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The Irish Agriculture and Food Development Authority

Management of ash in Ireland in the light of ash dieback

Dr Ian Short

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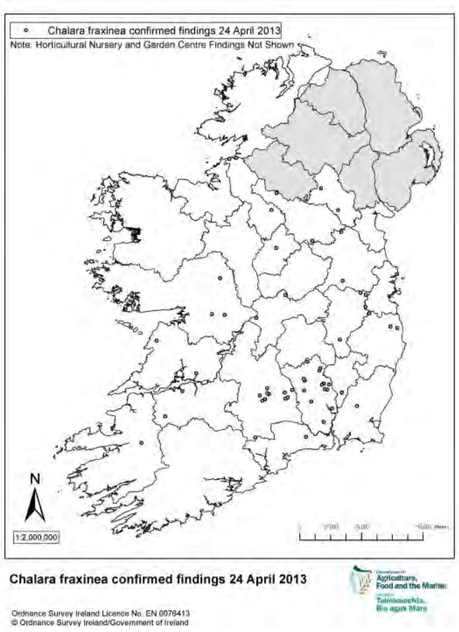
Ashtown Research Centre, Dublin 15

The Irish Agriculture and Food Development Authority

Overview of presentation

- Ash age profile
- Scenarios



- Silvicultural options
  - State-of-the-art
  - Options for Ireland?
    - Systems
  - The future

Ash in Ireland

Tony Grehan – Press 22

Ash in Ireland

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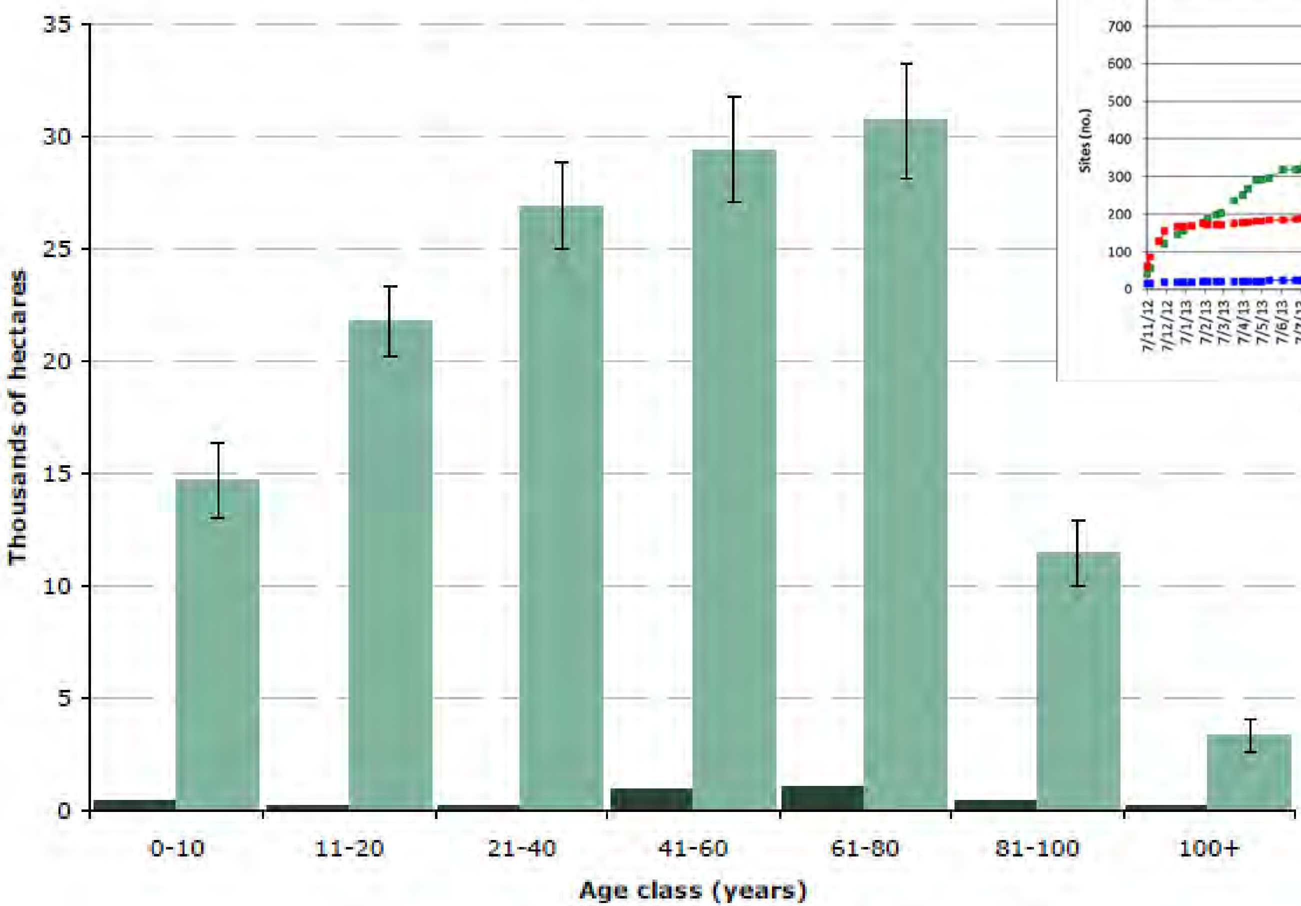
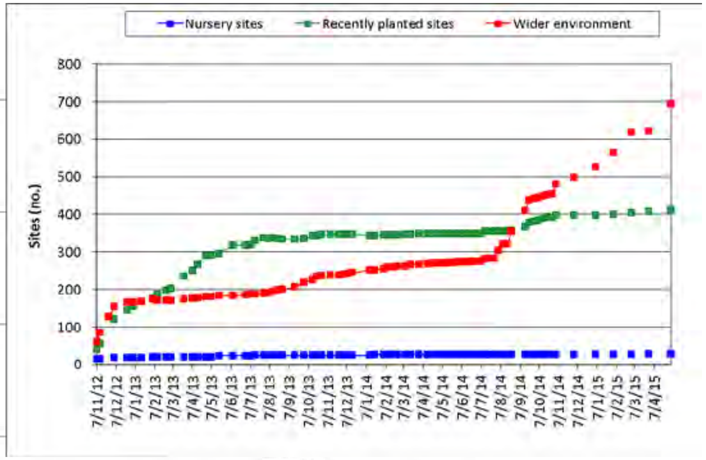
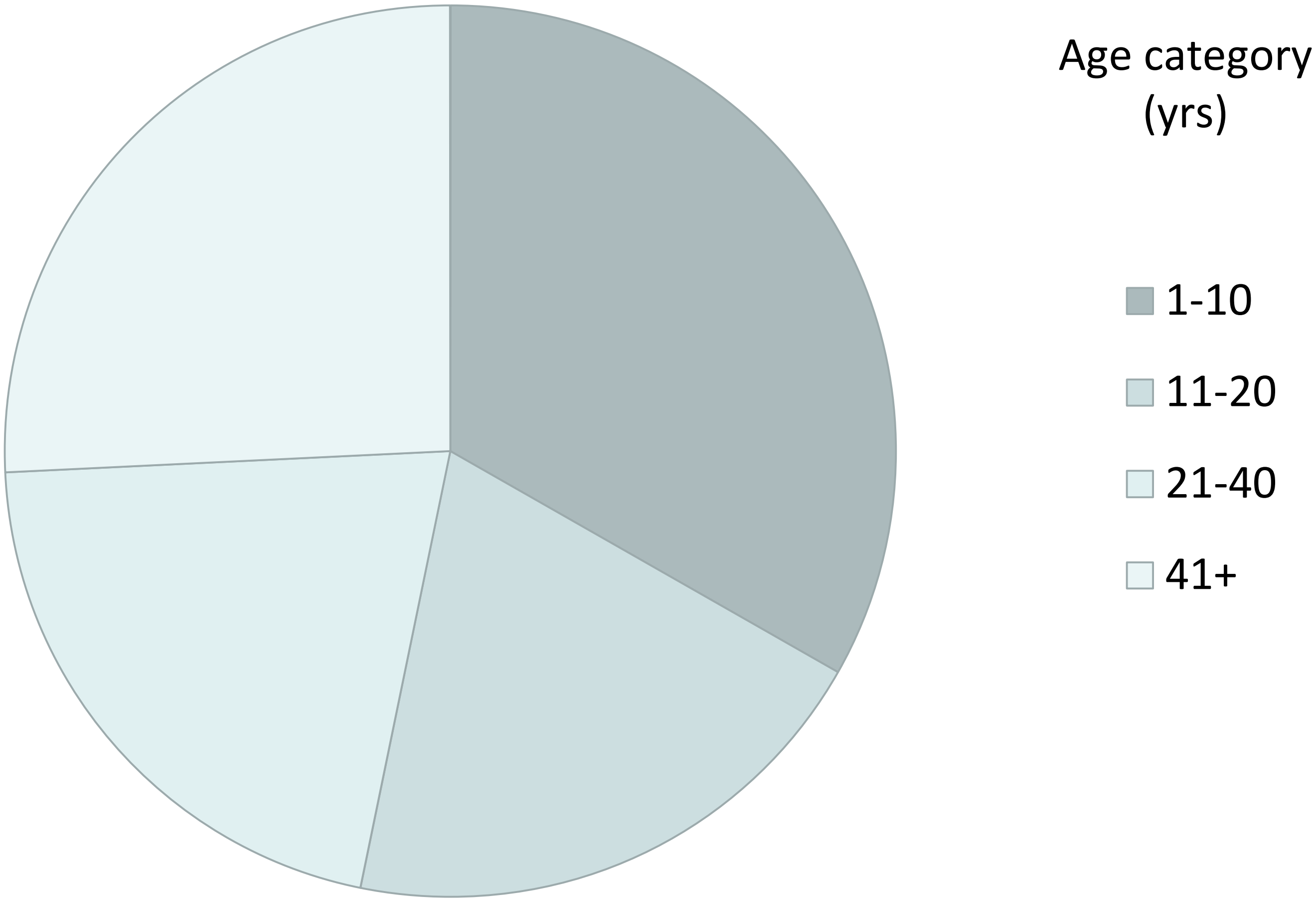
Age profile of ash (GB)

Figure 16a Stocked area by age class of ash for GB

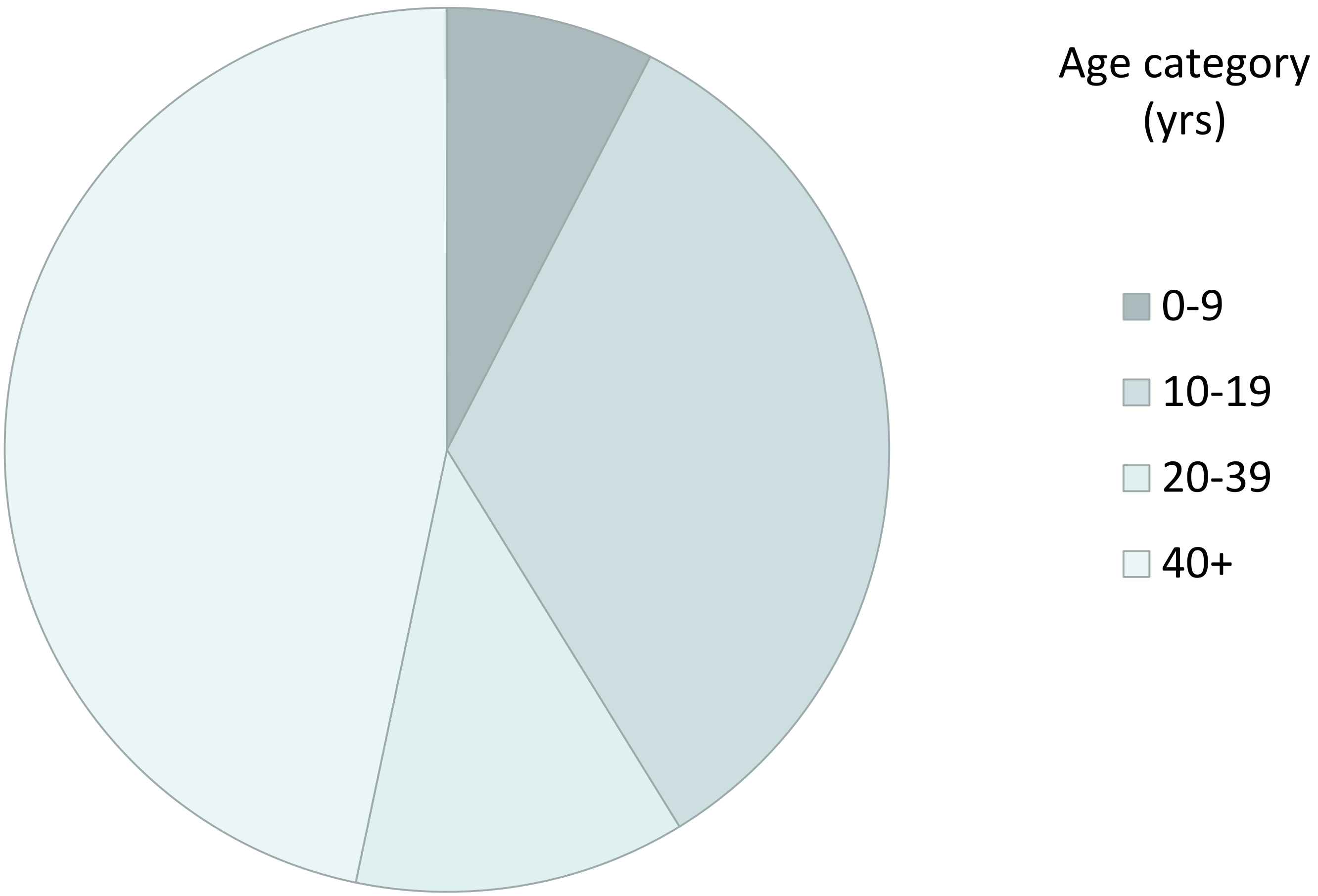




Age profile of ash (R. Ireland)

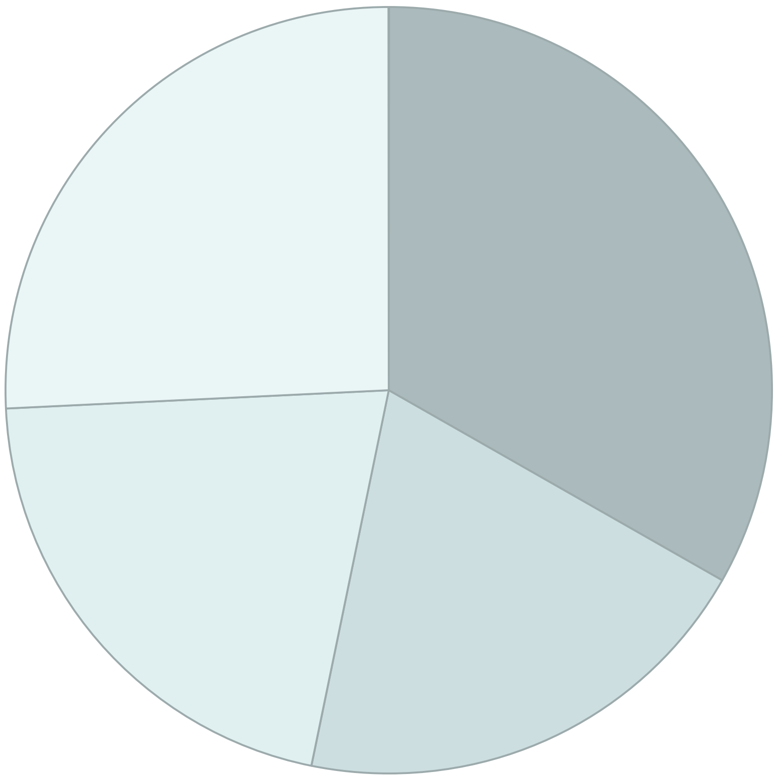


Age profile of ash (N. Ireland)

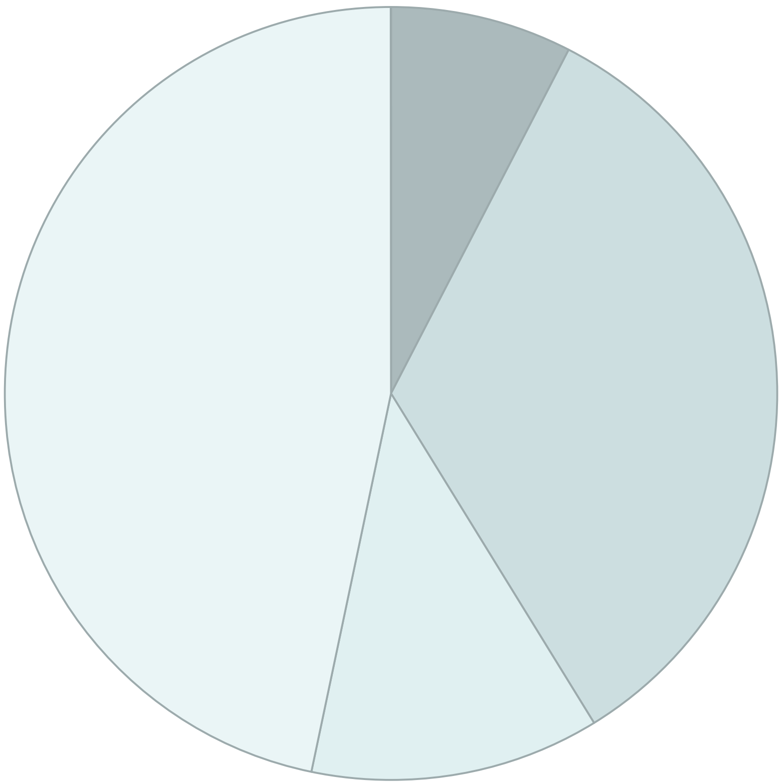


Ash age profile compared

R. Ireland



N. Ireland



Ash age profile compared

UK and R.I compared

UK: ≈ 142,000 Ha. ash

RI: ≈ 21,000 Ha. ash

UK: ≈ 460 cases per 100,000 km^2

RI: ≈ 170 cases per 100,000 km^2

UK: ≈ 8.0 cases per 1,000 ha ash

RI: ≈ 6.8 cases per 1,000 ha ash

- Ireland has had very few “Wider environment” cases to-date.

  Current eradication program.

- UK “wider environment” cases predominantly in the South and East. Will this spread westwards??

  No eradication program.

- Is there potential in the coming decades for dieback to spread across GB and over the Irish Sea?

Ash dieback in Slovenia

Ash Dieback in Slovenia

Tine Hauptman, Nikica Ogris and Dušan Jurc

Abstract

The first symptoms of the disease were observed in 2006, and since then the disease has rapidly spread throughout Slovenia. Dieback thus far has affected common ash and narrow-leaved ash. In 2008, involvement of the fungus *Chalara fraxinea* T. Kowalski in ash dieback in Slovenia as a causal agent was confirmed. Further research revealed differences in strain pathogenicity and the possible resistance of individual trees. The first sanitary fellings of ash trees due to the fungus *C. fraxinea* were done; the situation is also very serious in forest nurseries.

Keywords | ash dieback, *Chalara fraxinea*, Slovenia

Kurzfassung

Eschentriebsterben in Slowenien

Die ersten Symptome der Krankheit wurden im Jahr 2006 beobachtet, und seitdem hat sich Krankheit rasch in ganz Slowenien verbreitet. Vom Zurücksterben betroffen sind die Gemeine Esche und die Schmalblättrige Esche. Im Jahr 2008 konnte die Beteiligung des Pilzes *Chalara fraxinea* T. Kowalski am Zurücksterben in Slowenien als ein Hauptgrund bestätigt werden. Weitere Untersuchungen lieferten Hinweise auf Unterschiede in der Pathogenität einzelner Stämme und in der möglichen Widerstandsfähigkeit von einzelnen Bäumen. Die ersten Kalamitätsnutzungen von Eschen wegen des Pilzes *C. fraxinea* wurden durchgeführt; die Situation ist auch in Forstgärten kritisch.

Schlüsselwörter | Eschentriebsterben, *Chalara fraxinea*, Slowenien

Native ash species in Slovenia

There are three native ash species in Slovenia. Common ash (*Fraxinus excelsior*) is widespread across the country, especially on rich, moist, loamy soils along rivers and streams. With 2,877,000 m^3, common ash represents 0.9 % of total growing stock in Slovenia. Flowering ash (*Fraxinus ornus*) is especially frequent and important in the Karst, where it is known as a pioneer species in newly forming forests on abandoned grasslands and in Austrian pine (*Pinus nigra*) plantations. Its growing stock is 924,000 m^3. Narrow-leaved ash (*Fraxinus angustifolia*) represents only 0.07 % (214,000 m^3) of total growing stock in Slovenia. It is an important tree species in northeastern part of the country, where it is a good replacement for black alder (*Alnus glutinosa*) trees affected by hydro-melioration. This species also occurs in other parts of Slovenia, but rarely (Kotar and Brus 1999, Gozdni fondi 2009).

Research of ash dieback in Slovenia

Ash dieback was first observed in northeastern Slovenia in 2006. The symptoms were shoot, twig and branch dieback, wilting, lesions in the leaves and bark, and grey to brown discoloration of wood (Ogris et al. 2009b). In 2007 and 2008, the symptoms of ash dieback extended throughout Slovenia. Dieback thus far has affected common ash and narrow-leaved ash, while no symptoms have yet been observed on flowering ash.

In spring 2007, we started collecting samples from ash trees showing symptoms of the disease from different parts of the country. To date, we have collected 93 different *C. fraxinea* isolates from 28 different locations (Figure 1). The first isolation of the fungus *Chalara fraxinea* T. Kowalski in Slovenia was also made in 2007; its pathogenicity was confirmed the following year (Ogris et al. 2009b). The teleomorph of this fungus, apothecia on fallen leaf petioles of *F. excelsior* from previous year, was first noticed in the end of May 2009 in Ljubljana (Ogris 2009). They were formed abundantly up to the beginning of July.

Pathogenicity tests, made in 2008 on *F. excelsior* and *F. angustifolia* shoots inoculated with two isolates, showed greater susceptibility of narrow-leaved ash and great differences in necrosis size caused by different isolates. This indicates that isolates may differ in pathogenicity (Ogris 2009). Differences in necrosis length also existed between specimens of the same ash species, so we decided to further investigate differences in the resistance of individual trees. In 2009, we made observation of 467 trees in a 20-year old clonal seed orchard of *F. angustifolia* in Hraščica (Prekmurje). Assessments of crown damage caused by *C. fraxinea* and statistical analyses of collected data showed large differences among trees of the same clone, but also statistically significant differences among some distinct clones. On the basis of this research, we assume that differences in the resistance of individual trees really exist. To prove or reject this assumption we performed pathogenicity tests. The experiment is still in progress and the results are not yet known.

- Stop promoting ash for afforestation
- Replace in affor with sycamore
  - Or other suitable spp.
  - *Populus* on sandy soils near rivers
- Sanitary felling of heavily damaged ash trees

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Dieback of ash in Eastern Austria

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Extended Abstract

Dieback of ash (*Fraxinus excelsior* and *Fraxinus angustifolia*) in Eastern Austria: Disease development on monitoring plots from 2007 to 2010

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Dieback of *Fraxinus excelsior* and *Fraxinus angustifolia*, caused by *Hymenoscyphus pseudoalbidus* (anamorph *Chalara fraxinea*), is presently the most important damaging factor of hardwood trees in Austria. Results from permanent monitoring plots in Lower Austria show that disease development on mature ash trees was slow from 2008 to 2010. In 2008, mean dieback intensity ranged from 1 to 34% on the 14 plots (mean 11%). In 2010, mean dieback intensity per plot varied between 2 and 38% (mean 16%). Only on three of the 14 monitoring plots one out of the 20 sample trees had died during the observation period. Disease intensity was higher on most plots in the western parts of Lower Austria than on most plots in the eastern parts of the province. Relations between disease intensity and site and stand factors are discussed.

Key words: *Hymenoscyphus pseudoalbidus*, *Chalara fraxinea*, ash dieback, emerging forest disease, disease monitoring.

INTRODUCTION

Ash dieback (Figure 1) caused by *Hymenoscyphus pseudoalbidus* (Figure 2, anamorph *Chalara fraxinea*) was first recorded in Austria in 2005 and has since then become the most important damaging factor of hardwood trees in this Central European country (Cech, 2006, 2010; Kirisits et al., 2008, 2011). Both *Fraxinus excelsior* and *Fraxinus angustifolia* are affected by the disease (Cech, 2008, 2010; Halmschlager and Kirisits, 2008; Kirisits et al., 2009, 2010). In 2007, shortly after the massive occurrence of ash dieback, a monitoring project was initiated in the province of Lower Austria, aiming at surveying the extent and intensity of damage and studying the etiology of this emerging and at that time poorly understood phenomenon (Cech, 2008). Monitoring of ash dieback was subsequently continued on permanent plots from 2008 to 2010 (Kirisits et al., 2011). The main results of this research are briefly summarized in this presentation.

ASH DIEBACK MONITORING 2007

In 2007, 50 monitoring plots in mature ash stands (48 composed of *F. excelsior* and two of *F. angustifolia*) were established in various parts of Lower Austria (Cech, 2008). On each plot 20 mature ash trees were selected. For each sample tree the percentage of crown volume affected by dieback was visually estimated in 5% classes. Likewise, various other biotic and abiotic damaging factors were recorded. Assessments were done from July to August.

In this year, ash dieback was significantly less intensive in the plain and drier eastern parts of Lower Austria than in the mountainous and more humid western parts. In addition, suppressed individuals showed higher mean

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- Damage and mortality levels are much higher on
  - Nursery seedlings
  - In afforestations
  - On natural regeneration
  - In thicket-sized and pole-sized stands

  …than on old trees
- Ash dieback causes immense problems for establishing and tending young stands
- Old trees appear to be capable to endure the disease for a relatively long time

Thinning

Vol. 49, 2013, No. 3: 120–126 Plant Protect. Sci.

Patterns and Severity of Crown Dieback in Young Even-Aged Stands of European Ash (*Fraxinus excelsior* L.) in Relation to Stand Density, Bud Flushing Phenotype, and Season

Remigijus BAKYS[1], *Rimvydas VASAITIS*[1] *and Jens Peter SKOVSGAARD*[2]

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Abstract

Bakys R., Vasaitis R., Skovsgaard J.P. (2013): **Patterns and severity of crown dieback in young even-aged stands of european ash (*Fraxinus excelsior* L.) in relation to stand density, bud flushing phenotype, and season**. Plant Protect Sci., **49**: 120–126.

The extent and temporal pattern of crown damage (attributed to *Hymenoscyphus pseudoalbidus*) in even-aged stands of *Fraxinus excelsior* in relation to bud flushing phenotype, stand density, and season was investigated. Data were collected in 2007 in four statistically designed thinning experiments located in 12–15-years old plantations of ash in Denmark. The study included 21 plots of four contrasting, residual stand densities: (1) 1700–5500 trees/ha (unthinned control plots), (2) 1500 trees/ha, (3) 500 trees/ha, and (4) 100–150 trees/ha. Assessments included estimation of flushing phenotype in May, followed by evaluation of severity of crown damage (percentage of crown killed) in June and September. Simultaneously, for each tree, the presence or absence of crown wilt and dead tops were recorded. The seasonal pattern of disease severity (average crown damage) was similar in all stands, and disregarding stand density the extent of tree crown damage increased significantly towards the end of the growing season ($P < 0.005$). Disease severity was the worst in unthinned plots, but otherwise unrelated to stand density. Late-flushing trees were most severely affected ($P < 0.001$). The observed patterns of disease severity are probably associated with ecological features of the pathogen that still remain largely unknown.

- Thinned stands are less severely infected
- Late-flushing trees most severely affected

Senescence

Biological Conservation 158 (2013) 37–49

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journal homepage: www.elsevier.com/locate/biocon

Review

European ash (*Fraxinus excelsior*) dieback – A conservation biology challenge

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Invasion biology
Riparian woodland
Tree breeding

ABSTRACT

Common ash (*Fraxinus excelsior*) is a keystone tree species throughout temperate Europe whose future existence is threatened by an emerging invasive fungal disease. Ash dieback, which first appeared in Poland in the 1990s, has rapidly spread to most eastern, central and northern European countries. The causal agent of the disease, the ascomycete *Hymenoscyphus pseudoalbidus* (anamorph *Chalara fraxinea*), was recently described as a new species. Given that the disease lethally affects ash trees of all age classes, and that ash tree mortality levels are high, *F. excelsior* and the many organisms dependent on ash trees are under threat. Based on a literature survey, we provide an overview of the present knowledge on ash dieback, identify practical recommendations and point out research needs. The observation of relatively resistant individual ash trees (although at very low frequency) calls for a rapid germplasm collection effort to establish a breeding program for resistance or tolerance to the disease. Ash trees that appear to be tolerant to the pathogen should not be felled, unless they pose an unacceptable risk to people's security. Given that the pathogen does not form propagules on wood, and given the importance of deadwood for biodiversity conservation, dead and dying ash trees should be left in the forest. Landscape pathology and genetic tools can be used to reconstruct the dispersal pathways of *H. pseudoalbidus* and to identify environmental features associated with variation in disease severity, so as to better predict the further development of the epidemic. Observations on differences in susceptibility of various ash species are needed to locate the geographic origin of the pathogen and to identify *Fraxinus* species which might be used for resistance breeding or even replacement of *F. excelsior*. Conservation biologists, landscape managers, restoration ecologists, social scientists and tree geneticists need to engage with forest pathologists and the various stakeholders throughout the distributional range of *F. excelsior* so as to tackle this pressing conservation challenge.

- Trees with early leaf senescence in the autumn are less prone to infection

Associations among symptoms

Associations among symptoms of dieback in even-aged stands of ash (*Fraxinus excelsior* L.)

J. P. Skovsgaard[1,3], I. M. Thomsen[1], I. M. Skovgaard[2], T. Martinussen[2]

Article first published online: 28 MAY 2009

DOI: 10.1111/j.1439-0329.2009.00599.x

Issue

Forest Pathology

Volume 40, Issue 1, pages 7–18, February 2010

Summary

The objective of this study was to establish statistically based associations among macroscopic symptoms of crown dieback, cankers due to *Chalara fraxinea*, and symptoms caused by other pathogens and pests on *Fraxinus excelsior*. A total of 454 trees were observed in two plots of a 15-year-old experimental stand. The symptoms included: (i) overall extent of crown dieback; (ii) dieback of upper parts of the crown; (iii) canker in upper parts of the crown; (iv) wilting foliage; (v) cankers and bark proliferations at the lower part of the stem; and (vi) discolouration at stump or stem base. The analysis suggested that the observed symptoms of crown dieback are caused by a primary disease. The macroscopic symptoms attributed to dieback and canker in the crown were strongly associated. Moreover, the disease was associated with symptoms of *Armillaria gallica*, but no associations were found for symptoms of *Neonectria galligena*, *Pseudomonas syringae* subsp. *savastanoi* pv. *fraxini*, *Hylesinus fraxini* or *H. varius* when considered collectively. Dieback was more frequent on trees of average or below-average size, suggesting that individual tree resistance decreased with decreasing growth potential or tree vigour. The extent of canker in the crown depended on site conditions and possibly on silvicultural practices. The development of phytosanitary prescriptions for silviculture should primarily be targeted towards young stands as these represent the most critical phases of stand development.

Development of phytosanitary silviculture prescriptions should primarily be targeted towards young stands as these represent the most critical phases of stand development

- The disease was associated with symptoms of *Armillaria gallica*
- No associations were found for symptoms of *Neonectria galligena*, *Pseudomonas syringae* subsp. *savastanoi* pv. *fraxini*
- Dieback was more frequent on trees of average or below-average size
  - suggesting that individual tree resistance decreased with decreasing growth potential or tree vigour

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Occurrence on infected logs

Plant Pathology (2012) 61, 889–895 Doi: 10.1111/j.1365-3059.2011.02578.x

Plant Pathology

Occurrence of *Hymenoscyphus pseudoalbidus* on infected ash logs

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Ash decline induced by *Hymenoscyphus pseudoalbidus* is an emerging disease that severely affects *Fraxinus excelsior* stands in Europe. There has been an invasive spread of the disease from east to west in Europe over the last decade. Wood discoloration on infected trunks has been reported, but few data are available on the involvement of *H. pseudoalbidus* in such symptoms. Transport and trade of ash logs could introduce the pathogen into disease-free areas and therefore accelerate its dissemination. The aim of this study was to assess the prevalence and severity of *H. pseudoalbidus* in ash logs in infested areas located in the northeast of France and to clarify the role of secondary pathogens in ash decline. The results showed that prevalence of *H. pseudoalbidus* on collar lesions was high in the study area. The pathogen was able to produce conidia from infected wood. Thus, export of ash logs could represent a potential risk for spreading the disease. Involvement of *Armillaria* spp. in the decline process was confirmed, while no *Phytophthora*-induced collar lesions were found. Studying both disease prevalence and the age of callus tissues surrounding collar lesions in 60 ash stands enabled the origin of the disease in the study area to be determined.

Keywords: canker, collar, emerging disease, *Hymenoscyphus pseudoalbidus*, lesions, quarantine pathogen

Introduction

Since the early 1990s, an emerging lethal disease has reached epidemic levels on ash in Central Europe (Kowalski, 2006; Bakys *et al*., 2009). The causal agent, *Hymenoscyphus pseudoalbidus* (anamorph *Chalara fraxinea*), first described in Poland, is responsible for a severe decline on all age classes of *Fraxinus excelsior* and *F. angustifolia* trees (Kowalski & Holdenrieder, 2008; Kirisits *et al*., 2010; Queloz *et al*., 2011). Main symptoms described are brownish to orange bark necroses and cankers without exudates on shoots, stems and branches, leading to wilting of the leaves and dieback of the trees (Kowalski, 2006; Kowalski & Holdenrieder, 2009a; Schumacher *et al*., 2010).

Ash dieback could represent a serious threat to forest and nursery ash trees, and for this reason the European Plant Protection Organization (EPPO) Secretariat decided to add *H. pseudoalbidus* to the EPPO Alert List in 2007 (EPPO, 2010). Up to now, this invasive pathogen has not been reported on the west coast of Europe or outside of Europe. Although precise data are lacking on the biology of the fungus, trees for planting and infected *F. excelsior* logs are likely pathways for spreading the disease over long distances (EPPO, 2010). In France, disease emergence is very recent, as the first *H. pseudoalbidus* associated ash declines were observed in 2008 (Ioos *et al*., 2009). The disease is mainly located in northern and northeastern France where severe decline of *F. excelsior* stands has been observed (Husson *et al*., 2011). The west coast and southern France, where *F. excelsior* as well as *F. angustifolia* are well established, are still free of *H. pseudoalbidus* and keeping the region disease-free as long as possible is important. Spread of *H. pseudoalbidus* by infected ash logs needs to be better documented as massive logging is occurring in affected stands of eastern France and their transport and trade could introduce the pathogen to disease-free areas. For example, in Europe, phytosanitary measures including the treatment of imported oak logs by fumigation have been taken in order to prevent the introduction of *Ceratocystis fagacearum*, the causal agent of oak wilt, from North America (Desprez-Loustau, 2009). However, the frequency of *H. pseudoalbidus* presence on affected ash trees is not well documented. Although wood discoloration on mature tree trunks as well as root and butt rot have been reported, mostly on highly infected ash trees (Kowalski & Holdenrieder, 2008; Skovsgaard *et al*., 2010; Bakys *et al*., 2011), few data are available about their prevalence, and involvement of *H. pseudoalbidus* in such symptoms remains unknown. *Armillaria* spp. were in fact the most abundant fungi isolated from trees with these

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- The pathogen was able to produce conidia from infected wood
- Export of ash logs could represent a potential risk?
  - (requires confirmation [tested in the lab])
  - the available data do not support control of ash log trade as a quarantine measure
- Involvement of *Armillaria* spp. in the decline process was confirmed

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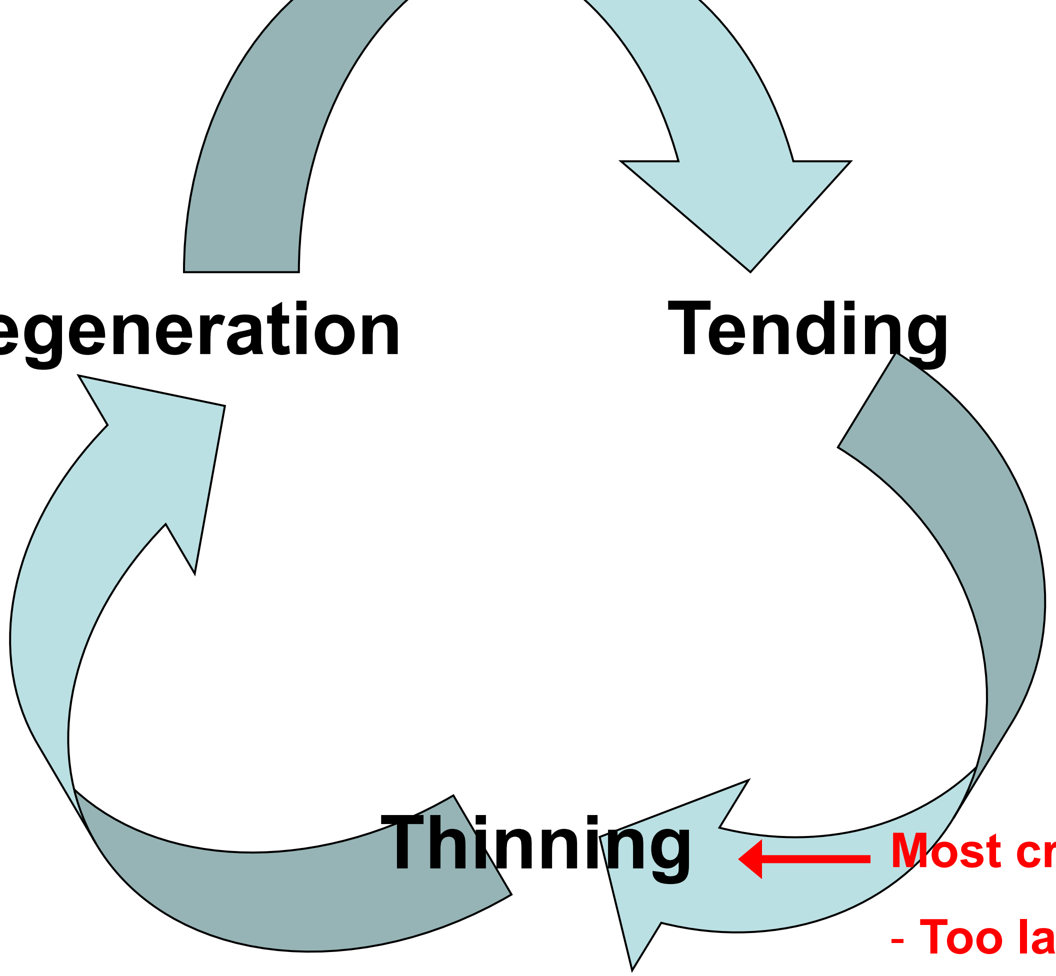
Silviculture



Most critical phase

- **Too late for replacement planting?**
- **Too early for commercial timber sale?**

Uninfected site

Forestry Commission

- Slow the impact of any future infection
  - promote fast growth of selected trees
  - Maximise timber value at time of felling
  - High standards of silviculture and establishment

Infected pole-stage

Forestry Commission

- Low disease level
  - Selective thinning of diseased and suppressed
- Stand is a mixture of species, and there are enough trees of other species to form a closed stand within 10 years, it is likely that management objectives can still be achieved without replanting after felling the ash.
- Stand is a mixture and there are NOT enough trees of other species to form a closed stand within 10 years, it is likely that the stand will have to be regenerated after felling by planting alternative species
- Stand consists of pure ash then consider what alternative species would do well on the site.

Older stands

Forestry Commission

- Individual-tree approach is recommended for older stands with infected trees.
- > 50% of the crown is infected, and where survival of the tree depends on epicormic shoots, felling should be considered
- < 50% of the crown is infected, trees should be regularly monitored. Assess the risk of Armillaria (honey fungus) attack. This is often the ultimate cause of death of ash trees once they are infected with *Hymenoscyphus fraxineus*.

Increase resilience of woodlands

Forestry Commission

- Increase the genetic and age diversity of the woodland
  - Developing stands of mixed species should make the woodland less vulnerable to disease
  - Adopting a continuous-cover approach, where practicable, is one way to promote higher levels of species and age diversity.

Our advice?

- Mark trees during or after leaf flushing
- Prefer trees that flush early and senesce early
- Thin
- Remove unhealthy stems
  - including those with epicormics
- Inspect stand annually

- Understory smooths the water balance fluctuations
  - conifers but also broadleaves?

But …

- We may have time on our side
  - *H. fraxineus* is not prevalent in the wider environment in Ireland
- Let's be pro-active
- We can prepare for the future

Clearfell and replant

Eradication strategy

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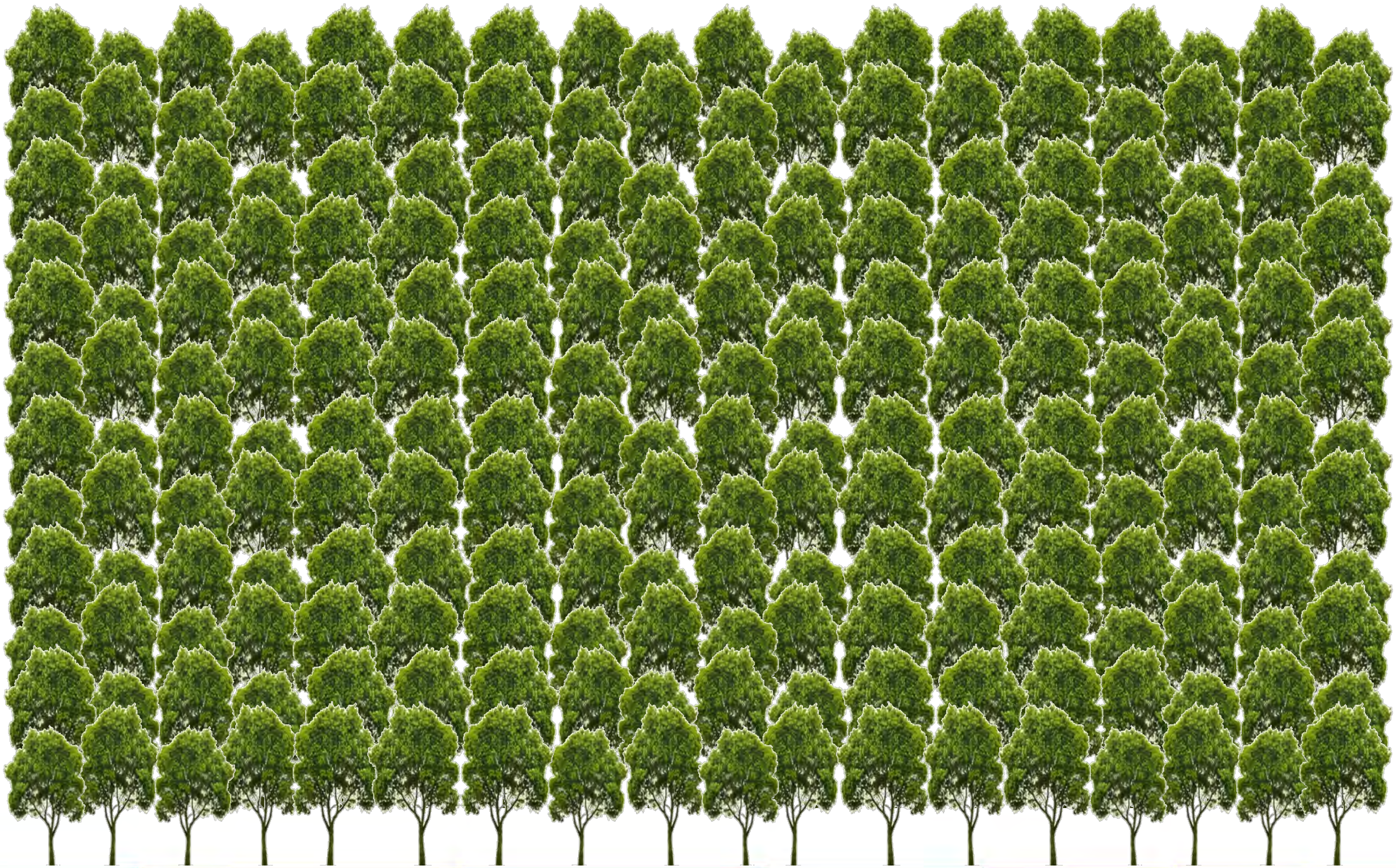
Rack and selection thinning



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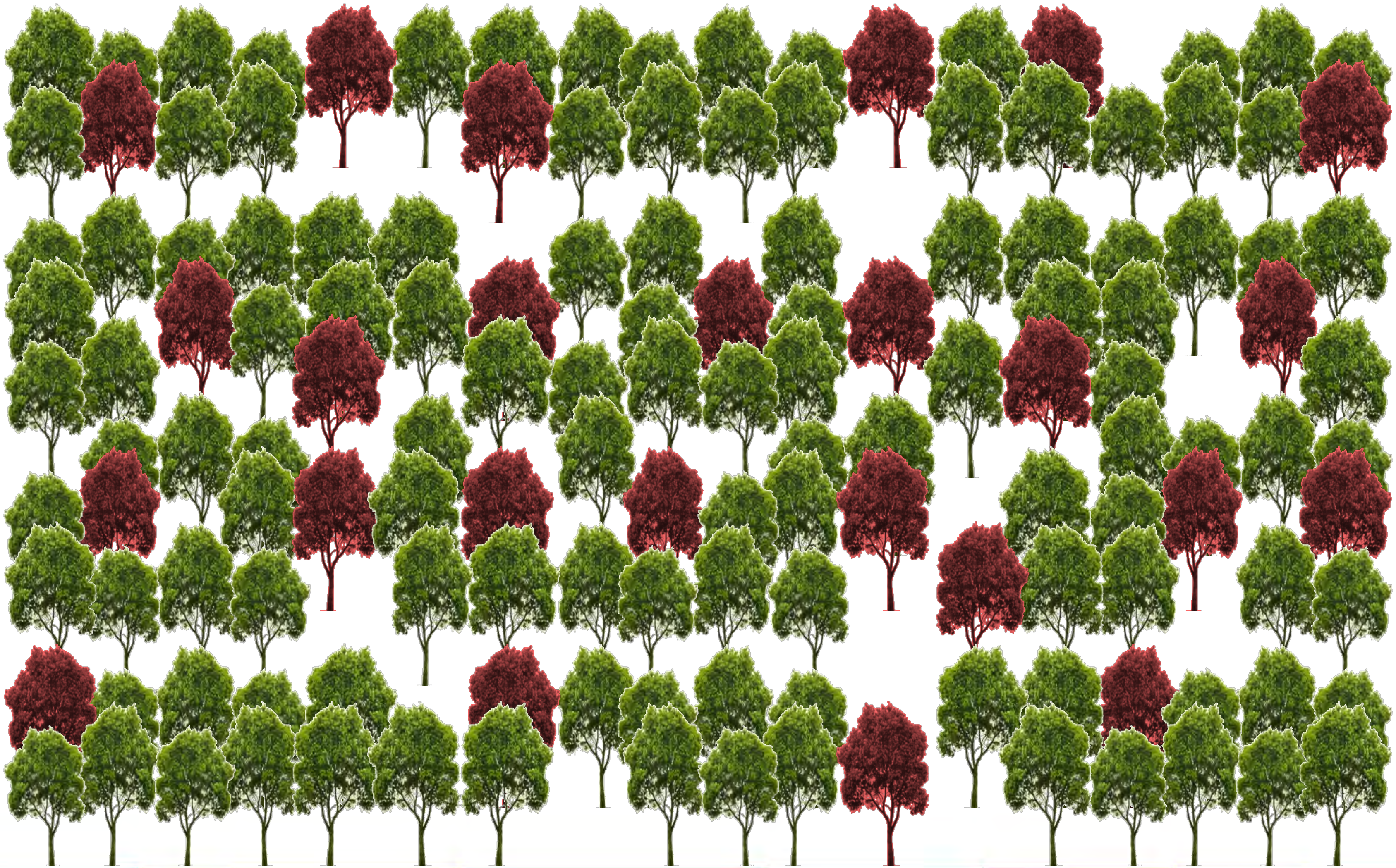
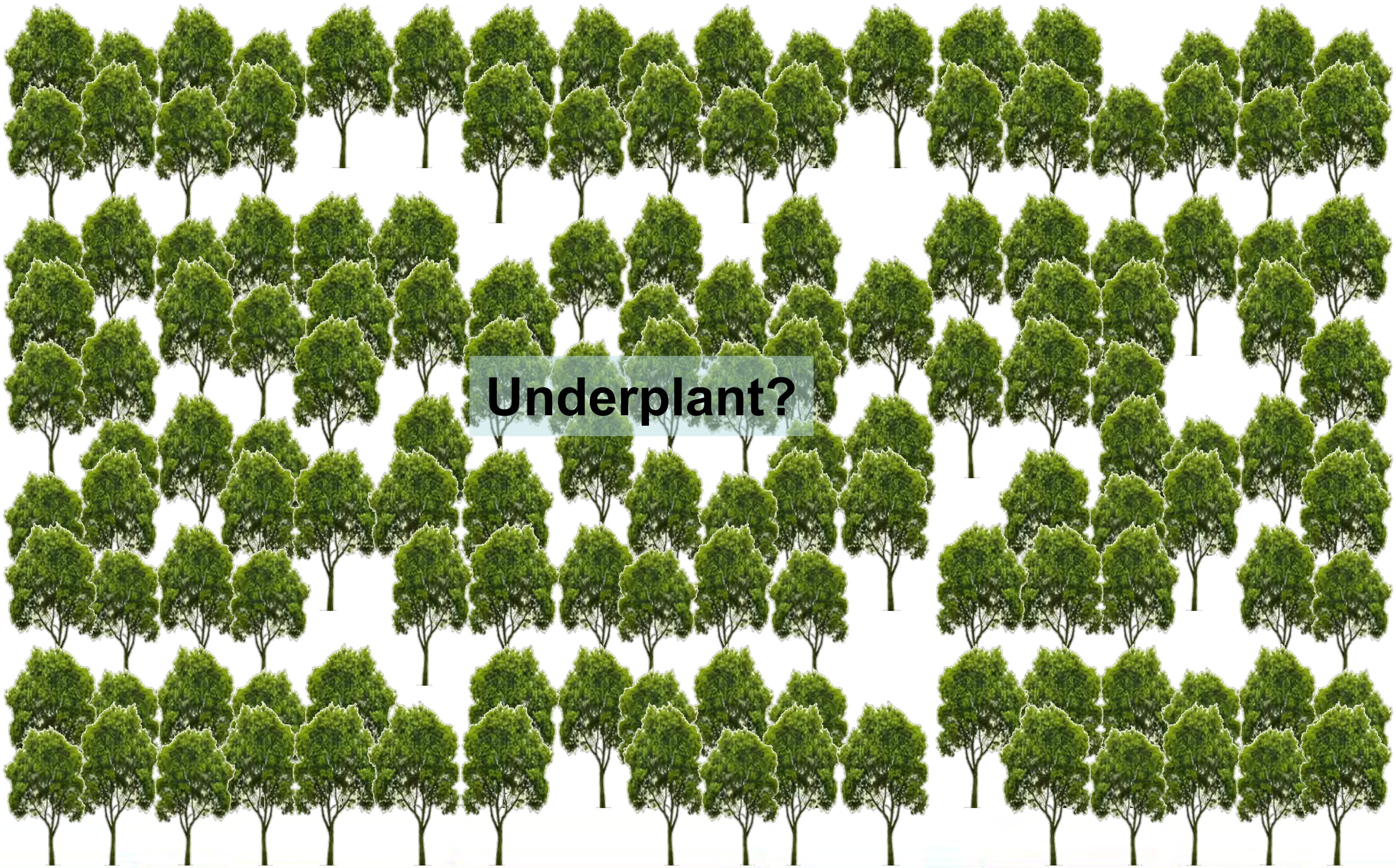
Rack and selection thinning



Rack and selection thinning



Rack and selection thinning

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Systematic thin and underplant?

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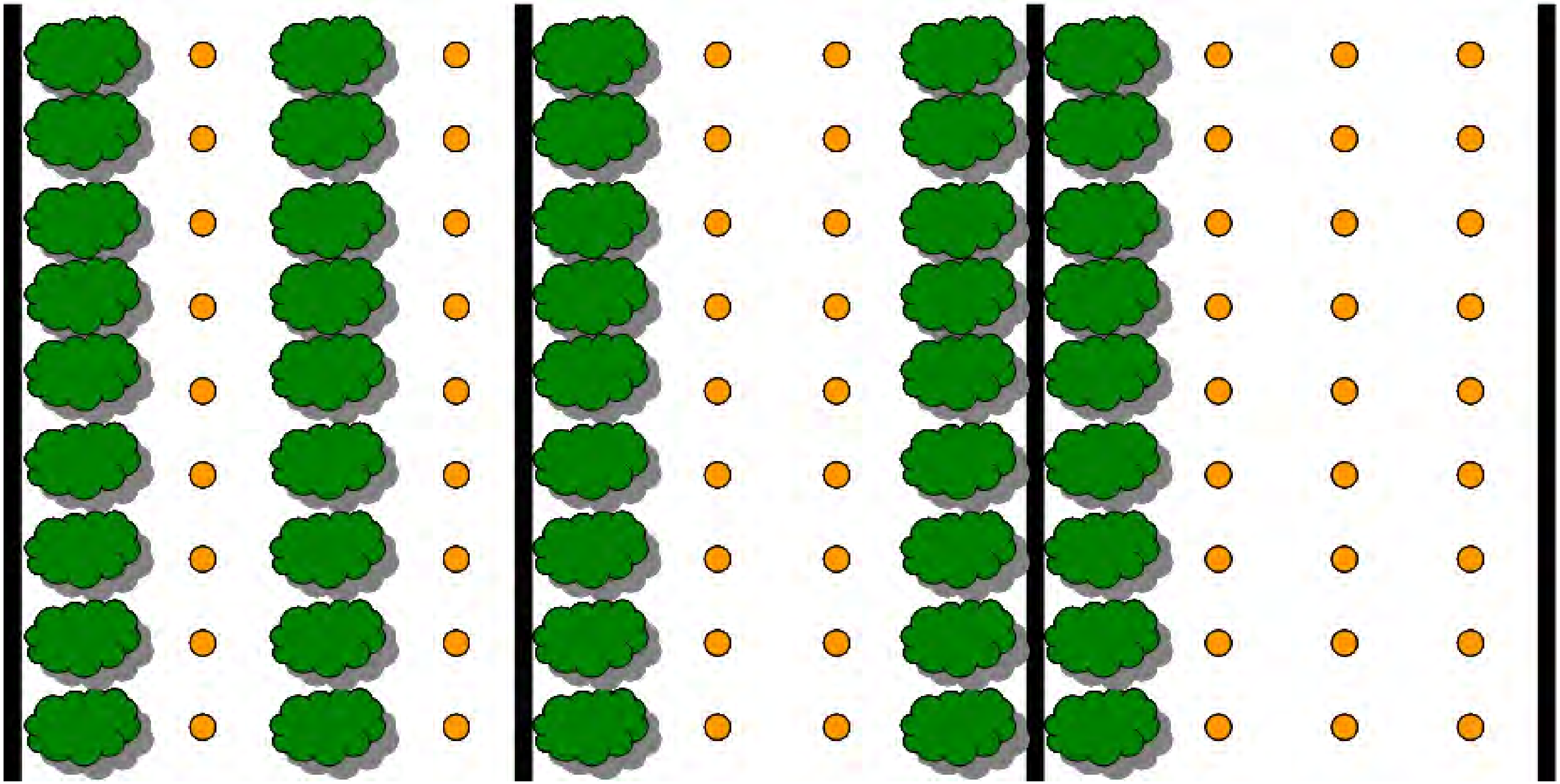
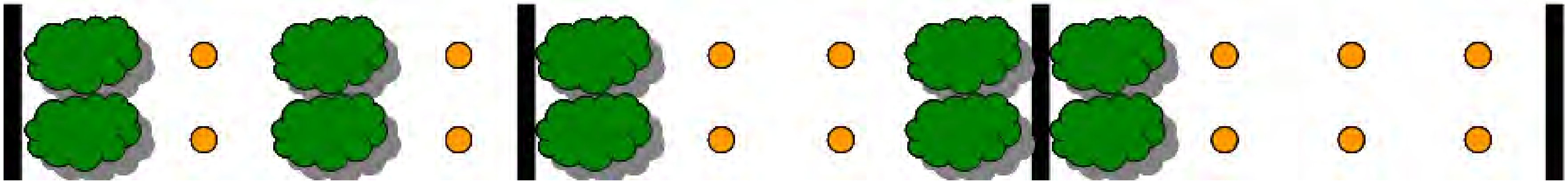
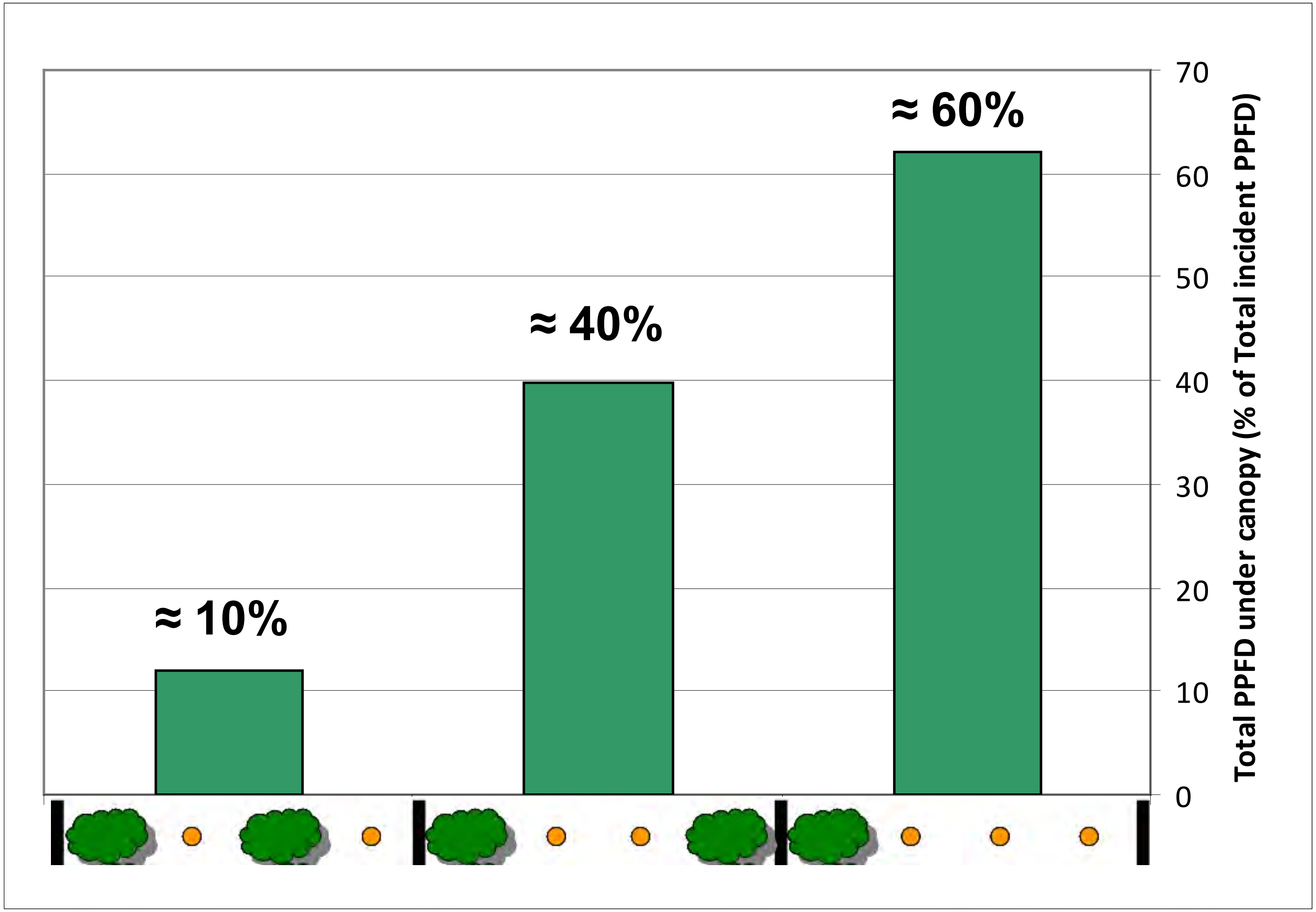
Systematic thin and underplant?



Systematic thin and underplant? - light



Relative illumination (sycamore overstory)



Species for underplanting? - Conifer

Western red cedar	4
Lawson cypress	5+
Douglas fir	6
Western hemlock	6
European larch	7+
Lodgepole pine	7+
Scot's pine	7+
Pinus nigra	7+

Norway spruce	7+
Sitka spruce	7+
Coast redwood	n/a
Leyland cypress	n/a
Monterey cypress	n/a
Grand fir	n/a
Serbian spruce	n/a

Ellenberg's indicator values for British plants – sapling stage

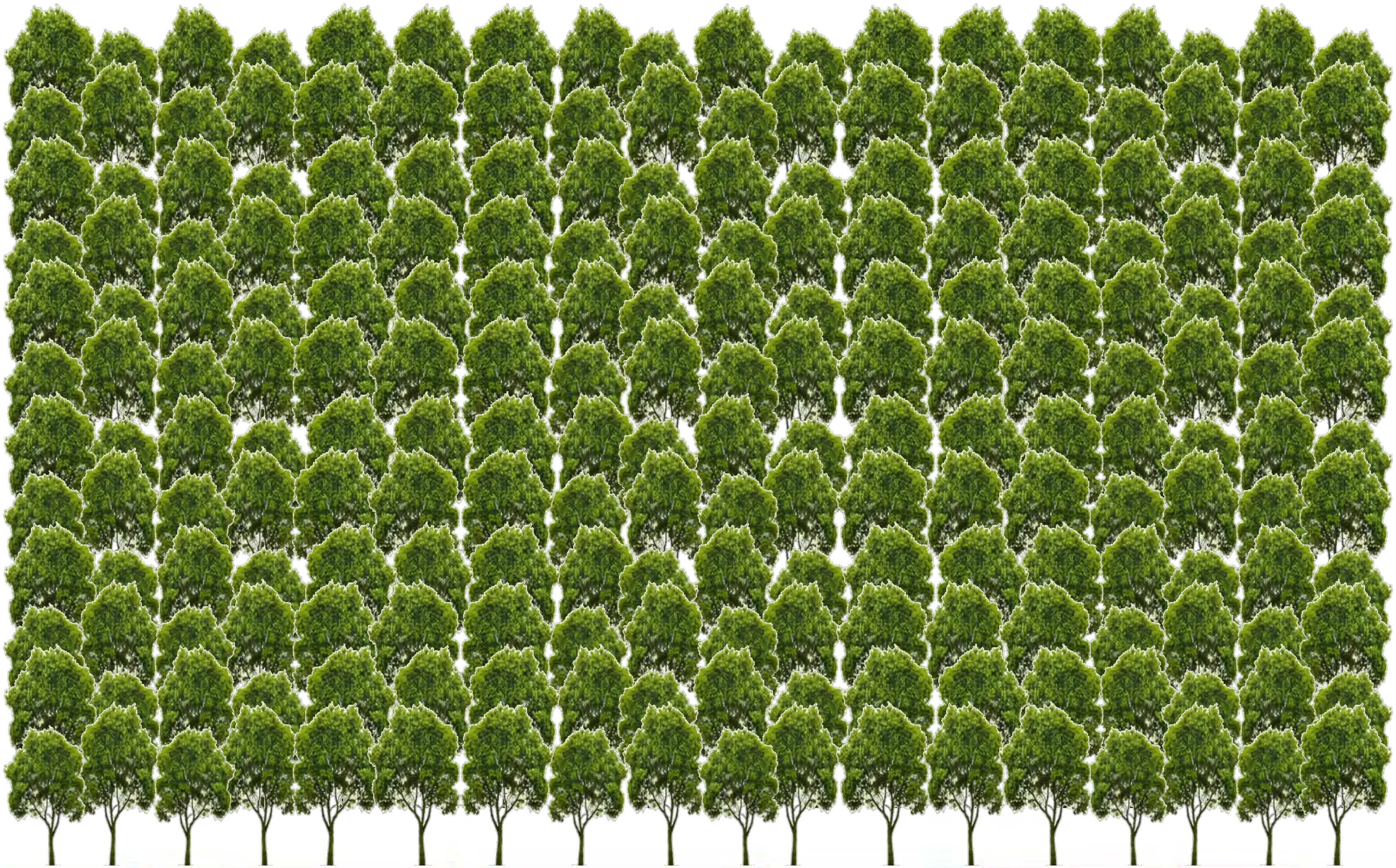
3. Shade plant, mostly **<5%** relative illumination, seldom **>30%** illumination when trees are in full leaf
5. Semi-shade plant, rarely in full light, but generally with **>10%** relative illumination when trees are in leaf
7. Plant generally in well lit places, but also occurring in partial shade
8. Light-loving plant rarely found where relative illumination in summer is **<40%**

Species for underplanting? - Broadleaf

Common beech	3+
Hornbeam	4
Wild cherry	4
Large-leaved lime	4
Norway maple	4+
Sycamore	4+
Common alder	5
Ash	5
Small-leaved lime	5
Common lime	5
Spanish (sweet) chestnut	5
Holly	5
Field maple	5+
Horsechestnut	5+

Black poplar	6
Walnut	6
Aspen	6+
Hybrid poplar	6+
White poplar	6+
Sessile oak	6+
Downy birch	7+
Silver birch	7+
Pedunculate oak	7+
Red oak	n/a
Southern beech	n/a

Free-growth / halo thinning



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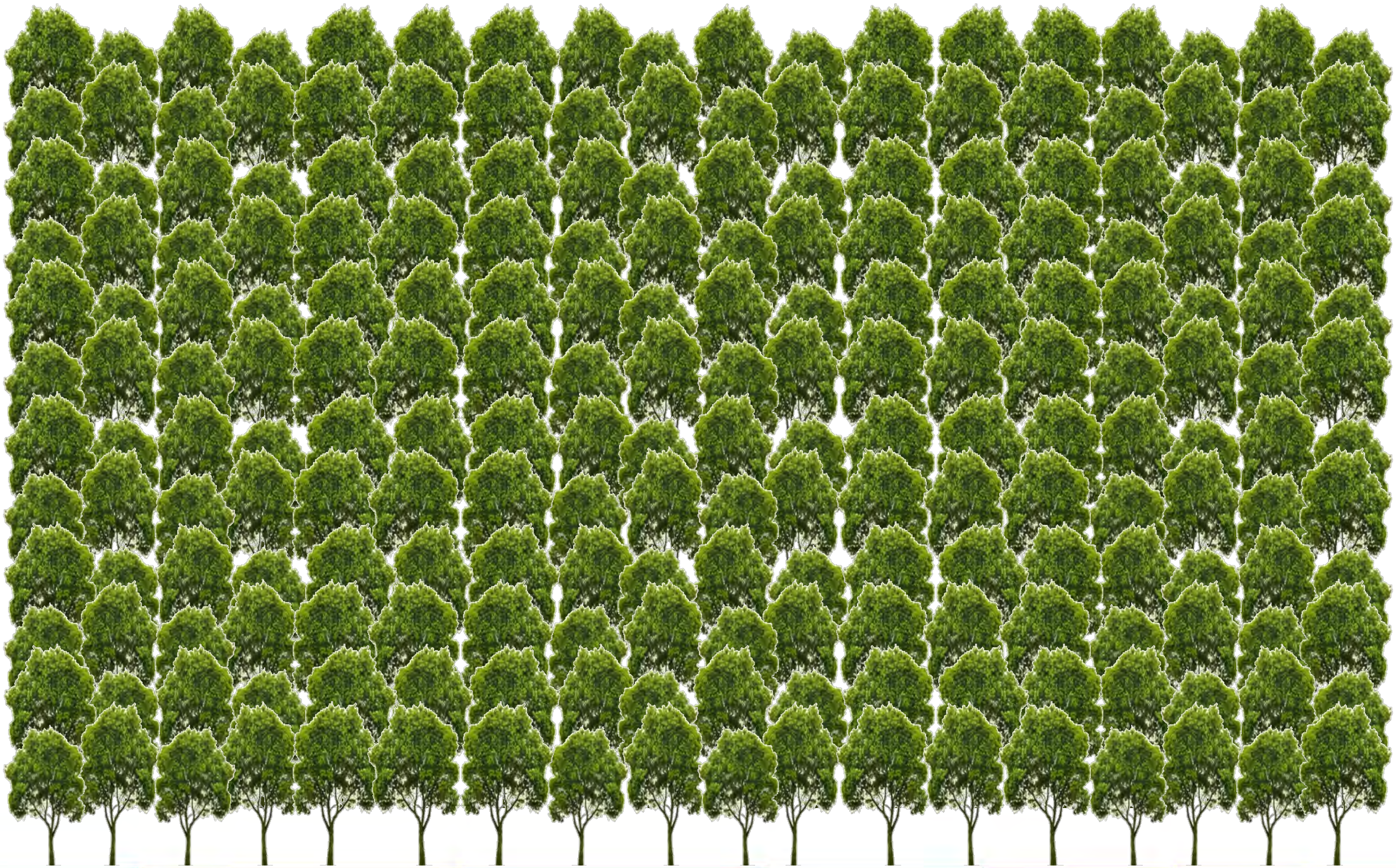
Free-growth / halo thinning

Free-growth / halo thinning

Free-growth / halo thinning

Group selection and nat regen / underplant



Group selection and nat regen / underplant

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Group selection and nat regen / underplant

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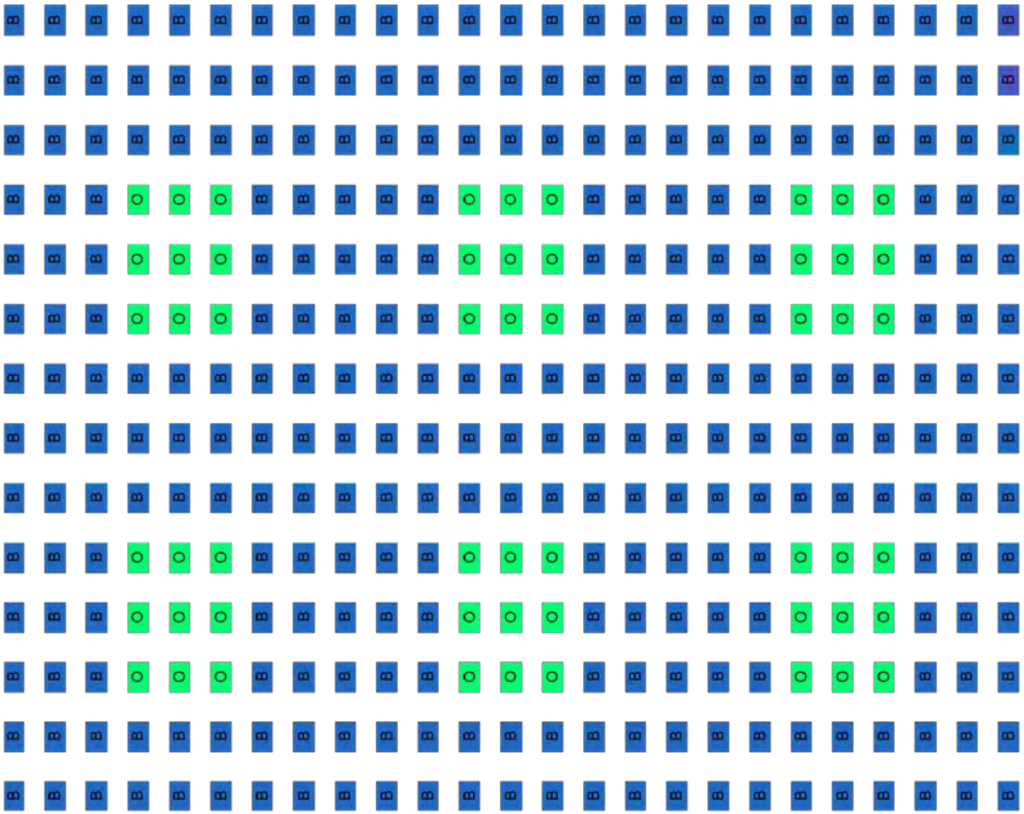
Strip felling and replanting

Strip felling and replanting

Establishment of mixtures?

- With tolerant ash provenances in the future
- Anderson Squares?
- Bands?
- Intimate?
- How many species?



Future positives from *Hymenoscyphus fraxineus* ash dieback?

- Improved silviculture?
  - Amelioration of poor-performing stands
    - Better soils for tree establishment
    - Shelter present?
  - Greater emphasis on thinning
  - Greater owner (and public) interest
  - Less prescriptive silviculture, more site specific silviculture
  - Greater emphasis on establishing mixtures?
- Improved planting stock made available?

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