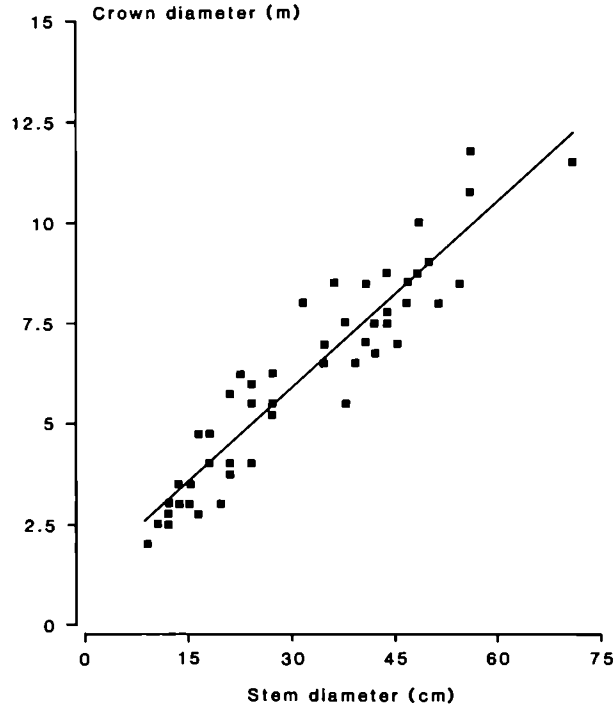

Figure 1. Graph of crown diameter (Dk) against stem diameter (dbh).
Regression line is: $Dk = 1.19 + 0.158 \times dbh$; $R^2 = 0.88$.

Table 1. Estimated numbers per hectare for a range of stand mean diameters and percentage canopy closures. Mean crown diameter is calculated by entering mean steam diameter into the equation presented in Figure 1. Estimated number per hectare is equal to $((CC/100) \times 10\,000) \div (\pi/4 \times Dk^2)$, where CC is percentage canopy closure, and Dk is mean crown diameter in metres.

Mean stem diameter (cm)	Mean crown diameter (cm)	Numbers per hectare at % canopy closure of: 100%	90%	80%	70%	60%
10	2.8	1624	1462	1299	1137	974
15	3.6	982	884	786	687	589
20	4.3	689	620	551	482	413
25	5.1	490	441	392	343	294
30	5.9	366	329	293	256	220
35	6.7	284	256	227	199	170
40	7.5	226	203	181	158	136
45	8.3	185	167	148	130	111
50	9.1	154	139	123	108	92

thinning cycle over 6 years is used, then thinnings will have to be very heavy. This may mean reducing the canopy closure to below 70 per cent; there will then be a noticeable loss of total volume production.

Mixtures

Cherry, being frost hardy and growing very rapidly in the first few years after planting, does not need a conifer nurse for shelter, nor for weed suppression. In addition, the rotation length for cherry need only be 10 years longer than the rotation length for most conifers. A conifer nurse is therefore not as appropriate to cherry as it might be to other broadleaved species. In fact, cherry is probably better used as an early-maturing component itself, in mixture with other broadleaved species.

If a conifer is required in mixture with cherry, then it should be carefully chosen. Cherry, as a strong light-demander, would be particularly sensitive to the neglect of the thinnings, resulting in crown dieback and poor girth increment. Comparison of the height growth of cherry and conifers shows that although cherry will keep up well with even the fastest growing crops early on, it will usually be overtaken after 40 years. However, the height growth of cherry and larch are usually well matched, at least up to around 50 years, at which date the larch should be removed. Nevertheless, both species are light demanding, and in several mixed stands thinnings had not been sufficiently heavy or regular and consequently the crowns of both components had suffered. A less aggressive, more shade-tolerant and narrow-crowned conifer such as *Thuja* would give a more satisfactory and 'robust' mixture in which delayed thinnings would cause less damage and loss of diameter increment.

Considering hardwood mixtures, several stands showed that cherry will keep ahead of oak in height growth throughout the rotation and the oak will suffer unless the crop is well thinned. Beck (1977) warns against cherry being suppressed when in mixture with beech, but mixed stands seen in the Chilterns and a comparison of the height growth curves suggest that this is unlikely to occur earlier than 60 years. Mixtures of cherry and ash appeared to be the most appropriate, with the majority of the cherry being removed before clear felling of the ash. Their height growth is usually similar, but, as with larch, both are light-demanding species and thinnings must be fairly heavy and not delayed.

Otter (1954) also recommends mixtures with sycamore and birch, and these are unlikely to over-top the cherry. If a two-storeyed forest is desired, Otter recommends under-planting cherry with hornbeam, beech or small-leaved lime. The only examples of under-planting seen in Britain were with western red cedar and grand fir, both of which were growing well under a moderately dense canopy. However, the only justification for such an understorey is the potentially increased total productivity, as cherry, unlike oak, does not need additional shading to kill lower branches and prevent epicormics.

Site and soil requirements

A range of site and soil characteristics was assessed at each of the sites visited. When combined with the height/age data, this information gives some indication of the site requirements for cherry. A full multivariate analysis was not deemed worthwhile given the limited information and the small number of sites available. Possible links between soil type and timber quality are discussed in a later section.

All sites visited lay between 50 and 250 m altitude and, within this range there was no noticeable effect of altitude alone. Further evidence would be needed before recommending the planting of cherry above 300 m in Britain. Evidence from several sites indicated that cherry does not grow well on exposed sites. Affected stands showed very one-sided crowns and stunted height growth. In older stands, even if only moderately exposed, leaning and windblown trees were frequent, especially on shallow soils.

Soil depth, as indicated by rooting depth and depth to parent material or C horizon, was found to be the most significant site factor. Poor growth was recorded on all soils where little-changed parent material was found within 40 cm of the soil surface. This included shallow brown earths formed on sandstone and shallow calcimorphic soils developed in thin drift layers overlying chalk. In contrast, the best growth was recorded from deep soils which had developed in thicker layers of drift overlying chalk or limestone. Soils developed on colluvium at the base of slopes also showed very good growth. Although cherry is renowned as a superficially rooting tree, like ash it seems to need a deep and moist soil for good growth. Beck (1977), however, suggests that good growth could be achieved on shallow soils if the right genetic 'type' could be found.

It was somewhat surprising to find that more than two-thirds of the sites were on silty clay loams, silty clays and clay loams, and that such heavy soils produced some of the best growth rates. However, in all cases the material underlying the drift or alluvium was permeable and usually calcareous; the soil, though heavy, was therefore fairly freely draining. Cherry was not found growing on any soils which showed signs of gleying in the top 50 cm. Only a few silt loams and sandy soils were encountered and at these sites the cherry was growing slowly. D. Mercer (personal communication) also reported poor growth on Greensand and gravels. This may have been a result of the soil being shallow rather than being light in texture, as both Beck (1977) and Bornand (1973) report good growth of cherry on sandy soils.

Soil pH varied more widely than expected, being in the range four to seven. However, there was no clear relationship between rate of growth and soil pH. Both Beck (1977) and Bornand (1973) state that cherry can grow on both calcareous soils and moderately acid sands, but that it prefers calcareous sites. This view is not fully supported by this study, where some of the fastest growth occurred on acid (pH 4.0 to 5.0) clays. It was noticeable, however, that most sites with acidic upper horizons had mull humus and were overlying calcareous material. Insufficient sites on acid or podsolised soils were seen for any firm evidence of the performance of cherry on such soils to be gained.

The soil types shown by this study to be particularly suitable for cherry were thus deep clay loams over chalk or limestone, and deep flushed soils on lower valley slopes. This was confirmed by Mercer (personal communication), who has observed very good growth on clay-over-chalk, and Masset (1979) who similarly recommends well-drained clay-with-flints in France. Thill (1975) compared the soil requirements of cherry and ash; he concluded that they are very similar, but that cherry is less tolerant of dry sites and more tolerant of heavier soils. This seems to have been generally supported by the current work. Better information on the performance of cherry on other site and soil types will not be available until the large number of recent plantings have reached a useful age.

Pests and Diseases

Pests

Cherry is renowned for not being damaged by grey squirrels (Rowe, personal communication), and throughout this study not a single tree was seen which had definite evidence of damage to stem or crown. This immunity has been widely attributed to the fact that the bark peels horizontally; but it seems likely that other factors, such as the composition of the bark and sap, are involved.

Deer are the most serious impediment to the establishment of cherry. Fallow, roe and muntjac all find the foliage highly palatable, and also very frequently cause severe damage by fraying cherry saplings. Culling, fencing, or individual tree protection is thus essential if the deer population is high. Natural regeneration normally escapes damage, but should only be respaced when it has got above deer browsing height. Damaged trees seldom die, and if necessary can be cut back to ground level to encourage the production of a new vigorous leading shoot ('stumping back'). Rabbits and hares also frequently damage unprotected whips and transplants and, if populations are high, spiral guards or tree shelters are essential.

The only insect pest damage noted on cherry was leaf curl and shoot distortion caused by the cherry blackfly, *Myzus cerasi*. Severe infestations can result in death of the terminal bud in the early years after planting. Such dieback is thought to have been the cause of the fairly high proportion (25 per cent) of forked stems found at some sites (notably Ditchley, Oxford, and Ecclefechan, Dumfries).

Diseases

Canker, caused by the bacterium *Pseudomonas syringae* pv. *mors-prunorum*, can become a problem in planted cherry trees. The bacteria overwinter in cankerous lesions on young twigs and branches. These cankers extend in the spring, as bacterial activity increases, and gum frequently oozes from areas of bark subsequently killed. Dieback of shoots usually occurs, and if the main stem is girdled the whole tree may die. The bacteria die out in the cankers in early summer but by then leaves are usually infected, resulting in dark spots and 'shot-holes' in the foliage. Similar symptoms can be caused by some viruses. In the autumn, woody growth is re-infected, usually via leaf-scars. Wounds will also facilitate infection and pruning should be done in June–August when infection of woody material is least likely. Once the bacteria are present in a stand some control can be effected by removal of infected branches, or even whole trees. It was noticeable that canker was not present in most stands seen. The only stands in which canker was prevalent were those on shallow soils and D. Mercer (personal communication) confirms this observation. However, when considering orchard cherries, there is 'slight evidence' that canker is more frequent in orchards on deep, well-drained soils (MAFF, 1980). Because of the increased planting of cherry in the recent past, the incidence of bacterial canker has become more apparent. In certain years, when weather conditions are conducive to canker development, damage could become locally serious.

Witches' brooms are often seen on cherry and occasionally they become so frequent and large that they dominate a tree's crown. These are caused by a fungus, *Taphrina cerasi* (Fckl.) Sadeb. (Peace, 1962), which appears to be specific to cherry. Although disfiguring, they are seldom of economic importance.

Silver leaf, caused by *Chondrostereum purpureum* (Pers. ex Fr.) Pouz., is a major fungal disease of fruit orchards but is not likely to become a problem in the forest. To minimise the chances of infection of wounds, pruning should be done between May and mid-July (Brown, 1972).

Killing of roots by *Phytophthora* spp. is quite common on waterlogged soils (Strouts, 1981). Root rotting fungi are discussed in the next section.

Ornamental and fruiting cherries are known to be hosts to numerous viruses (USDA, 1976). These frequently impede growth, cause leaf damage, and can even kill whole trees. Most of these viruses are known to have several hosts; for example, cherry leaf roll virus also infects birch, walnut, elm and alder (Cooper and Atkinson, 1975). Many are transmitted via pollen and seed. In a recent examination of several seedlots from Europe and the USSR, Cooper and Edwards (unpublished) found an average of 34 per cent of seed to be infected with prune dwarf virus. The horticultural industry takes considerable care to ensure that mother stock is free of virus infection, and the use of infected stock in forestry plantings near stone fruit orchards could have serious consequences. Any seed stands, here or on the continent, should therefore be checked to ensure that they are free of seed-borne viruses.

Decay and heart-rot

Heart-rot of cherry can be economically devastating and it is more serious than any of the above diseases. The Wessex Silvicultural Group, when looking at cherry in 1971–72, concluded that it was often a race to get the trees to sawlog dimensions before rot became too prevalent (Darrah, personal communication).

There is very little published information on heart-rots in cherry. Masset (1979), in a survey of cherry timber quality in France, found that heart-rots were the most frequent and serious fault. Thill (1980) examined over 300 felled cherry trees in Belgium and found 39 per cent had some evidence of heart-rot. Both these authors distinguished two types of heart-rot. By far the most frequent was a 'pale' rot which seldom extended more than a metre above ground level. Comparatively rarely they found a 'brown/red' rot which, when present, often extended throughout the butt. They stated that butts with a small core of the pale rot were still saleable for veneering; in fact, several veneer merchants in France considered such heart-rot to be a sign of good, mature timber. Unfortunately the species of fungi involved in these rots were not identified.

Very little can be learned about the frequency and occurence of heart-rot without examining felled trees. In the present study this was only possible at three sites, and heart-rot was only found in one of these stands. Hardwood saw-millers and veneer merchants obviously see far more cherry butts than anyone else. A questionnaire was therefore sent to six companies who handle a large amount of the mature cherry sold in this country. The response yielded much useful information. The buyers questioned usually considered that between 15 and 20 per cent of the stems they saw were affected by heart-rot. They confirmed that a white and a brown rot can be distinguished but, in contrast to the continental studies, they generally reported that white rots were not necessarily the most frequent and that brown rots were quite common. They pointed out that white rots can extend a considerable distance up a stem and they are therefore reluctant to buy logs which contain any rot unless they have been 'sounded-off'.

The one stand examined in this study in which heart-rot was found was at Fringford, Buckinghamshire, where a stand of semi-mature cherry had been windblown; 18 out of 34 trees showed evidence of heart-rot. Four types of rot were found; these were cultured and identified by D.K. Barrett of the Oxford Forestry Institute. Three of the rots were white rots and one a brown cubical rot. The white rots included those caused by the fungi *Armillaria mellea* (Vahl. ex Fr.) and *Heterobasidion annosum* (Fr.) Bref., and the brown rot was caused by *Phaeolus schweinitzii* (Fr.) Pat. *P. schweinitzii*, and a third, unidentified white rot fungus caused the most vertically extensive of these rots.

Information concerning the decay of cherry by other fungi is limited. R.G. Strouts of the Forestry Commission's Pathology Branch reports that *Armillaria* spp. have been recorded in the past as the cause of death of individual cherry trees. Phillips and Burdekin (1983) refer to infections of cherry by *Laetiporus sulphureus* (Bull. ex Fr.) Murr., and this could be responsible for some of the brown rots found in cherry stems.

It is likely that some of these fungi, such as *H. annosum* and *P. schweinitzii*, enter through the roots. Other species, such as *L. sulphureus*, can cause top-rots and could enter through wounds in the aerial part of the tree.

British merchants did not report any clear association between frequency of rot and particular site or soil types. However, Masset (1979) found that all merchants in France agreed that brown heart-rots were more frequent on waterlogged and compacted soils. He also suggested that both types of rot occur earlier on shallow soils overlying chalk. D. Mercer (personal communication) also reports that severe rot is more likely on compacted and shallow soils, and less common on calcareous clays. This is presumably because soils which are shallow, or liable to waterlogging, can often cause dieback of both crown and roots. The liability of cherry to windthrow was also observed to be highest on such sites and is presumably partly a consequence of root decay.

Heavy and regular thinnings prevent intense competition and consequent dieback and may therefore reduce the risk of decay developing. Such management will also shorten the rotation length and thereby avoid the senile phase in which decay usually becomes prevalent. The chances of infection by some decay fungi can also be reduced by carrying out pruning while the branches removed are small and able to callus over quickly.

It is thus felt that although heart-rot is a serious problem, careful site selection, heavy and regular thinning, and early pruning, should reduce its incidence to acceptable levels.

Timber Quality

Markets for cherry timber

As with other high quality hardwoods the demand for cherry is to some extent determined by fashion, and fluctuations in the market have occurred in the past. However, almost every published reference to cherry since the First World War has commented that the demand for this timber greatly exceeds the supply. In recent years demand has been comparatively stable compared with some other hardwoods.

The early thinnings are marketable as firewood as cherry splits easily and burns well, with a pleasant smell. It is also acceptable for hardwood pulp. Cherry is a desirable species for commercial turnery and this provides a slightly more attractive market for second and later thinnings.

Most of the sawn timber goes into the furniture trade and surprisingly small sizes are acceptable: down to 24 cm top diameter, fetching around £45 per cubic metre at roadside in 1987. Planking logs generally have a mid diameter greater than 35 cm and prices range from £65 to £120 per cubic metre depending on size, form and colour. Veneer logs are usually over 45 cm mid diameter but slightly smaller logs are occasionally accepted. They must be at least 2.7 m long, free of all defects, and of a desirable colour. Price increases with diameter and quality, and is usually in the range £120–£200 per cubic metre although sums in excess of £400 per cubic metre have been paid for exceptional butts.

Timber quality and defects

As with most hardwoods, cherry timber is liable to various defects which adversely affect its value. Unfortunately, in this study only a limited amount of felled timber could be examined. It was therefore not possible to investigate the frequency and causes of these defects, but the views of sawmillers and veneer merchants were again very informative. Masset (1979) gives a detailed account of cherry timber quality in France.

Most defects simply result in the log being degraded from veneer to sawlog quality, with a related drop in price. But extensive heart-rot and spiral grain will degrade a log to mining timber or even firewood. The sapwood of cherry is normally fairly narrow – less than 20 per cent of the diameter – but if it is unusually wide, for example on open-grown trees, then buyers may raise their size specifications for both veneer and sawlogs. A few small branches and 'pin knots' are usually acceptable in sawlogs, but prime planking and veneer logs must be entirely free of knots and other blemishes and irregularities in the bark.

The colour of the timber is important, with rich pink being the most desirable shade for veneering. Colour is not so important in sawlogs as furniture components are often stained, although homogeneity of colour is still important. Otter (1954) mentions a bluish stain, but a green discoloration, often termed 'green lines', is the most serious colour defect. The green stain tends to occur in the earlywood of wide rings, and not only is this considered unattractive but it also causes buckling of veneer sheets and warping of planks during seasoning. However, it does appear that careful seasoning and storage of planks and veneers can improve the colour and minimise the warping. Estimates from merchants of the proportion of stems affected varied from 'often 100 per cent' to 'not very common'; but the majority suggested that 50–70 per cent of stems were affected. Masset (1979) reported that in France 20–25 per cent of timber is affected by this stain. Affected butts are not acceptable for veneer, and if the stain is severe and extensive it will decrease the value of sawlogs. Masset considered it to be more frequent in the paler timber which is produced on poorly-drained clay/marl soils. There is some evidence to support this in Britain, and one buyer reported it to be more marked in fast-grown trees.

Narrow rings (1.5–4 mm) are usually more desirable for veneering but much wider rings are quite acceptable for planking. Tension wood (in leaning trees), and tortuous or spiral grain, can degrade a log. Masset (1979) claims that spiral grain is common in cherry, but British merchants did not confirm this finding. Sapwood blisters ('oysters') and resin pockets (from occluded wounds) are a frequent reason for degrade in this country. Many cherry butts are irregular or quadrilateral in shape, but this was not suggested as a problem by British veneer buyers and was in fact considered by many French buyers as a desirable feature (Masset, 1979).

Timber properties

Cherry wood is recorded as having been popular with furniture-makers for several centuries (Rackham, 1981; Beck, 1977), and the furniture trade is still the main user of the timber. The physical properties of cherry timber recorded at the former Princes Risborough Laboratory of the Building Research Establishment are listed in Farmer (1972). The heartwood is generally pink-brown in colour, darkening slightly with age. Part of the appeal of cherry to furniture-makers and restorers is that, with alkaline treatment, it can be made to look very similar to mahogany. Sawn timber must be seasoned carefully, preferably weighted, as it has a pronounced tendency to warp. However, once dried it is fairly stable. The density is 600 kg per cubic metre at 12 per cent moisture content and it is a very strong timber, being only slightly weaker than beech. It is moderately hard with a fine even texture and it works easily to give a very good finish. It has very good wood-bending properties and it takes most finishes and stains very well. The durability of even the heartwood is only moderate outside, but indoors it has been known to last centuries.

It thus seems to be not only a very attractive timber but also thoroughly serviceable; and as Arkwright (1969) says, "the chief drawback of the timber . . . is that it is not more readily available". With hardwood logs from the tropics almost certain to become more difficult to obtain in the future, we can be fairly confident that the demand for such fine home-grown hardwoods will continue to increase.

Given cherry's good strength and working properties, then, even if it does become less fashionable as a decorative veneer in the future, there should still be plenty of other uses for this timber.

Volume and Yield

In an attempt to remedy the lack of information on the potential yield of cherry a mensurational study was carried out. The main focus was on the growth of stands and the production of a yield model, but individual tree volume tables and a free-growth model were also produced. Only a brief outline of the method of yield model construction is given here; readers are referred to Pryor (1985a) for full details. The fact that only a small number of pure stands of cherry could be located was a major limiting factor in this study.The tables and yield models produced from this sample should therefore be treated as preliminary estimates only.

Tree volume tables

The volumes of 252 standing cherry trees were measured using a 'telerelaskop' (Bitterlich, undated). These were predominantly trees growing in stands but also included isolated and avenue trees.

For each tree, diameter at breast height, total height and timber height (height to the spring of the crown) were recorded, and for trees in stands, top height (average height of the 100 'fattest' trees per hectare) was also recorded. These data were analysed by a multi-linear regression program, written by H. Wright, to produce volume functions based respectively on dbh with total height, dbh with timber height and dbh with top height.

The most useful predictor variables for practical forestry are dbh and timber height, but only 82 of the larger trees had a recognisable timber height. For this data set the following logarithmic function gave the best fit (using Furnival's Index as an indicator of 'best fit'):

$$\ln(v) = -8.821 + 2.131 \ln(d) + 0.4723 \ln(h)$$
$$R^2 = 0.978$$

where
v = tree volume to 7 cm top diameter in cubic metres
d = diameter at breast height (1.3 m) in centimetres
h = timber height in metres.

The volume table derived from this function is given in Table 2 and this can be used in a similar manner to the 'Single Tree Alignment Charts' of Hamilton (1975), although in this case volume is read directly rather than via tariff tables.

Bark

Cherry has a noticeably thin bark when young, and even when mature is not as rugose as that of either ash or oak. Using the felled stems which were available, 98 estimates of bark thickness were made. These included measurements on a full range of stem diameters and at all positions along the stem. A linear regression of double bark thickness (twice the average bark thickness) on stem diameter was found to be the best predictive function:

$$db = 0.367 + 0.0353 \times d \qquad R^2 = 0.8$$

where
db = double bark thickness in centimetres
d = stem diameter in centimetres.

Table 2. Single tree volume table for cherry. By entering dbh in centimetres and timber height in metres, the stem volume in cubic metres can be read off. The lines drawn on the table show the range of the sample of trees; the use of figures outside these limits is not recommended.

	Timber height (m)						
dbh (cm)	8.0	10.0	12.0	14.0	16.0	18.0	20.0
10.00	0.053	0.059	0.064	0.069	0.074	0.078	0.082
12.00	0.079	0.087	0.095	0.102	0.109	0.115	0.121
14.00	0.109	0.121	0.132	0.142	0.151	0.160	0.168
16.00	0.145	0.161	0.176	0.189	0.201	0.213	0.223
18.00	0.186	0.207	0.226	0.243	0.258	0.273	0.287
20.00	0.233	0.259	0.282	0.304	0.323	0.342	0.359
22.00	0.286	0.317	0.346	0.372	0.396	0.419	0.440
24.00	0.344	0.382	0.416	0.448	0.477	0.504	0.530
26.00	0.408	0.453	0.494	0.531	0.566	0.598	0.629
28.00	0.478	0.531	0.578	0.622	0.663	0.700	0.736
30.00	0.553	0.615	0.670	0.721	0.767	0.811	0.853
32.00	0.635	0.705	0.769	0.827	0.881	0.931	0.978
34.00	0.722	0.803	0.875	0.941	1.002	1.059	1.113
36.00	0.816	0.906	0.988	1.063	1.132	1.196	1.258
38.00	0.915	1.017	1.109	1.192	1.270	1.343	1.411
40.00	1.021	1.135	1.237	1.330	1.417	1.498	1.574
42.00	1.133	1.259	1.372	1.476	1.572	1.662	1.746
44.00	1.251	1.390	1.515	1.629	1.736	1.835	1.928
46.00	1.375	1.528	1.666	1.791	1.908	2.017	2.120
48.00	1.506	1.673	1.824	1.961	2.089	2.209	2.321
50.00	1.643	1.825	1.989	2.140	2.279	2.409	2.532
52.00	1.736	1.984	2.163	2.326	2.478	2.619	2.753
54.00	1.935	2.150	2.344	2.521	2.685	2.839	2.983
56.00	2.091	2.324	2.533	2.724	2.901	3.067	3.224
58.00	2.254	2.504	2.729	2.935	3.127	3.305	3.474
60.00	2.422	2.692	2.934	3.155	3.361	3.553	3.734
62.00	2.598	2.387	3.146	3.384	3.604	3.810	4.004
64.00	2.780	3.089	3.366	3.620	3.856	4.077	4.285
66.00	2.968	3.298	3.594	3.866	4.117	4.353	4.575
68.00	3.163	3.514	3.830	4.120	4.388	4.639	4.876
70.00	3.364	3.738	4.074	4.382	4.667	4.934	5.186

No appreciable increase in the goodness of fit was obtained by including either dbh or height up the stem as additional predictor variables.

Values of double bark thickness predicted using this equation are given in Table 3. The final column, 'Sectional area %' can be used as a multiplier to convert overbark volumes to underbark volumes. Comparison with the bark thicknesses presented by Hamilton (1975) for other hardwoods confirms that within the range of the data (diameters between 10 and 50 cm), the bark of cherry is very similar in thickness to that of ash.

Table 3. Predicted values of double bark thickness, calculated using the regression equation in the text, for a range of diameters. 'Double bark %' is double bark thickness as a percentage of overbark diameter; that is, the percentage by which overbark diameter must be reduced to give underbark diameter (column 4). The 'Sectional area %' is underbark cross-sectional area divided by overbark cross-sectional area, expressed as a percentage.

Overbark stem diameter (cm)	Double-bark thickness (cm)	Double bark %	Underbark stem diameter (cm)	Sectional area %
5	0.5	11	4.5	81
10	0.7	7	9.3	86
15	0.9	6	14.1	88
20	1.1	5	18.9	89
25	1.3	5	23.7	90
30	1.4	5	28.6	91
35	1.6	5	33.4	91
40	1.8	4	38.2	91
45	2.0	4	43.0	91
50	2.1	4	47.9	92

Top height/age curves

Top height/age data were obtained from 38 stands. Measurements of top height at an earlier date were only available for 10 of these sites. This precluded the use of the very efficient techniques of 'nested regression analysis' (as used by Kilpatrick and Savill, 1981) for the fitting of height/age curves.

Producing height/age curves from temporary sample plot data alone is potentially unreliable, and subjective 'harmonised' and 'proportional' curves have often been constructed. The initial approach in this case was to fit a single exponential curve to all the data. The parameters of this curve were then modified to try to produce either a polymorphic, or an anamorphic, family of curves. Unfortunately this did not prove possible and was also considered to be unsatisfactory as the values of the parameters had to be chosen subjectively.

The following method (similar to that used by Carmean, 1972) was therefore used, by which the data are divided into 'site classes' and separate curves fitted to each class. Initially a single curve was fitted to all the data. This 'average' curve was then used to divide the data into two classes: those sites lying above, and those lying below, the curve. Separate non-linear functions were then fitted to each of these sets of data producing one top height/age curve for 'better' sites and another independent curve for 'poorer' sites. In both cases an inverse exponential function gave the best fit and these curves are shown in Figure 2.

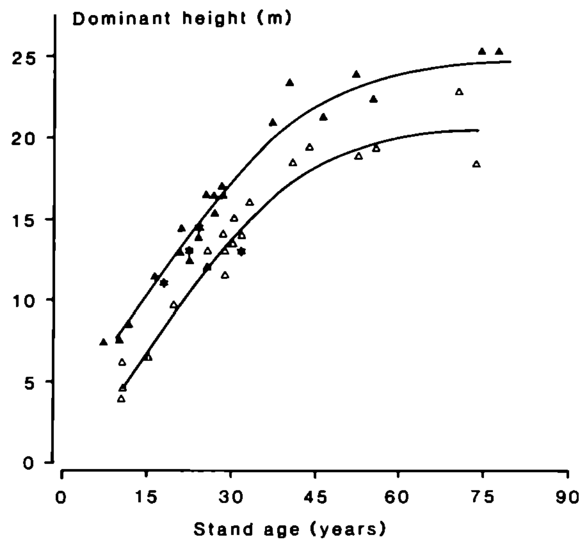

Figure 2. Top height-age data for 'good' (▲) and 'poor' (△) stands. The upper curve, fitted to the good sites, is $H = 1/(0.0402 + 0.2133 \times \exp(-0.0842 \times A))$, $R^2 = 0.97$; and the lower curve, fitted to the poor sites, is $H = 1/(0.04819 + 0.4402 \times \exp(-0.09693 \times A))$, $R^2 = 0.95$. (H = dominant height in metres; A = age in years. * represents two or more coincident points.)

Both curves reflect the very rapid height growth of cherry in the first 40 years, and in fact these rates of growth exceed those of most other broadleaves and are comparable with those of conifers of yield class 14 to 18.

The curves are, however, markedly asymptotic, as height growth tails off rapidly after 50 years and, for poor sites especially, almost ceases after 60 years.

Measurements of whorl heights were taken in many of the younger stands and these provided estimates of top height at earlier stages in the life of these stands. These measurements were used as a semi-independent data set with which to verify the height/age functions, and close agreement was found.

Mean diameter, stocking and basal area

The most difficult stand parameters to predict are stocking, mean diameter and basal area, of which obviously only two need be predicted. In this study there was no historical data available from the stands and, when combined with the variation in thinning history, this made prediction of these variables particularly difficult. Attempts to predict mean diameter directly from top height proved unsatisfactory due to the asymptotic height growth which gave a wide range of diameters for a given height later in the rotation. Age was found to be a much better predictor, and in fact diameter growth was found to be much less dependent on site fertility than expected.

The predictive functions eventually selected were multiple regressions of diameter on age and stocking, with separate functions for 'better' and 'poorer' site classes.

'good sites': $d = 3.14 + 0.375A + 2564/N \quad R^2 = 0.98$
'poor sites': $d = 34.35 + 0.442A - 10.47\ln(N) \quad R^2 = 0.95$

where
d = mean diameter in centimetres
A = stand age in years
N = number of stems per hectare.

The inclusion of stocking in these predictive functions enabled the mean diameters and basal areas to be calculated for any appropriately chosen stocking regime. Care was, however, taken to ensure that the selected stocking always lay well within the range of the data. Since most of the stands were rather under-thinned the stocking which could be selected for any given age was fairly high. The rates of diameter growth were therefore correspondingly low.

Stand volumes

For each stand of cherry assessed the volumes of between 8 and 15 trees were measured using the telerelaskop. These data were used to construct a volume/basal area line (Hummel, 1955) for each of the 25 stands, and these were then used to estimate stand volume.

The usual variables from which stand volume is predicted are basal area and top height. Several multiple regression models were tried, including weighted functions, and the following logarithmic function gave the best fit:

$$\ln(V) = -0.52 + 1.12\ln(H) + 1.011\ln(G) \quad R^2 = 0.97$$

where
V = stand volume to 7 cm top diameter, in cubic metres per hectare
H = stand top height in metres
G = basal area in square metres per hectare.

This function was used to produce the stand volume table given in Table 4 which can be used in the same way as the 'Stand Volume Alignment Charts' of Hamilton (1975).

A size assortment table was produced from an asymptotic equation, fitted by non-linear regression, which related the proportion of the volume greater than 18 cm to the stand mean dbh (Table 5).

Table 4. Stand volumes to 7 cm ($m^3\ ha^{-1}$), predicted for a range of basal areas ($m^2\ ha^{-1}$) and dominant heights (m), using stand volume function given in text. Values 'boxed-out' are outside the range of the data, and should be used with caution.

Basal area ($m^2\ ha^{-1}$)	Dominant height (m) 12	14	16	18	20	22	24
18	91	108	125	143	161	179	197
20	101	120	139	159	179	199	219
22	111	132	153	175	197	219	242
24	121	144	167	191	215	239	264
26	132	156	182	207	233	259	286
28	142	169	196	223	251	280	308
30	152	181	210	239	269	300	331
32	162	193	224	256	288	320	353
34	173	205	238	272	306	340	375
36	183	217	252	288	324	361	397
38	193	230	267	304	342	381	420

Yield tables

By combining these three basic sets of predictive functions (top height/age; mean diameter/age + stocking; volume/top height + basal area) with representative stocking regimes, then the growth of the main crop for both 'good' and 'poor' sites was predicted.

The information on thinning yields was not available and had to be estimated. The stocking regime determined the number of stems removed in each thinning. The mean diameter of the thinnings was predicted using a conventional 'diameter-ratio' (mean tree basal area before thinning divided by mean tree basal area after thinning) (see Edwards and Christie, 1981). Thinning volumes were calculated using the single tree volume function

Table 5. Predictions of the percentage of the stand volume (to 7 cm) which is greater than 18 cm top diameter limit, for a range of mean diameters. These were obtained from the following function fitted to the data:

$$\frac{v^1}{v} = 0.889 \times (1 - \exp(-0.198 \times d))^{31.6}$$

where d is the stand mean diameter in centimetres and v and v^1 the stand volume to 7 and 18 cm top diameter respectively, in $m^3\ ha^{-1}$.

Mean diameter (cm)	% volume >18 cm
15	17
17.5	33
20	48
22.5	61
25	71
27.5	78
30	82
35	86
40	88
45	89
50	89

based on diameter and stand top height. These were checked by entering the 'after thinning' main crop basal areas into the stand volume equation and subtracting this from the 'before-thinning' stand volume to give total volume removed in the thinning. The agreement between these two estimates was very close.

The completed yield tables are shown in Tables 6a and 6b. Most immediately striking are the high mean annual increment figures. The maximum value, that is yield class, for the 'good' sites is 9.1 $m^3\ ha^{-1}$ and that for the 'poor' sites is 7.9 $m^3\ ha^{-1}$. Both figures represent the average productivity of their respective sites and are strikingly high for a hardwood crop in this country.

With present markets a stand of cherry could be considered 'financially mature' when the mean dbh has exceeded 40 cm. These yield tables show that for both good and poor sites this is achieved in a rotation of about 70 years. Most of the sample stands measured had suffered under-thinning, and these yield tables therefore can only represent a light thinning regime.

Free-growth

In an attempt to learn more about the possible effect of heavier thinnings, a large sample of free- or open-grown cherry trees was measured. These included avenue trees and trees situated on compartment corners. Height growth was found, as expected, to be slightly slower, so that by 40 years free-grown trees were generally 2 m shorter than dominant trees in neighbouring stands.

A free-growth yield model was constructed, predicting both height and mean diameter directly from age. The crown/stem diameter relationship was used to estimate stocking and hence basal area. The tree volumes were estimated using the single tree volume functions and thinning volumes were calculated as for the stand yield models. The method of yield model construction was therefore similar in some ways to that used by Jobling and Pearce (1977) for the oak free-growth model. Full details of the functions and methods are given in Pryor (1985a).

The resultant yield table is shown in Table 7. The data used were fairly limited (92 trees) and assumptions on crown plasticity and spacing were necessary for the construction of the model. The resulting yield table can therefore not be expected to be as reliable as conventional tables produced using stand data.

The need to keep crowns virtually isolated resulted in the numbers per hectare which could be allowed being only 25–30 per cent of those for the stand yield tables. This represents a very open canopy and the maximum mean annual increment as a result is reduced from over 8 $m^3\ ha^{-1}$ to below 5 $m^3\ ha^{-1}$.

The main benefit is that a stand mean diameter of over 40 cm can be attained in 55 years. Obviously free growth is an extreme treatment, but interpolating between this and the normal yield tables suggests that a more conventional heavy thinning might give a rotation length of 60–65 years.

Financial yield

The costs of establishing cherry are low when compared with other hardwoods. Losses are very seldom more than 10 per cent and early growth is so rapid that weeding is often only necessary for 2 years. However, if deer populations are high then culling, fencing or individual tree shelters will be necessary and this will considerably increase the costs.

A cash flow for a typical plantation on a good site is given in Table 8. Discounted figures, using 3 and 5 per cent discount rates, are also given. These show that cherry, unlike many hardwood species, is a very profitable crop. Depending on the assumptions made on tax, grants, etc., the internal rate of return is likely to be between 4 and 5½ per cent, which is comparable to that achieved by a fast growing conifer plantation. It must be noted however that these cash flows are based on the good prices currently paid for cherry timber and it may

Table 6 (a). Yield table corresponding to good site quality.
(The final two columns are 'cumulative volume production', and 'mean annual increment').

	Maincrop before thinning						Thinning yield					Total yield	
Age (years)	Top height (m)	No. per ha	Mean diam. (cm)	Basal area ($m^2\ ha^{-1}$)	Mean volume (m^3)	Vol. per ha (m^3)	No. per ha	Mean diam. (cm)	Basal area ($m^2\ ha^{-1}$)	Mean volume (m^3)	Vol. per ha (m^3)	Cum. vol. ($m^3\ ha^{-1}$)	MAI ($m^3\ ha^{-1}$)
20	12.5	1950	12	22	0.06	117	650	10	5.1	0.04	27	117	5.9
25	15.1	1300	15	22	0.11	140	270	11	2.6	0.06	16	167	6.7
30	17.5	1030	17	23	0.17	178	200	14	3.1	0.12	23	221	7.4
35	19.5	830	19	25	0.26	213	160	17	3.5	0.18	29	279	8.0
40	21.0	670	22	26	0.36	241	125	19	3.5	0.26	32	336	8.4
45	22.2	545	25	26	0.48	263	100	21	3.6	0.36	36	390	8.7
50	23.1	445	28	27	0.64	283	75	24	3.3	0.47	35	446	8.9
55	23.7	370	31	27	0.80	297	60	26	3.2	0.58	35	495	9.0
60	24.1	310	34	28	1.00	310	50	29	3.3	0.74	37	543	9.1
65	24.3	260	37	29	1.23	319	40	32	3.3	0.93	37	589	9.1
70	24.5	220	41	29	1.49	327	30	34	2.8	1.07	32	634	9.1
75	24.6	190	45	30	1.79	340	25	37	2.7	1.24	31	679	9.1
80	24.7	165	49	31	2.12	349						719	9.0

Table 6 (b). Yield table corresponding to poor site quality.
(The final two columns are 'cumulative volume production', and 'mean annual increment').

	Maincrop before thinning						Thinning yield					Total yield	
Age (years)	Top height (m)	No. per ha	Mean diam. (cm)	Basal area ($m^2\ ha^{-1}$)	Mean volume (m^3)	Vol. per ha (m^3)	No. per ha	Mean diam. (cm)	Basal area ($m^2\ ha^{-1}$)	Mean volume (m^3)	Vol. per ha (m^3)	Cum. vol. ($m^3\ ha^{-1}$)	MAI ($m^3\ ha^{-1}$)
25	11.5	1950	11	19	0.05	89	750	10	5.4	0.04	28	89	3.6
30	13.8	1200	15	22	0.11	132	320	13	4.1	0.08	24	160	5.3
35	15.9	880	19	25	0.20	173	190	16	3.9	0.14	27	225	6.4
40	17.5	690	22	27	0.30	208	140	19	4.1	0.23	32	287	7.2
45	18.6	550	26	28	0.42	233	100	22	3.7	0.31	31	344	7.6
50	19.4	450	29	29	0.56	253	75	24	3.4	0.40	30	395	7.9
55	19.9	375	32	30	0.70	264	60	27	3.4	0.50	30	436	7.9
60	20.2	315	35	30	0.86	271	45	29	2.9	0.60	27	473	7.9
65	20.4	270	38	30	1.02	276	35	32	2.8	0.74	26	505	7.8
70	20.5	235	41	30	1.19	280	25	33	2.1	0.80	20	535	7.6
75	20.6	210	43	31	1.36	286						561	7.5

Table 7. Preliminary free growth table for cherry.
(The final two columns are 'cumulative volume production', and 'mean annual increment').

	Maincrop before thinning						Thinning yield					Total yield	
Age (years)	Top height (m)	No. per ha	Mean diam. (cm)	Basal area ($m^2 ha^{-1}$)	Mean volume (m^3)	Vol. per ha (m^3)	No. per ha	Mean diam. (cm)	Basal area ($m^2 ha^{-1}$)	Mean volume (m^3)	Vol. per ha (m^3)	Cum. vol. ($m^3 ha^{-1}$)	MAI ($m^3 ha^{-1}$)
15	9.2	690	14	11	0.07	49	295	13	3.8	0.06	18	49	3.3
20	10.6	395	17	9	0.11	43						61	3.1
25	12.1	395	20	12	0.17	68	125	18	3.3	0.15	19	86	3.4
30	13.5	270	23	11	0.26	71						108	3.6
35	15	270	27	15	0.39	105	80	25	3.9	0.34	27	142	4.1
40	16.3	190	30	14	0.55	104						168	4.2
45	17.5	190	34	17	0.74	140	48	32	3.8	0.65	31	204	4.5
50	18.6	142	38	16	0.96	136						231	4.6
55	19.6	142	41	19	1.21	172	32	39	3.8	1.09	35	267	4.9
60	20.5	110	44	17	1.46	161						291	4.9
65	21.2	110	47	19	1.73	190						320	4.9
70	21.7	110	50	21	1.95	215						345	4.9

Table 8 (a). Discounted cash flow for cherry.

Year	Operation	Cost/revenue	Discounted value 3%	Discounted value 5%
0	Planting: plants	−400	−400	−400
0	guards	−400	−400	−400
0	labour	−380	−380	−380
1	Beating-up	−180	−175	−171
1	Weeding	− 70	− 68	− 67
2	Weeding	−120	−113	−109
3	Weeding	− 70	− 64	− 60
8	Cleaning	− 80	− 63	− 54
20	Pruning	− 80	− 44	− 30
25	Thinning 43 m^3 @ £ 2 per m^3	86	41	25
30	Pruning	−100	− 41	− 23
30	Thinning 23 m^3 @ £ 4 per m^3	92	38	21
35	29 m^3 @ £ 6 per m^3	174	62	32
40	32 m^3 @ £ 9 per m^3	288	88	41
45	36 m^3 @ £12 per m^3	432	114	48
50	35 m^3 @ £15 per m^3	525	120	46
55	35 m^3 @ £18 per m^3	630	124	43
60	37 m^3 @ £22 per m^3	814	138	44
65	37 m^3 @ £25 per m^3	925	135	39
70	327 m^3 @ £56 per m^3	18312	2313	602
		£20398	£1425	£ −753

Table 8 (a) gives typical costs and revenues for a 70 year rotation of a cherry plantation on a 'good' site. All figures are per hectare and pounds are of 1987 value. The transplants are planted at 2 m x 2.5 m spacing (2000 per hectare), and are protected by spiral guards supported by bamboo canes. Weeding and cleaning are a combination of mechanical inter-row swiping, with granular chemical spot treatment, plus some hand-weeding in the second year. High pruning is carried out on only 300 'elite' trees per hectare. For each thinning and felling, the predicted yield in cubic metres per hectare is given, together with estimated standing value (i.e. income net of working costs).

Table 8 (b).

	Net Discounted Revenues £		
	0%	3%	5%
As per cash flow	20 398	1425	−753
With management costs	19 348	988	−1043
With management costs and grant	20 348	1929	−133
With management costs, grant and Schedule D tax relief	20 996	2523	372

Table 8 (b) gives Net Discounted Revenue for a single rotation under various assumptions. Annual management costs are included at £15 per hectare, to cover management, maintenance and insurance. Grants were for the former Broadleaved Woodland Grant Scheme, for a 1–2.9 ha plantation. The final row assumes Schedule D tax relief at 60% for the first 23 years, with consequent reduction in net establishment costs, grants and management costs. *Note in press*: the 1988 budget made changes to grant schemes and grants payable. Refer to the Forestry Commission's *Woodland grant scheme* booklet for current details.

be unwise to expect this premium value always to exist. However, the workability of cherry timber suggests that its value is unlikely to drop below that of beech and other 'main-stream' hardwoods. Cherry should therefore not be considered as a risky 'decorative timber' to be grown only on a small scale but rather as a highly productive and potentially very profitable hardwood crop. Certainly the productivity was found to be sufficiently high to merit further mensurational study of this species.

Environmental Aspects

Landscape

Cherry is obviously a species which can contribute a great deal to the landscape, not only with its glorious blossom in late spring but also with its blazing colours in the autumn. As it is so brightly coloured and conspicuous at these times of year it must be used carefully and sensitively. Line mixtures of cherry should certainly be avoided on conspicuous hillsides. Simply planting a band of cherry around an otherwise obtrusive plantation will not 'landscape' – it will often make it more conspicuous. Intimate mixtures with larch or broadleaves are very pleasing, and scattered plantings along roadsides, although something of a landscape cliché, can be very attractive.

Nature conservation

From a nature conservation point of view, cherry should be an acceptable species for planting on most sites. It is a native broadleaved tree which was at one time widespread in the 'wildwood' (Rackham, 1980). This does not of course mean that it can be considered 'locally native' in all areas, but at least it should be more acceptable as a component in a plantation than an exotic, high-yielding hardwood. Cherry is often found in primary woodland, although Rackham suggests that being a pioneer species it is probably more typical of secondary woodlands.

Pure plantations are obviously artificial and if conservation is the main objective then cherry should only be used as a minor component.

Cherry does not cast a heavy shade and its litter decomposes rapidly, so when planted it should not result in a dramatic change in the flora. The mass of flowers in the early spring, with their extra-floral nectaries, are a valuable insect food source. The cherries that subsequently form are much relished by a wide range of woodland birds, and judging by the piles of empty shells the stones are an important component of the winter food supply of woodmice (*Apodemus sylvaticus*) and other rodents. The tendency to heart-rot means that occasionally large-sized logs are left in the wood and these will provide an important micro-habitat for fungi and invertebrates.

Conclusion

Cherry appears to show considerable silvicultural potential for lowland broadleaved woodlands. In contrast to many hardwoods it is quick and therefore cheap to establish. Once on a site its ability to regenerate from both suckers and seedlings will mean subsequent crops are even less costly to establish. Providing deer damage can be prevented, and the recommendations for minimising decay are heeded, there should be no major pest and disease problems. Unlike other 'new and exciting' species there are no uncertainties about the timber which is likely to remain one of the most sought-after in the trade. For a native broadleaved species height growth is rapid and volume production is particularly high. Providing heavy and regular thinnings are carried out, diameter growth is fast and rotations are comparatively short (55–60 years). These factors all contribute to make cherry probably the most financially rewarding hardwood crop to grow.

The remaining enigma is "why has cherry always been such a minor forest species throughout Europe?" Rackham (1980) has pointed out that, though it is easily recognised, it is 'exceedingly rare as a place-name element' and the historical record is 'surprisingly meagre'. With its suckering ability and good seed production one might have expected it to increase when man started clearing the primary woodland by invading felled areas. Yet there are very few woodlands today in which it is naturally dominant in the canopy. The demand for the timber could explain a short-term scarcity, but such a demand should eventually have led to more cherry being planted. However, until recently it has apparently only been planted occasionally, despite the fact that it is easy to establish. Could it be that for too long we have simply overlooked the potential of this promising species?

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