



- In 1903 it was agreed that action was needed to address the low woodland cover in Ireland that had reached an all time low in modern times.
- There was little information available at the time on what were the best species to plant in a forestry programme.
- The action was addressed through the purchase by the State of Avondale estate near Rathdrum in Co Wicklow and the laying down of a large series of species trials in addition to the establishment of a forestry school.
- Between 1905 and 1913, 49 ha of land were planted in 104 different plots, with 84 tree species: 46 coniferous and seven broadleaf. A further 16 rare species brought the total species planted to 100.
- The conifers far outperformed the broadleaves. The best performers included Sitka spruce, Corsican pine, Douglas fir, grand fir, Lawson cypress, European larch, Norway spruce, western hemlock and western red cedar.
- Beech, hornbeam, pedunculate and sessile oak, Spanish chestnut and sycamore were the most promising broadleaves.

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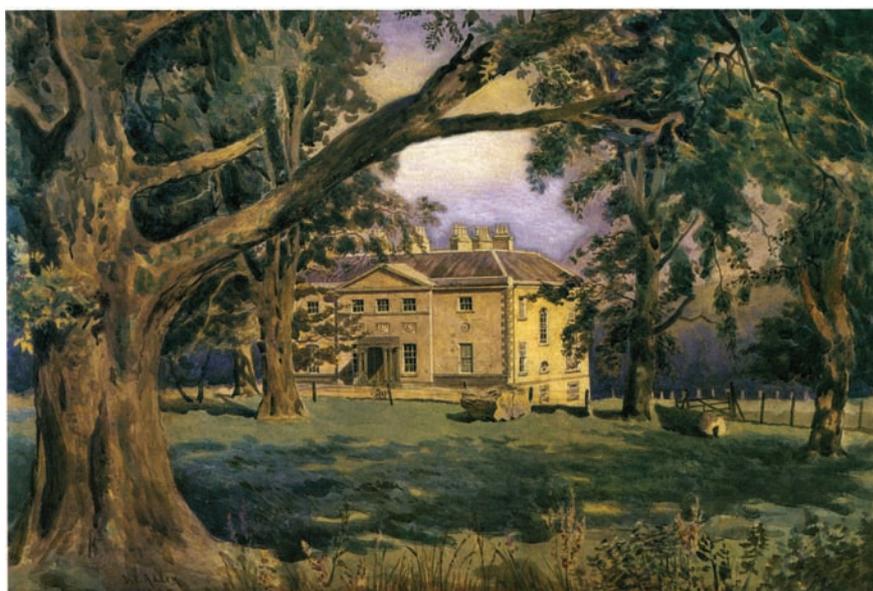
The Avondale Initiative 1905

Michael Carey¹

Introduction

By 1903 the area of woods and plantations in Ireland had been reduced to some 122,000 ha, representing a landscape cover of about 1.6%, probably the lowest point in historic time. The lack of woodland led to a consensus for action to address future wood supplies. This centred on the laying down of a series of field trials to determine the most suitable tree species for Ireland's forestry programme and the setting up of a forestry school for working foresters in which young men could be trained in plantation establishment and management. Although landlords introduced many tree species to the country, and planted quite extensively around their demesnes and manors during the eighteenth and nineteenth centuries, there was no scientific information available on the best species or on how they should be managed.

Enquiries regarding a suitable site for the venture commenced in 1903, during which various localities were considered but it was finally decided to purchase Avondale near Rathdrum in Co Wicklow for the project². The decision in favour



Avondale 1890s. J. Poole Addey.

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² Avondale is now owned by Coillte Teoranta, The Irish Forestry Board.

of Avondale was probably influenced by an approach by John Parnell, who had inherited the estate, to the Department of Agriculture with a proposition: *‘to place the estate under the Department as an experimental farm in part of which trees would be grown and experimented which would do for all parts of Ireland from Wicklow to Galway as we have so many diversified positions such as valley, hill, sea, lake and mountain exposures’*³.

Excluding tenanted holdings and outlying portions of the property unsuitable for forestation, the Avondale estate comprised the present country house and outbuildings, about 80 ha of unplanted grassland and 120 ha of woodland. The outlying areas, mostly mountain land, amounted to some 1,200 ha. A price of £9,870 was paid for the whole property. Most of the land within the demesne was under grass at the time with a number of scattered trees and a small area (0.8 ha) under tillage.

Avondale has an interesting history and strong association with forestry in recent centuries. The home of one of

Ireland’s earliest celebrated tree planters, Samuel Hayes, in the eighteenth century, the property later came into the hands of Charles Stewart Parnell in second half to the nineteenth century. The older planted woodland and trees on the estate dated back to the second half of the eighteenth century. Samuel Hayes was a prolific tree planter, and in 1768 was awarded a gold medal by the Royal Society for *‘having planted out since October last 2,550 beech trees under five years old not nearer to each other than fifteen feet’*.⁴ Many of these, and a limited number of other specimen trees, notably European larch, sessile oak, silver fir, Spanish chestnut and walnut, planted by Hayes, are still to be seen around the estate. Hayes died in 1795 but clearly left his mark. The traveller, Robert Fraser, writing in 1801⁵, refers to *‘the improvements of Avondale made by the late Colonel Hayes, a name truly endearing to all who feel the enthusiasm of extending zeal for the rural arts’*. He mentions plantations of larch and large specimens of Weymouth pine and on *‘the front and side of the house large beech trees and remarkably well-grown fir, particularly the spruce’*.

1905 Forestry Action Plan

Following its acquisition, Arthur Forbes, a 37 year-old lecturer in Forestry from Armstrong College of Science, Newcastle-Upon-Tyne, was chosen to drive the initiative at Avondale. Forbes was described as being *‘dynamic’* and was well acquainted with the history of forestry in Britain and Ireland and convinced as to its importance in the economic life of a country. His attitude was described as being essentially commercial; he had little time for social forestry or the acquisition of land for that purpose. Subsequently he became the first Director of Forestry in Ireland.

Avondale was seen to have advantages as a site because of its location in the centre of a relatively well-wooded district, and its proximity to the Wicklow Uplands where there were opportunities for forestry expansion⁶. These views were not shared entirely by Forbes, however, who felt it was, in many ways, *‘not too suitable’* for the purpose for which it had been acquired. He felt the area was somewhat on the small side to allow work to be carried out on economic lines and that *‘the bulk of it was fairly good tillage land not usually devoted to tree planting’*⁷.



Eighteenth century Spanish chestnut planted by Samuel Hayes. The tree has a circumference at breast height of 6.0 m.

³ Forbes, A.C. 1946. The Forestry Revival in Eire. *Irish Forestry* 4: 11-26.

⁴ Royal Society Minutes. 1768. The Society became known as the Royal Dublin Society after 1820.

⁵ Fraser, Rt. 1801. *General view of the County of Wicklow*. Statistical Survey of County Wicklow. Royal Society, Dublin.

⁶ The forest area of Co Wicklow subsequently increased from 7,000 ha in 1906 to over 32,000 ha in 2007.

⁷ Forbes, A.C. 1946 op. cit.

Despite these reservations, Forbes set about the task with enthusiasm and decided to turn the main part of the property into a forest experimental station on the lines of a continental forest garden. In addition to the training of foresters, he saw one of the main objectives as being to ‘*prove as far as this can be done in one place, on a limited area, the cost of production, yield in timber and the comparative market of the species planted*’⁸.

Between 1905 and 1913 approximately 49 ha of land were planted mostly along the Great Ride in 104 different plots. Most of the plots were 0.4 ha in area. Planting was also carried out on the slopes leading down to the Avonmore River. Overall 84 tree species were planted, including 46 coniferous and 38 broadleaves. Pure groups of 16 species (nine coniferous and seven broadleaf and other rare specimens) were also planted in situations considered ‘*likely to suit them*’⁹. This brought the total number of species planted to 100. Given the paucity of information available at the time on species selection, the initiative represented a milestone in Irish forestry. Some species were planted pure, others in mixture with nurses - mainly larch and Norway spruce. Most of the planting took place between 1905 and 1907.

The Experimental Plots

The area was divided into 19 sections with separate species being allocated to a series of plots within each section. The layout is shown in Figure 1. Table 1 gives a breakdown of the species planted and the number of plots in each section.

Table 1: Main genera planted at Avondale between 1905 and 1912.

Section	Main genus	Number of plots	Total Area ha
1	Maples	4	1.21
2	Elms	4	1.21
3	Beech, Spanish chestnut, Hornbeam	8	3.23
4	Oaks	14	5.26
5	Silver firs	7	2.83
6	Spruces	7	2.83
7	Pines	14	4.85
8	Larches	7	5.66
9	Cedars	2	1.01
10	Ashes	9	2.73
11	Chestnut coppice	1	4.45
12	Locust tree coppice	1	2.42
13	Douglas firs	2	2.83
14	Hemlock	2	1.21
15	Cypress and Junipers	3	1.21
16	Western Red Cedar, Redwoods, Cryptomeria	4	1.61
17	Hickory, Walnut, Plane, Tulip tree	10	2.02
18	Cherries	2	1.61
19	Poplars	3	0.80
Total		104	49.00



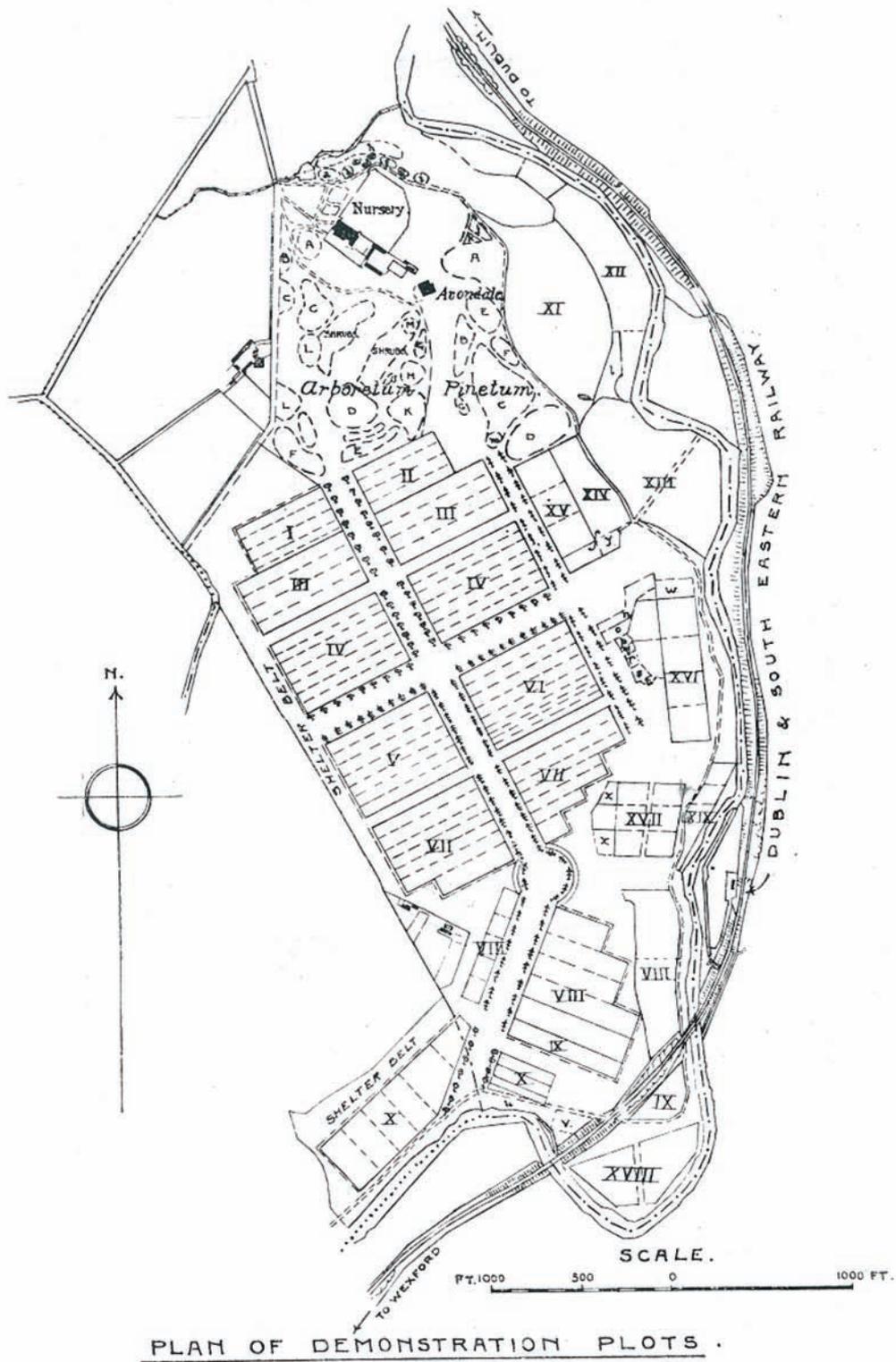
The first Avondale forestry team (1904/1905).

Included are: Andy Stewart, George Farrell, John Murphy, John O Loughlin, Matt Byrne, Martin Murphy, John Carey and Edward Johnson.

⁸ Forbes, A.C. circa 1915. *Avondale Forestry Station. General Description and Progress of Work 1906-12.* Department of Agriculture and Technical Instruction for Ireland.

⁹ Forbes, A.C. 1915. *ibid.*

— AVONDALE FORESTRY STATION —



PLAN OF DEMONSTRATION PLOTS.

Figure 1. The original layout of the experimental plots, Arboretum and Pinetum at Avondale 1905. The Roman numerals refer to the Section numbers shown in Table 2. Refer to column 1 in Table 2 for location of each genus.

Source: Forbes, A.C. Avondale forestry station. General description and progress of work, 1906-12. Department of Agriculture and Technical Instruction for Ireland.



General appearance of the plots, sections I-IV, circa 1913. Note the house in the background to the right.

Source: Forbes, A.C. Avondale forestry station. *General description and progress of work, 1906-12.* Department of Agriculture and Technical Instruction for Ireland.

The following are some of the main features of the plots:

- None of the plots were replicated. Although this represented a shortcoming in terms of experimental design, the growth pattern recorded for the different species enabled judgements to be made on their suitability for Irish conditions. The soils at Avondale, although mainly light in texture, are generally relatively fertile and suitable for growing trees.
- Before planting commenced, the whole area was ploughed, apart from the sloping area adjacent to the river that contained some scrub.
- All plants were sourced as 2+2 transplants, 30-60 cm in height according to species. Difficulty was experienced in sourcing some rare species with the result that quality varied.
- Planting commenced in the autumn of 1905 was done by digging pits and continued on into the two following winters.
- Filling in and planting of species slow and difficult to procure continued until 1912.
- Average costs for planting, including labour, trees and replacement of failures over the first three years are given as £12-£18/ha¹⁰.
- A single tree of the same species in each plot was planted on the Great Ride. This enabled the species included within the plot to be easily identified and the growth of the trees under free growing and forest conditions to be studied and compared.
- Species mixtures were used in many of the plots in order to reduce the cost of plants and to minimize the risk of frost damage. Frost was seen as a risk factor which was well founded, in that some of the more susceptible species, notably Sitka spruce and silver fir, were damaged in the early years after planting. The following principles applied in the case of the mixtures:
 - The species intended to represent the main crop formed at least 25% of the total number planted. A general planting distance of 1.22 m (4 feet) apart provided about 1,682 main crop trees and 5,045 nurse trees/ha.
 - Nurse species were either closely allied to the main crop, or, as in the case of larch, capable of being commercially harvested at an early age. European larch and Norway spruce were the two most commonly used nurse species.
 - Pure crops of all the important species were planted side by side with the same species in mixture, with a view to monitoring their growth and development under both conditions.
 - Larch and Norway spruce were mainly used to nurse the broadleaf species. Scots pine was used as a nurse for most of the more unusual pines, with common silver fir used for the fir section. Beech was used as a nurse with larch and oak and ash with oak, walnut, American ash, hickory and the tulip tree. Silver fir and ash failed as nurse species due to frost damage. In most cases larch outgrew all other species which necessitated cutting back its side branches.

¹⁰ Equivalent to about €4,680-€7,020 today (Liam Kennedy, personal communication).

Forest Demonstration Plots main species of current interest (2009)



- F. sylvatica P/1905 Specimen Plot
- Specimen Tree
- Centenary Trail
- Cairn Walk
- Exotic Tree Trail
- Pine Tree Trail
- River Walk
- Slí na Sláinte

- Minor Road
- Forest Road
- Forest Track
- Path
- Forest
- P Car Park

0 250 metres
0 ¼ Mile

Avonmore River
Railway: To Rosslare

Railway to Dublin

Avondale House

C. sativa (Hayes's tree)

J. regia (Hayes's tree)

Ulmus P/1905

up Tsuga heterophylla P/1950

Carpinus betulus P/1905-1909

P. abies P/1905

Carpinus betulus P/1903-09

Castanea sativa P/1971

Clawsoniana P/1906

T. heterophylla P/1906

P/1971

Leucopis

Acer pseudoplatanus P/1906

Acer platanoides P/1906

Acer spicatum P/1906

F. sylvatica P/1905

F. sylvatica P/1905

Castanea sativa P/1905-06

Q. petraea P/1905

F. sylvatica P/1905

Q. petraea P/1905

P. sitchensis P/1926

Sequoiadendron giganteum P/1906

Sequoia sempervirens P/1906

Pinus nigra P/1905-10

up F. sylvatica

Pinus nigra P/1905-10

up T. heterophylla

P. sylvestris P/1905

up T. heterophylla

Under planting initiative in the 1950s

In the 1950s it was decided to under plant a number of the original plots with shade tolerant species, a decision that led to some controversy and criticism at the time. *‘The decision to under plant was influenced by the fact that the broadleaved plots, apart from beech and hornbeam, and the pine and larch plots, had 50 years growth of briar, furze, hazel and other species and were an impenetrable jungle. I tried having inspection paths opened through it but it proved impracticable. We therefore cleared the undergrowth out of a face. The question was how to keep the ground clear for the future. It was then that Tom OCarroll came up with the idea of under planting with shade bearing species. He brought along the then Chief Inspector, Sean O’Sullivan, and duly talked him into agreeing with his proposal. It must be admitted that O’Sullivan had reservations about what he considered the fundamental change to the character of the plots. He agreed, however, to give the proposal his blessing on the understanding that the new planting would not be allowed to become a constituent of the crop’¹¹.*

The end result was a number of the plots, notably the elms, some of the Corsican pine plots in addition to the Scots pine, Weymouth pine and Monterey pine plots were under planted with a variety of species, the most common being western hemlock, Lawson cypress, Douglas fir, grand fir and western red cedar. One promising plot of Corsican pine was under planted with beech in 1957, but the beech has grown poorly. Douglas fir also grew poorly when under planted whereas the shade-tolerant western hemlock performed well.

Unfortunately, concern about the under planted trees not becoming a constituent of the crop was more or less ignored

in subsequent years, even though thinning was carried out. This resulted in shade tolerant species becoming dominant over time in a number of the plots, notably the elms.

Species performance

The performance of the various species is summarised in Tables 2-7.

Fir (*Abies*) species

The fir species tested are shown in Table 2.

Grand fir was the outstanding performer. European silver fir was also used as the nurse species in all the plots and replaced where it failed with the same species. It showed the greatest vulnerability to frost of all the fir species.

Spruce (*Picea*) species

Table 3 is a list of the spruce species tested and their performance.

All spruce species grew well for the first few years but Sitka spruce was by far the most vigorous. It was also the best performer despite having suffered badly from both frost and aphid damage in early years.

Apart from Norway spruce, none of the other spruces showed any potential. (*P. omorika* was best of these. The *P. smithiana* was planted later in 1916).

No nurse species was used for either Sitka spruce or Norway spruce. However, lines of Japanese larch were planted on the boundary of the Sitka spruce planted in 1926. Norway spruce and red spruce were used as nurses for other species.

Table 2: Fir species originally planted at Avondale and notes on performance.

Species	Common name	Yield class ¹²	Performance
<i>A. procera</i>	Noble fir	16	Good growth but frost damage initially. Felled in 1964, age 58 years. Reached top height of 24 m.
<i>A. grandis</i>	Grand fir	26	Very good growth. Two rotations since 1906. Wind damaged.
<i>A. nordmanniana</i>	Caucasian fir	16	Frost damage initially. Top height of 26 m at age 68.
<i>A. concolor</i>	Colorado fir	16	Severe frost damage. Poor quality with multiple stems. Top height 26 m age 68. Blown in 1974.
<i>A. alba</i>	European silver fir	16	Severe frost damage. Blown in 1974. Top height 27.5 m. Poor quality
<i>A. cephalonica</i>	Greek fir	20	Severe frost damage. Quality poor.
<i>A. numidica</i>	Algerian fir	Poor	Planted in 1916. Referred to by McCusker.

¹¹ Grateful acknowledgement is extended to Mr Michael O’Donovan, former Region Manager, Coillte, Cork Region, for this account. He was House Master at Avondale at the time.

¹² Potential maximum mean annual volume increment, in m³ ha⁻¹ yr⁻¹.

Table 3: Spruce species planted at Avondale and notes on performance.

Species	Common name	Yield class	Performance
<i>P. sitchensis</i>	Sitka spruce	20	Very good. However, severely frosted initially and also suffered aphid damage. Fomes noted. The plot planted in 1926 currently has a top height of 35 m and mean DBH of 67 cm.
<i>P. abies</i>	Norway spruce	14-16	Good. Pure NS was blown in 1990s. Reached top height of 30 m. NS planted in mixture with pedunculate oak (which was suppressed) has a top height of 29.7 m and DBH of 55.9 cm.
<i>P. smithiana</i>	Morinda spruce	-	Started well but did not persist. Replaced.
<i>P. jezoensis</i>	Japanese spruce	-	Poor
<i>P. omorika</i>	Siberian spruce	-	Grew well but died off after about 55 years. Attractive appearance.
<i>P. alba</i>	White spruce	-	Poor
<i>P. pungens</i>	Colorado spruce	-	Poor
<i>P. nigra/mariana</i>	Black spruce	-	Poor
<i>P. rubens*</i>	Red spruce	-	Poor

* Used only as nurse species.



Sitka spruce on the left of the Great Ride, looking south. Planted in 1926.



Corsican pine planted 1905-1910. Height 30 m. Mean diameter at breast height 54.3 cm.

Pines (Pinus) species

The pine species planted are outlined in Table 4. The main findings were:

Corsican pine grew well and performed best on its own. It was suppressed when planted in mixture with either Norway spruce or European larch. The quality of the pure stand of Corsican pine that was under planted with beech in 1957 is very good. The plot currently has a mean height of 29.2 m and a DBH of 54.3 cm.

Radiata (Monterey) pine was and continues to be very impressive where it survived. Scots pine is medium quality. No detail on seed source. Macedonian pine appeared promising.

Lodgepole pine was not tested until 1964 when it was planted in one of the clear felled *Abies procera* plots. It grew vigorously and was of poor form and blew over as is typical on fertile sites. The species was extensively planted on poor soils in Ireland between 1970 and 2000.

Table 4: Pine species planted at Avondale and notes on performance.

Species	Common name	Yield class	Performance
<i>P. nigra var maritima</i>	Corsican pine	16	Good form. Was under planted with beech in 1957.
<i>P. pinaster</i>	Cluster pine	-	Could not compete with larch nurse.
<i>P. banksiana</i>	Jack pine	-	Poor. Suppressed by larch nurse.
<i>P. nigra var nigra</i>	Austrian pine	-	Poor.
<i>P. peuce</i>	Macedonian pine	-	Planted in 1916. Comparable with good Scots pine.
<i>P. sylvestris</i>	Scots pine	12	Poor quality and form.
<i>P. strobus</i>	Weymouth pine	-	Started well but died off.
<i>P. radiata</i>	Monterey pine	18	Survival poor. Growth impressive where it survived.
<i>P. sylvestris var rigensis</i> ?		-	Poor.
<i>P. rigida</i>	Northern pitch pine	-	Poor.
<i>P. contorta</i>	Lodgepole pine (coastal)		Was not tested until 1964 when it was planted in one of the clear felled <i>Abies procera</i> plots. It grew vigorously, but was of poor form.

Larch (*Larix*) species

The larch species tested are shown in Table 5. European larch and Japanese species grew best. Many fine specimens of both are still present, particularly in plots of the other species where they were used as nurse species.

Beech, Norway spruce and larch were used as nurse species for the larch plots. Tyrolese larch performed poorly. Lack of information on the west American larch suggests it also grew poorly although extra seed for the species was sourced in 1910. *Larix x eurolepis* (hybrid larch) was not tested until the 1970s.

Other conifer species

Other conifer species tested are outlined in Table 6.

Douglas fir, western red cedar, western hemlock, Lawson cypress and the coastal redwood (*Sequoia sempervirens*) in particular have all developed well and benefited from their location on a sheltered fertile slope. Douglas has been a consistently good performer at Avondale.

Although a number of the species, notably the redwoods, western red cedar, western hemlock and Lawson cypress are highly productive this must be viewed in the context of the sheltered fertile sites on which they were planted.



European larch grew consistently well at Avondale.

Table 5: Larch species planted at Avondale and notes on performance.

Species	Common name	Yield class	Performance
<i>L. decidua</i>	European larch	8-12	Grew well. Good quality.
<i>L. kaempferi</i>	Japanese larch	10	Grew well. Good quality.
<i>L. occidentalis</i>	West American larch		No records.
?	Tyrolese larch		Poor.
?	Irish larch*		No records.
<i>Larix decidua var polonica</i>	?	?	One line of trees planted. Canker resistant.

* It is unclear what species the 'Irish larch' was. Perhaps it was larch produced from seed obtained from older larch trees growing in Ireland. These would have been of European stock originally.



Western hemlock grew well and has regenerated profusely.



Western red cedar.

Table 6: Other conifer species planted at Avondale with notes on performance.

Species	Common name	Yield class	Performance
<i>Pseudotsuga menziesii</i>	Douglas fir	16-20	Good. Oregon origin better than Colorado. Larch nurse. Interior provenance also planted in 1929 and was poor.
<i>Tsuga heterophylla</i>	Western hemlock	22	Good. Prolific natural regeneration. An impressive plot.
<i>Tsuga canadensis canadensis (mertensiana)</i>	Mountain hemlock	-	Failed due to frost.
<i>Thuja plicata</i>	Western red cedar	22	Good. Larch nurse.
<i>Sequoia giganteum</i>	Giant redwood	20	Good. Larch nurse.
<i>Sequoia sempervirens</i>	Coast redwood	20	Good. Larch nurse.
<i>Cupressus lawsoniana</i>	Lawson cypress	18	Good. Larch nurse.
<i>Cupressus macrocarpa</i>	Monterey cypress	-	Bad frost damage. Poor survival but there are a few excellent trees. Larch nurse.
<i>Cryptomeria japonica</i>	Japanese cypress	-	Bad frost damage. Form poor. Forked trees.
<i>Juniperus virginiana</i>	Eastern red cedar	-	Failed - taken over by larch nurse.
<i>Cedrus atlantica</i>	Atlantic cedar	-	Mixed, poor.
<i>Cedrus deodara</i>	Deodar cedar	-	Mixed, poor.

Broadleaf species

The broadleaf species tested are outlined in Table 7. The main results were:

- Pedunculate and sessile were originally planted together; their overall performance has been disappointing, although they are far superior to all the other oak species, most of which failed.
- Oak grew better under larch, hornbeam or beech nurses than where it was planted pure. Beech was the best nurse, but it tended to out-perform the oak.
- Norway spruce dominated as a nurse. It suppressed all broadleaf species when planted in mixture.
- Ash and hornbeam were ineffective as nurse for pedunculate oak.
- American oaks generally performed very poorly relative to European oaks.
- Spanish chestnut did best where planted pure. It was the most productive of the broadleaf species.
- As stated Norway spruce nurse suppressed all broadleaves, including hornbeam, but the latter responded positively to European larch as a nurse, but its quality was poor.



Free-grown sessile oak on the edge of the Great Ride.

Table 7: Broadleaf species originally planted at Avondale and notes on performance.

Species	Common name	Performance
<i>Acer pseudoplatanus</i>	Sycamore	Grew reasonably well. Quality mediocre and may be related to provenance. Yield class 8.
<i>Acer. platanoides</i>	Norway maple	Poor. Grew well initially. Quality poor.
<i>Acer dasycarpum</i>	Silver maple	Poor. Outgrown by larch nurse. .
<i>Acer saccharinum</i>	Sugar maple	Poor. Outgrown by larch nurse.
<i>Acer macrophyllum</i>	Oregon maple	Poor. Badly affected by frost. Larch nurse grew well.
<i>Carpinus betulus</i>	Hornbeam	Good growth. Yield class 8. Suppressed by Norway spruce nurse. Best with larch nurse.
<i>Castanea sativa</i>	Spanish chestnut	Frost initially. Suppressed by larch nurse. Best where grown pure.
<i>Fagus sylvatica</i>	Common beech	Good growth and quality. Yield class 6.
<i>Fraxinus excelsior</i>	European ash	All ash species performed poorly.
<i>Fraxinus spp.</i>	American ash	All ash species performed poorly.
<i>Fraxinus pubescens</i>	?	Failed.
<i>Fraxinus latifolia</i>	Oregon ash	All ash species performed poorly.
<i>Quercus petraea</i>	Sessile oak	Mediocre. Yield Class 6-8. Best oak species. Larch and hornbeam effective as nurse. NS suppressed the oak.
<i>Quercus robur</i>	Pedunculate oak	Mediocre. Yield class 4 - 8. Second best oak species. Dominated by beech nurse. Ash and hornbeam were not effective as nurse species. NS suppressed oak.
<i>Quercus frainnetto</i>	Hungarian oak	Grew well initially. Yield class 4. Poor records.
<i>Quercus coccinea</i>	Scarlet oak	Poor. Yield class 6!
<i>Quercus velutina</i>	Black oak	Failed.
<i>Quercus palustris</i>	Pin oak	Failed.
<i>Quercus borealis</i>	Red oak	Frost damaged. Beech nurse which is now dominant.
<i>Quercus cerris</i>	Turkey oak	Failed. Yield class 4. Poor records.
<i>Quercus pannonica</i>	?	Failed.
<i>Quercus tinctoria</i>	?	Failed.
<i>Ulmus procera</i>	English elm	Slow start. Unimpressive. Not possible to differentiate the 4 species. All under planted in 1958.
<i>Ulmus glabra</i>	Wych elm	Slow start. Unimpressive. See above.
<i>Ulmus x vegeta</i>	Chicester elm	High mortality due to disease. Unimpressive. See above.
<i>Ulmus americana</i>	American elm	Unimpressive. See above.
<i>Platanus orientalis</i>	Plane	Poor survival.
<i>Juglans nigra</i>	Walnut	Poor records.
<i>Liriodendron</i>	Tulip tree	Died out.
<i>Carya porcina</i>	Hickory	Poor records.
<i>Carya amara</i>	Hickory	Poor records.
<i>Pterocarya cauasica</i>	Causican wing nut	Poor records.
<i>Zelkova keaki</i>	Iron tree	Poor. Note: <i>Ostrya virginiana</i> which is in the arboretum is also called Ironwood.
<i>Prunus serotina</i>	Rum cherry	Poor.
<i>Prunus cerasus</i>	Cherry plum	Poor.
<i>Populus alba</i>	White poplar	Did best of the poplars but poor.
<i>Populus serotina</i>	Black Italian poplar	Poor. Unhealthy.
<i>Populus serotina nova</i>	Black Italian poplar	Poor. Unhealthy.

- Information on the performance of the species in the lowermost 12 rows in Table 7 is lacking, but in general none showed any promise. Ash and European larch were the nurse species.

Summary comments on performance

Conifers

Of the 54 coniferous species tested in the initial experimental plots and later trials only a relatively small number were found to perform outstandingly well. These included Sitka spruce, Norway spruce, and Douglas fir. Grand fir had the highest yield class of all the conifers. However, its timber has limited use relative to the other high performing species.

- Corsican pine performance is impressive and the species warrants further investigation.

- Monterey pine, where it survived, is outstandingly impressive. The performance warrants further investigation.
- European and Japanese larch performed consistently well. Their inherently lower yield class makes them a less attractive option for commercial forestry. However, the vigorous nature of many of the old trees remains impressive.
- Western hemlock performed well. Continues to be vigorous and healthy.
- Western red cedar performed well. Continues to be vigorous and healthy.
- Lawson cypress performed well. Continues to be vigorous and healthy
- The redwoods, notably the coast redwood, *Sequoia sempervirens*, continues to be impressive.
- Only four of these species now play a significant role in forestry in Ireland: Sitka spruce, Norway spruce, Douglas fir and larch, notably Japanese larch and



Douglas fir grew very well at Avondale. This group was planted in 1925 in Section V and has a mean diameter at breast height of 80 cm and a top height of 31 m.

hybrid larch. The latter was not included in the original plots. Lodgepole pine played a significant role in the afforestation programme in the 20th century but was not included in the initial experimental plots at Avondale. However, the performance of ‘*an original coastal lodgepole pine tree*’ at Avondale was said to have influenced A.C. Forbes in deciding to favour that provenance of the species, rather than the inland provenance for the national afforestation programme. This had far-reaching consequences in that the coastal provenance of the species was planted extensively between the 1960s and 1990s on exposed sites, particularly in the west of Ireland, and tended to suffer from basal sweep.

The overall findings and performance of the coniferous species at Avondale over the last century vindicate current policies on species selection. The key species, Sitka spruce, Norway spruce and Douglas fir, remain vigorous and healthy and the most productive. Although a substantial area of the Norway spruce planted in 1905 was blown in 1998, when it was 93 years old, one of the remaining plots (Section 4, plot 10) has a current mean height of 25.7 m and a mean DBH of 55.9 cm. In this particular plot, Norway spruce was planted as a nurse with pedunculate oak but completely suppressed the latter. The Sitka spruce planted in 1926 currently has a mean height of 35 m and a mean DBH of 67.0 cm. The performance of the species is impressive given that it is recorded as having suffered from severe frost damage and aphid attack in the earlier years.

Species such as western hemlock, western red cedar, Monterey pine, Corsican pine, and Macedonian pine deserve further consideration. Indeed the yield class for a number of these species exceeds that for Norway spruce. Collectively, when taken as a group, they offer some opportunities for species diversification particularly on reasonably fertile sites.

Broadleaf species

A total of 45 broadleaf species was tested in the plots, 38 in the original series followed by a further seven in later years.

In summary it can be said that only six of the broadleaf species showed any promise, none had a yield class greater than 8 and quality of stems was generally poor to mediocre.

The most promising species included sycamore, Spanish chestnut, beech, sessile oak, pedunculate oak and hornbeam.

Although the quality of the sycamore is not overly impressive it is by far the best of the maples tested with an indicative yield class of 8. The two native oaks, although they were generally unimpressive in terms of performance (yield class 4-8), were far better than the other species of oak species tested, most of which failed.

Because of the lack of duplication of the plots, and paucity of data, it is not possible to state which of the two oaks, sessile or pedunculate, performed best.

The findings on mixtures were also far from clear although larch, hornbeam and beech mixtures appeared to have a positive effect relative to pure plots of oak. However, beech took over in both the sessile oak and pedunculate oak plots and is now the dominant species. Larch was generally more effective as a nurse but suppressed Corsican pine, Weymouth pine and the other slower growing pine species such as Jack pine and cluster pine. Larch also appears to have been compatible with western red cedar, Lawson cypress and the redwoods. However, it is not possible to state if it had any positive effect on the growth of the nursed species.

Beech grew relatively well and had an indicative yield class of 6-8. The current stands are reasonably impressive and of better quality than the other broadleaf species. Where beech was planted as a nurse for sessile oak and pedunculate oak it tended to take over and dominate. The plots of both oak species in which beech was originally mixed are now virtually pure beech, with few oak remaining. Spanish chestnut was also promising although it suffered badly from frost in the earlier years.

Although a number of ash species were included in the plot series none appear to have grown satisfactorily. The acid nature of the soils at Avondale and the severe frost damage in the earlier years of the trials may have had a negative impact on their performance. Their location on the lower lying areas near the river may have aggravated this risk.

Mixtures are commonly planted in practice nowadays with larch being a particularly well proven in terms of its nursing effect, particularly on impoverished mineral soils. Larch is also planted for other values related to amenity. Mixtures of spruce and pine are also planted widely on peat soils in

particular but these were not included in the plots at Avondale. Neither were mixtures of Douglas fir and Sitka spruce. These appear to be developing in interest. Mixing conifers with broadleaves at Avondale was particularly unsuccessful because the former invariably out grew the latter.

The Arboretum and Pinetum

In addition to the experimental plots an Arboretum, covering an area of 17 ha and incorporating a Pinetum of 6.75 ha, was also developed. Most of the planting here took place between 1905 and 1917 but the collection was extended in the 1920s, 1940s and 1970s. By the mid 1970s it stood at 413 taxa spread over 123 genera.

At its inception the value of the arboretum was defined as follows: *'The principle upon which the arboretum and*

*pinetum have been laid down is that of demonstrating the botanical character and ornamental value of all the hardy trees capable of thriving in the Irish climate. These two adjuncts to the forest plots have both a botanical and arboricultural value, and while affording material for the botanical instruction of students, they will also illustrate the comparative values of the various species as ornamental features on the landscape, the garden or the vicinity of a dwelling house'*¹³.

The broadleaf species in the arboretum were laid down in clumps, groups and as single specimens planted among the old parkland trees. The pinetum was located on what was originally bare ground east of the main house), the different genera being planted in larger masses, their distribution influenced by landscape features. The pines, spruces and firs were planted in large groups and the less important species as single trees.



Avondale pre-1900. Note the pinetum situated on the slope below the house. The field with the animals was planted with Douglas fir in the early 1900s, clearfelled in the 1960s after which it was replanted with Douglas fir and Sitka spruce.

¹³ MacOscair, P. 1978. *Avondale Report*. 2 Volumes. Coillte Library.

The Forestry School

The establishment of a forestry school formed an integral part of the action plan at Avondale¹⁴. Between 1904 and 1915 a total of 44 students completed the forestry course. By 1915 the original planting had been completed and in March of that year Avondale ceased to be a training school. However, Neeson claims the school closed in 1914 ‘partly as a war measure and partly because it seems, of a decision by Forbes as a result of threatened industrial action by the staff in sympathy with the General Strike of 1913’¹⁵.

The training requirements for forestry apprentices were reviewed in 1934 after which Avondale was reopened as a forestry school. It remained there until 1955 when it was moved to Shelton Abbey (Co Wicklow) and later to Kinnitty Castle in Co Offaly due to the increased demand for extra space arising from the larger number of forestry trainees.

Conclusions

A century after the Avondale initiative the forest area in the Republic of Ireland has reached 700,000 ha representing a landscape cover of 10% compared with 1.6% at the dawn of the twentieth century. This has been a remarkable achievement, given the socio-economic background, and the fact that planting for most of the 20th century was confined to marginal land or land peripheral to the needs of agriculture. Although many of the new forests were planted on land of poorer quality than that at Avondale, the experimental plots have provided a wealth of information on species adaptability, suitability, stability and longevity. Little of this information was available in 1903. Although the coniferous species far outperformed the broadleaf species, increased planting of the latter in recent years has added to the value of the century old plots for those who are so engaged. Woodland owners can now visit the various plots and envisage what their own woods may look like at a similar age in the future with the caveat that differences may arise due to site quality, management regime and source of seed¹⁶. The origin of the seed for most of the trees planted in the initial



Eight species of *Eucalyptus* were planted at Avondale in the spring of 1950. A number of the species were killed off by frost, but one of these, *E. delegatensis*, is generating interest nowadays because of its tolerance of low temperatures, rapid growth and versatility in terms of end use.

plots remains uncertain. Modern tree breeding initiatives are likely to result in enhanced growth and adaptability for a wide range of broadleaf species.

The Forestry School at Avondale also achieved its objectives. The students who trained there in the first two decades of the twentieth century, and later on in the 1930s and up to the mid 1950s and again in the 1960s and 1970s, provided the background and expertise needed to develop the successful state forestry programme, and more recently the expanding private forestry initiatives.

¹⁴ Carey, M. 2009. *If trees could talk - Wicklow's trees and woodlands over four centuries*. COFORD, Dublin.

¹⁵ Neeson, E. 1991. *A History of Irish Forestry*. Lilliput Press.

¹⁶ Coillte instigated a ‘Centenary Walk’ through the various species plots in 2004 to enable woodland owners and the public at large to access the areas and review the performance of many of the species referred to. The walk is well signposted with explanatory labels on the more important species and plots.



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