Project number: 6052
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B-SilvRD – Broadleaf silviculture research and development

Key external stakeholders:
Farm forest owners; Forest managers.

Practical implications for stakeholders:
The project established medium- to long-term broadleaf silviculture trials in establishment, thinning and remedial silviculture for poorly performing pole-stage stands.

- Initial observations are that some novel silviculture practices may improve the potential production of high quality broadleaf timber from poorly performing broadleaf stands.
- Provisional guidelines for remedial silviculture have been produced.
- Thinning of ash can be conducted at a heavier intensity, on a site-by-site basis, than current guidelines recommend to increase its impact on potential crop tree growth.
- Broadleaf silviculture trials have been established that will provide useful results over the medium- to long-term related to nurse crops, thinning and remedial silviculture.

Main results:
- Provisional protocols for the management of poorly-performing pole-stage broadleaf stands formulated.
- Beech and oak seedlings are suitable for underplanting under permanent canopy cover that reduces light to as low as 28% of full sunlight.
- Thinning intensity of ash can be increased relative to the current guidelines.

Opportunity / Benefit:
The research has established a number of medium- to long-term trials that will provide useful results in the future. Owners of poorly performing pole-stage broadleaf stands may be able to increase their future productivity potential by employing the provisional remedial silviculture protocols produced. Owners of ash may, if the site conditions are suitable, increase thinning intensity to the removal of 4 competitors per potential crop tree to further increase stem diameter growth rate.

Collaborating Institutions: UCD

Teagasc project team: Dr. Ian Short (PI), Jerry Campion, Ignacio Sevillano

External collaborators: Dr. Conor O'Reilly, UCD. Jerry Hawe, Sylviron Ltd. Project advisory group. Private forest owners.

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1. Project background:

Approximately 48,000 hectares of broadleaves were planted during the period 1990 – 2015 inclusive (Forest Service statistics, 2008; 2015 Afforestation statistics), both as pure stands and as mixtures with conifers. Where broadleaved mixtures have been attempted results are variable at best. Inappropriate mixtures are understandable given the lack of cohesive guidance in this area and subsequent piecemeal nature of experimentation. This is understandable however given that historical data on broadleaved species mixtures is neither well collated, nor tested within the environmental context of the Irish forestry sector. Research is required in order to address both aspects of this knowledge gap, and ultimately to feed new knowledge into practical silvicultural guidelines. In the case of conifer / broadleaf mixtures the problems are somewhat different and are generally associated with two situations:

- Early loss of apical dominance due to lack of nursing effect from the conifer species
- Suppression of broadleaved crop species due to lack of timely management input / removal of conifer species.

From observation in the field during COFORD field-tours and reports from the industry, it is apparent that there is a substantial area of broadleaf plantations, particularly ash, that for whatever reasons are under-performing and/or are of poor quality. The vast majority of broadleaf plantations are privately owned and their owners require an income from the plantations. Currently it is unclear how such poorly growing plantations should be managed.

The Irish broadleaf plantation age structure is such that there is now increasing demand for silvicultural interventions to realise its full potential. The demand from forest owners and the wider industry for advice on broadleaf tending and thinning, especially for ash, has increased in recent years, as demonstrated by the increase in number of enquiries to Teagasc Forestry Development Officers. There has also been increasing interest in continuous cover forestry.

2. Questions addressed by the project:

- Can birch act as a nurse when establishing oak?
- What impact does planting density and mixture intensity have on ash and sycamore growth planted together in mixture?
- Is there any advantage to the growth of oak if Scots pine is planted 2 or 4 years in advance of the oak being planted?
- Can ash thinning intensity be increased to improve potential crop tree stem diameter growth?
- Can novel silvicultural practices be used to improve the potential productivity of poorly performing pole-stage broadleaf stands?
- What impact does reduced light have on underplanted oak and beech transplants in continuous cover forestry?

3. The experimental studies:

Literature reviews of various aspects relevant to the work were conducted to collate state-of-the-art information. These have been published and were used to inform trial establishment. Silviculture research by its very nature tends to be medium- to long-term and the majority of the trials established in this project are for medium- to long-term use (e.g. birch:oak nursing trial). Some sites were also used for broadleaf silviculture demonstration days. A novel fully replicated Nelder trial design, incorporating a mixture of two species (*Fraxinus excelsior* and *Acer pseudoplatanus*), has been established to investigate the effect of spacing and mixture proportion on the growth of the trees. This is the only Nelder trial in Ireland that incorporates two species. A novel trial has been established to investigate the effect of planting a Scots pine (*Pinus sylvestris*) nurse in advance of the oak (*Quercus robur*) crop species. Novel remedial silviculture systems have been investigated to assess their potential for rehabilitating some poorly performing pole-stage broadleaf stands: coppicing; coppice-with-standards; systematic thinning with underplanting; modified free-growth. A novel fully replicated shadehouse trial was established to investigate the impact of shade intensity on the performance of oak and beech (*Fagus sylvatica*) transplants. Eight broadleaf thinning demonstration sites have been used and monitored during the project. Information gained from these sites has been used to inform industry and, as these sites develop and subsequent thinnings carried out, they will provide additional data to further illustrate the impact of thinning on Potential Crop Tree response. A thinning intensity trial in ash (*Fraxinus excelsior*) was established. A fully replicated thinning trial in oak:Scots pine alternate line mixture has been established. It is too early for this trial to provide results. Nine broadleaf silviculture demonstration days, each well attended, were held during the project.

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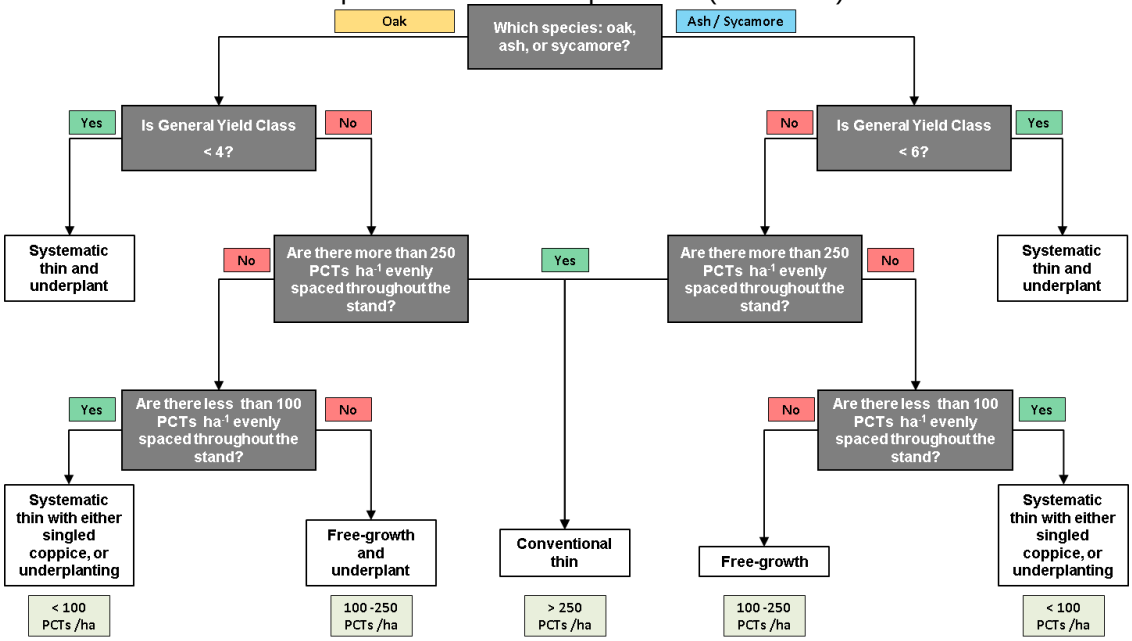
4. Main results:

- New broadleaf silviculture trials have been established that, with continued management and monitoring, will provide useful results to inform industry in the medium- to long-term.
- A fully replicated shadehouse trial was established in which oak and beech were planted. Light availability strongly affected the performance of beech and oak transplants. Although the best growth was observed at full sunlight, both species were able to tolerate shade as low as 28% of full sunlight through morphological and physiological acclimation.
- Each of the remedial silvicultural systems employed is feasible and have provided greater potential for future good quality sawlog than was evident prior to their use on those sites. Systematic thinning of sycamore resulting in 3 lines from 4 being removed resulted in more successful coppice shoots than alternate lines removed which resulted in a higher proportion of stumps unsuccessfully coppicing.
- Systematic thinning of poorly performing ash resulting in either 3 lines from 4, or the 2 middle lines from 4, being removed and underplanting with alder was successful with some of the ash coppice subsequently having been singled.
- Provisional remedial silviculture protocols have been produced (see below).



- The currently recommended thinning intensity for ash (2 competitors per Potential Crop Tree) can be doubled to further increase the stem diameter increment response of the Potential Crop Trees.
- The thinning demonstration sites have provided, and will continue to provide, information on the effect of thinning on broadleaf PCT diameter increment, as subsequent thinnings are carried out in the future.

5. Opportunity/Benefit:

Results of this project have informed Teagasc Forestry Advisors and the wider industry. If remedial silviculture techniques are employed they have potential to increase the future potential of a poorly-performing pole-stage broadleaf stand to produce sawlog. Increased intensity of thinning in ash will reduce rotation length and may increase net present value of a stand at final felling. It may also have an impact on susceptibility of ash to ash dieback (*Hymenoscyphus fraxinea*) as recent research in Estonia suggests that ash trees tend to be healthiest in open conditions (Rosenvald *et al.* 2015). Data and information from the thinning sites can be used to inform industry of the benefits of thinning and thereby encourage more owners to conduct this important management intervention.

6. Dissemination:

Main publications:

Sevillano, I., Short, I., Grant, J. and O'Reilly, C. (2016) 'Effects of Light Availability on Morphology, Growth and Biomass Allocation of *Fagus Sylvatica* and *Quercus Robur* Seedlings'. *Forest Ecology and Management* 374: 11-19.

Short, I., Hawe, J., Campion, J. and Byrne, R. (2015) 'A Review of Stumping Back and Case Study of its Use

in the Rehabilitation of Poorly Performing Pole-Stage Sycamore'. *Irish Forestry* 72: 58-77.
Bravo-Oviedo, A. *et al*. (2014) 'European Mixed Forests: Definition and Research Perspectives'. *Forestry Systems* 23(3): 518-533.
Short, I. (2013) 'The Potential for Using a Free-Growth System in the Rehabilitation of Poorly Performing Pole-Stage Broadleaf Stands'. *Irish Forestry* 70: 157-171.
Hawe, J. and Short, I. (2012) 'Poor Performance of Broadleaf Plantations and Possible Remedial Silvicultural Systems – a Review'. *Irish Forestry* 69(1&2): 126-147.
Short, I. and Hawe, J. (2012) 'Possible Silvicultural Systems for Use in the Rehabilitation of Poorly Performing Pole-Stage Broadleaf Stands – Coppice-With-Standards'. *Irish Forestry* 69(1&2): 148-166.

Popular publications:

Short, I. and Campion, J. (2015) 'How Remedial Silviculture Can Improve Poorly Performing Pole-Stage Broadleaves'. *Forestry & Energy Review* 5(2): 14-16.
Short, I. and Campion, J. (2014) 'Coppice-With-Standards: An Old Silvicultural System With New Potential?' *Forestry & Energy Review* 4(1): 42-44.
Short, I. (2011) 'Tending and Thinning of Broadleaves: A Simple Guide to Selecting Quality Trees'. *Forestry & Energy Review* 1(2): 34-36.

YouTube: 'Selecting and Marking Potential Crop Trees: the 2-Stick Method'

Selected presentations:

2015 Silviculture of broadleaves for quality timber. National Hardwoods Conference, Enfield, 27/05/2015.
2015 Management of ash in Ireland in the light of ash dieback. Presented at Farm Woodland Forum Annual Meeting, Organic Research Centre, Newbury, UK. 18-19/05/2015.
2014 Ecophysiological responses of *Fagus sylvatica* and *Quercus robur* seedlings to light intensity. Natural and human-assisted adaptation of forests to climatic constraints: the relevance of interdisciplinary approaches (LE STUDIUM Conference), Orléans (France), 18-19/11/2014.
2014 Physiological responses of *Fagus sylvatica* and *Quercus robur* seedlings to light intensity. Plant Biology Europe Congress, 22-26/06/2014.
2014 The impact of shade on photosynthetic characteristics in *Fagus sylvatica* and *Quercus robur* seedlings. Agricultural Research Forum 2014, Tullamore Court Hotel, 10-11/03/2014.
2014 Physiological characteristics of *Fagus sylvatica* and *Quercus robur* in response to extreme light environments. Presented at Irish Plant Scientists' Annual Meeting, UCC, Cork. 28-29/04/2014.
2014 Management of ash in the light of *Chalara* dieback. Presented at the All Ireland *Chalara* conference, Crowne Plaza Hotel, Dundalk, Co. Louth. 08/05/2014.

Demonstration days:

2010 National Demo. Tending & Thinning of Broadleaf Woodlands. Dunmanway, Co. Cork. 09/09/2010.
2011 Preparation for the Thinning of Broadleaves. Clonbulloge Village, Edenderry, Co. Offaly. 23/02/2011.
2011 National Demo: Tending and Thinning of Broadleaf Woodlands. Milltown Village, Co. Cavan. 20/04/2011.
2011 National Demo: Tending & Thinning of Oak Woodlands. Cappamurragh, Co. Tipperary. 26/10/2011.
2012 Hurley ash field day. Dalgan Park, Co. Meath. 22/03/2012.
2012 National Forestry Demo. Tending & Thinning in Broadleaf Woodlands. Cordal, Co. Kerry. 19/04/2012.
2012 National Forestry Demo. Tending & Thinning in Broadleaf Woodlands & Small Scale Timber Extraction. Dunnamaggin, Co. Kilkenny. 10/10/2012.
2013 National Forestry Demo. Management & Thinning of Oak & Conifer Mixtures. Cloughjordan, Co. Tipperary. 10/07/2013.
2014 National Forestry Demo. Thinning of Alder & Sycamore. Ballycrissane, Co. Galway. 17/06/2014.
2014 National Forestry Demo. 2nd Thinning of Broadleaf Woodlands. Summerhill, Co. Meath. 16/10/2014.
2015 Current Research on Remedial Silviculture for Pole-stage Stands of Poorly Performing Broadleaves. Curry, Co. Sligo, 30/06/2015.

Theses:

Sevillano, I. (2016) *Morphological and physiological responses of* Fagus sylvatica *and* Quercus robur *seedlings to light availability.* Ph.D.
Hawe, J. (2014) *Early thinning of ash,* Fraxinus excelsior *L., plantations in Ireland – thinning intensity and crop tree growth responses.* M.Sc.

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