Aspects of oak species in Ireland, and the Forest Genetic Resources Trust oak conservation and improvement programme

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Dair ghaelach - sessile oak - *Quercus petraea* (Mattuschka) Liebl. and dair ghallda - pedunculate oak - *Quercus robur* L. are both native to Ireland. Sessile oak is regarded as the national tree of Ireland.

Biology and ecology

Oaks (*Quercus*) belong to the family $F^{l}agaceae$, a large family of trees and shrubs comprising some 930 species, which occur mainly in the northern hemisphere, ranging from tropical to the boreal regions.

Oak itself is one of the most widespread and species-rich tree genera, comprising 500 present day species, which are distributed across North America, Asia and Europe. The genus has an extraordinary species diversity in America and Asia, which together with the continuous continental distribution of a limited number of European species, makes the genus *Quercus* an "evolutionary success story" (Kremer and Hipp 2019). One of the important features of the genus *Quercus* is the propensity for hybridization and introgression of genes over many generations.

Pedunculate (Q. robur) and sessile (Q. petraea) oak belong to the subgenus Quercus, section Quercus, also called white oaks, comprising around 100 species. Oaks are important components of many forest ecosystems as well as major drivers of terrestrial biodiversity. They are reputed to play host to more species of insects than any other native tree species. In common with other closely related oak species, pedunculate and sessile oak frequently hybridise.

Distinguishing the two oak species

Q. robur is distinguished from Q. petraea by its leaves having only a very short stalk (petiole) 3–8 mm long (mean 6 mm), whereas Q. petraea has longer leaf stalks (petioles) (mean 15 mm).

The acorns of Q. robur are attached to branches by stalks whereas the acorns of Q. petraea are clustered on branches without stalks.

Table 7.6-1 (reproduced here as Figure 1) from *Broadleaf Forestry in Ireland* (Huss et al. 2016) provides further guidance on distinguishing the species.

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Figure 1. Distinguishing oak tree species.



Table 7.6-1: Key distinguishing characteristics of sessile and pedunculate oak.

Occurrence and distribution of the two oak species

In Ireland pedunculate oak covers some 11,200 ha, while sessile oak occupies 6,700 ha (Department of Agriculture, Food and the Marine. 2017).

Across Europe, sessile oak has a much more limited distribution than pedunculate oak. It is concentrated in the more sub-atlantic regions of Europe. Its southerly extent includes the Mediterranean countries with the exception of southern Spain and Greece. To the north it extends to the coastal regions of southern Norway and Sweden, and extends eastwards to north-east Poland, and south to the Crimea. It is also found in regions south of the Black Sea, in the Caucuses and on into the south and east of Turkey. In Ireland sessile oak is found throughout the island, having been present since shortly after the end of the last glaciation – or some 9,000 years ago. It is being particularly prevalent in the southwest and parts of the west, generally on more acidic soils at higher elevations.

Regarding the distribution of oak, the Joint Research Centre (JRC) of the European Commission published the European Atlas of Forest Tree Species, which describes more than 80 species, in 2016. The atlas includes chorology maps, which reflect the currently known distribution of a tree species, some of which build on the European Forest Genetics Resources Programme (EUFORGEN²) maps. It also includes modelled distribution maps developed by the JRC. These modelled maps show where a given species might survive and the probability of it currently occurring there (Caudullo et al. 2017). The map for *Q. petraea* is reproduced here.



² http://www.euforgen.org/

Pedunculate oak has a wider distribution than sessile, being found throughout most of Europe, with the exception of the more northerly parts of Scandinavia and the southern parts of Greece, Italy and Spain. Scattered populations extend eastwards into Asia Minor, the Caucuses and as far as the Caspian Sea. It is also found throughout the island of Ireland, being more common than sessile oak, and is found on 1.6% of the stocked forest area (National Forest Inventory 2018). The chorology map for pedunculate oak is reproduced here.



Site types and oak

In considering the reintroduction of oak woodland under the Forest Service grant aid schemes it is vital to match species to site. Guidance on site section for oak is available from a number of sources (Huss et al. 2016, Horgan et al. 2003, Cross et al. 2010). For example, Cross et al. (op cit.) set out five main native woodland types, which are in turn divided into a number of sub-types.

Sessile oak-woodrush (*Quercus petraea-Luzula sylvatica*) is a woodland type given the designation QL. Sessile oak high forest occurs on acidic (pH typically c. 4.5), well-drained mineral soils, mostly podzols, in upland areas, frequently on hillsides and valley sides. These woodlands are characterised by a dominance of oak, mostly sessile oak (*Quercus petraea*) but sometimes pedunculate oak (*Quercus robur*) or the hybrid (*Q. x rosacea*), often growing with downy birch (*Betula pubescens*) and rowan (*Sorbus aucuparia*). Typically, holly forms the understorey and/or the shrub layer A dwarf shrub layer of bilberry (*Vaccinium myrtillus*) and

sometimes ling heather (*Calluna vulgaris*) is typically present. The herb layer is usually species poor and often dominated by woodrush (*Luzula sylvatica*) with abundant ferns, for example hard fern (*Blechnum spicant*), common polypody (*Polypodium vulgare*) and bracken (*Pteridium aquilinum*). Honeysuckle (*Lonicera periclymenum*) and ivy are often present.



Fine Quercus petraea stand at Kilcooly, Co Kilkenny.

Pedunculate oak is classified as a sub-type set of Ash-ivy woodland (FH). FH2 Pedunculate oak – bramble (*Quercus robur – Rubus fruticosus*) sub-type comprises oak high forest stands on well-drained mineral soils, which range from base-poor to mildly base-rich in nature, that is generally on acid brown earth soils (pH 5.0). They are often associated with old demesnes. Pedunculate oak dominates the canopy with ash a frequent companion (albeit now threatened by widespread ash dieback). Birch, beech and sycamore are only occasional. The understorey frequently includes hazel, hawthorn and holly. The field layer is variable but is typically rather species-poor as bramble is often dominant and may form extensive tangles. Ivy, honeysuckle and broad buckler-fern are also very frequent. At some sites bluebell may form large drifts in the spring. On more acidic soils, such as acid brown earths and brown podzolics, the field layer may take on the character of stands from the *Quercus petraea* –

Luzula sylvatica group with woodrush carpeting the woodland floor. Bracken may occur in areas with a lighter canopy or where the understorey is poorly developed.



The Squire's Walking Stick, an outstanding Quercus robur at Tullynally Estate, Co Westmeath.

Tree improvement and genetics

In general, the quality of older oak stands is mixed, across both Ireland and Britain (Future Trees Trust 2016). This is a reflection of the lack of coherent tree improvement effort in the past, along with a management practice that tended to remove the better performing trees when they reach merchantable size, in what is termed 'negative selection'. Nevertheless, some good quality stems have survived and a selection from these forms the basis of the FGRT seed orchard programme.

The main objectives of the Forest Genetics Resources Trust (FGRT) oak programme are to:

- 1. Secure, conserve and utilise key genetic resources of selected oak plus trees and seed stands for the production of improved forest reproductive material.
- 2. Increase the volume and value of oak resources through the use of genetically improved oak reproductive material, and through good silvicultural practice.
- 3. Promote the use of improved oak plant material, through engagement with the nursery sector, forest owners, foresters and policy makers.

FGRT is addressing these objectives in a number of ways.

First by working with Coillte and private landowners we have taken responsibility for the maintenance and assessment of a number of oak provenance and progeny trials. These are in three main series

- 1. A 1998 provenance trial covering both species, representing 27 locations across the island. The trial is partially replicated across four sites Belturbet, Camolin, Donadea and Durrow. The objectives of the trial are to indicate the best areas for collection of oak seed, to enable the genetic characteristics of native oak to be better understood, and to provide a conservation collection of native oak seed sources. Early results for the series have been summarised. Currently (2022) the trials are being recorded and evaluated as part of the FITFOREST project funded by the Departments of Agriculture in the island of Ireland (DAFM and DAERA).
- 2. A 2003 oak provenance and progeny trial at Manch, Tullynally and Shillelagh. This trial is currently undergoing a basal area and form assessment, and will be reported on in 2022. The progeny trial is based on collections made at the oak plus tree clone bank at Kilmacurragh. While confined to a relatively small number of plus trees clones, it will provide some information of the level of genetic variation among the oak plus tree population.
- 3. A 2009 oak trial to evaluate seed stand performance is replicated across two sites: Camolin and Manch. These sites will be cleaned and relabelled in 2022, with a view to future assessment.

FGRT and the Future Trees Trust (UK) have jointly funded a growth and bud-burst assessment of an oak breeding seedling seed orchard (BSSO), which is located at the Coillte broadleaf seed production area at Rathluirc. The results of the assessment will be published to describe bud burst monitoring from replicated oak families and their relationship with geographical characteristics of selected mother trees.

Over the course of the last four years FGRT has established an oak clone bank at the JFK Arboretum in cooperation with the National Botanic Gardens, Glasnevin. It consists of clonal replicates of a collection of plus trees which were identified in forests throughout Ireland and the UK.

An important part of FGRT's work is the establishment of oak seed orchards. Over the period 1990-1994 some 102 oak plus trees (roughly half and half *Q. robur* and *Q. petraea*) were selected in Ireland, based on straightness of stem, vigour, and absence of epicormic shoots. Scion wood was obtained from most of the plus trees and placed in clone banks at two Coillte properties in Co Wicklow. This material, supplemented by plus tree selections in GB and a

small number of French and Dutch locations forms the basis for the current FGRT oak seed orchard programme.



A *Quercus petraea* seed orchard recently established by the Future Trees Trust in collaboration with FGRT at Castelwellan, Co Down.

In 2019 a *Q. petraea* seed orchard was planted at Castlewellan in Co Armagh, on a site owned by the Northern Ireland Forest Service.

Seed orchards are recognised as an effective way to produce seeds with improved genetic qualities. Seed production in oak stands in Ireland is intermittent, with mast years occurring at irregular intervals of 6-10 years. Although acorns may be borne every year in some stands, the quantity is generally low and insufficient for national needs. Furthermore, current practise is to inspect and collect from a limited number of oak stands annually. Some acorns are borne every year however, and are collected in a small number of seed stands on an annual basis.

As a result, reliance on imported oak seed is high, with the preferred source being Dutch material, which comes from a long-established system of seed orchards based on selected parent material (see COFORD Connects Note on the Dutch approach). Given the periodicity of indigenous seed production and the small number of oak seed stands used for seed collection, FGRT has taken the view that a move to more assured and better adapted oak material is necessary. To that end, FGRT's interventions are mainly to facilitate establishment of oak seed orchards, as well as a more regular collection of acorns from a larger number of selected stands.

Annual acorn demand in Ireland is ca 10-12 tonnes (total for both species). Given the likely expansion of broadleaf forest, demand is likely to increase and could conceivably double over the coming decade. FGRTs view is that 50-60% of annual acorn production should be through the seed orchard route, supplemented where necessary by seed stand collection and

imports. The establishment of multiple seed orchards of oaks in multiple locations is a strategy to optimise acorn production to favour a reliable annual yield.

The FGRT approach to the genetic improvement of oaks is based on recurrent selection through progeny testing, and supplementing the breeding population with new genotypes based on plus tree selection. We also see a need to be ready to address wood quality in future breeding strategies, as processing and use of oak begins to grow over the coming decades.

With these considerations in mind, a realistic and achievable seed orchard and progeny testing programme in oak is being progressed by FGRT and is planned for the coming 20-year period.

The implementation model is that FGRT will facilitate the establishment of oak seed orchards by supplying selected plant material to the nursery sector and land owners at low to zero cost, under licence, for commercial exploitation (in the form of the acorns produced). Genetically improved material will then be deployed for forest establishment and regeneration. FGRT and/or FTT, Coillte and other originators of the material would retain ownership of the underlying genetic material.

FGRT has undertaken the collection and propagation of approximately 50 genotypes of both species and is working with landowners to establish the first four seed orchards in oak in Ireland over the course of 2022 through to 2024.

We are also working with the National Parks and Wildlife Service and other bodies which have oak seed stands registered by the Forest Service to examine ways to ensure that acorns can be collected more regularly in their registered seed stands so that these important native sources of acorns are mobilised for deployment in forestry.

Silviculture of oak and use in afforestation

Oak has been and continues to be one of the main broadleaved species used in afforestation. The *Forestry Standards Manual* (Forest Service 2015), permits the use of three oak species: *Q robur*, *Q petraea* and *Q rubra* (red oak) for afforestation purposes. Accepted seed origins/provenances for the native oaks are set out as:

Pedunculate oak	First Choice: Registered Irish material. Otherwise, registered British
(Quercus robur)	(English and Welsh), French (north of Paris), Belgian, Dutch, Danish,
	German (north of Frankfurt) seed stands
Sessile oak	First Choice: Registered Irish material. Otherwise, registered British
(Quercus petraea)	(English and Welsh), French north of Paris), Belgian, Dutch, Danish,
	German (north of Frankfurt) seed stands

The material being included in the oak seed orchard programme match these origins.

Regeneration of existing oak stands though the use of group and shelterwood systems is difficult to achieve in practice due to infrequent mast years, and the need to fell out strips or groups of mature oak to allow sufficient light penetration for the emerging seedlings to thrive (oak is strong light demander). Some form of vegetation control and/or ground preparation may be needed. Natural regeneration mostly fails due to extremely high levels of seed

predation by a range of mammals. In most cases it is likely that supplementary planting will be needed to achieve a stocking sufficient to engender competition and good form.

Oak utilisation: wood, bark and acorns

Oak wood is strongly ring porous, meaning it has large early vessels, reaching up 0.3 mm and easily visible to the naked eye, at the beginning of an annual ring, and then abruptly changing to smaller latewood vessels. Oak is a strong dense timber, and the heartwood has good natural durability. It has a long-documented history of use, in construction as a roofing and framing timber, in furniture making for tables and shelving, and for cooperage, now one of the main uses for certain oak species. In the past oak bark was widely used for tanning animal hides in the production of leather. Oak bark (*Q suber*) is the source of cork, which continues to be widely used in bottling and a range of other applications.

Acorns were and continue be used as a source of animal feed, and also served an important role in early human history and were a source of food for many cultures around the world. For instance, the Ancient Greeks and the Japanese used acorns for food, especially in times of scarcity. To modern tastes acorns are unpalatable due to presence of bitter-tasing tannins.

From an ecological perspective one of the main ways European oaks have spread out from glacial refugia after the last Ice Age is through the agency of jays and squirrels that scatter-hoard acorns in caches for future use. Even though jays and squirrels retain mental maps of cache locations and return to consume them, some acorns are lost, or a jay or squirrel may die before consuming all of its stores. A small number of acorns manage to germinate and survive, producing the next generation of oaks and extending the geographic range of the species. Scatter-hoarding behaviour depends on jays and squirrels associating with plants that provide good packets of food that are nutritionally valuable, but not too big to handle. The beak sizes of jays determine how large acorns may get before jays ignore them.

Cultural aspects

Oak has played an important role in early Irish and European culture. Human societies, political systems and religions have used oak to symbolise strength, durability and fertility (Leroy et al. 2020). In Ireland oak was also an important part of Celtic culture. Oak groves were associated with Celtic ceremonial sites, including Derry city, Doire Cholmcill or Colmcille's oakwood. Kildare – Cill Dara – the church of the oak (see Lucas 2017, and Mac Coitir 2016 for more on cultural aspects of oak in Ireland.).

Oak was widespread across the island of Ireland, as the pollen record shows (Mitchell 2000). The occurrence of over 1,000 placenames with *doire* or *derry*, extending to *gerry* and *kerry* and similar, has connotations of oak woodland or trees (see logainm.ie). Good evidence exists for regulated management of oak and other woodland in early Ireland from archaeological remains and some written records. Most if not all this skill set and legal structure was lost during the upheavals of the 15th and 16th centuries, and woodland itself had been under pressure for well over a millennium as a result of clearance for grazing.

Kelly (1999), refers to the law-text which contains most information on trees, *Bretha Comaithchesa*, 'judgements of neighbourhood', which dates from about the eighth century. It "deals with the various offences which a farmer is liable to commit against his neighbour, and includes a section on damage to trees and shrubs. Four different degrees of damage are distinguished: complete extirpation of the tree, cutting it off at the base, fork-cutting and branch-cutting. Obviously, damage to an especially valuable tree such as an oak or yew would be a more serious offence than to a less prized tree such as a birch or willow. For this reason, the twenty-eight principal trees and shrubs are divided in *Bretha Comaithchesa* into four classes of seven, based on their economic worth." Dair or oak is included in the first class, the seven lords of the woods (*airig fedo*). Strong fines were levied for damage to any of the lords of wood, according to the severity of damage (Kelly 1999). It is worth quoting Kelly (op cit.) in full on oak:

Dair: oak A ninth-century legal commentary appended to Bretha Comaithchesa provides a useful summary of the reasons why the seven lords of the wood are so highly prized. The value of the oak is said to derive from "its acorns and its use for woodwork". There are many references in our sources to the importance of the acorn-crop (mes), particularly in relation to the fattening of pigs. A later legal commentator claims that a single oak can provide enough acorns to fatten one pig in a good year. This commentator describes the oak as in Temair feda "the Tara of the wood" on account of its size and eminence. The value of oak-timber is stressed in many texts. The sturdiest type of fencing described in Bretha Comaithchesa is the dair-imbe 'oak-fence', and there are many references to a type of church called a dairthech (or daurthach) lit. 'oak-house'. Another use of the oak which is quite often mentioned in legal material is the provision of bark for the tanning of leather. If a person illegally removes enough bark from another person's oak to tan a pair of woman's sandals, he must give him a cow-hide. If he removes enough to tan a pair of man's sandals, he must give an ox-hide. In addition, he must cover the wound with a mixture of smooth clay, cow-dung and fresh milk until there has been the width of two fingers' new growth on all sides. This technique is similar to the modern one of painting an air-excluding preparation over the wound where a bough has been sawn off.

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