Alternative forest management to address future challenges in Ireland's western peatland forests

Irish management prescriptions and demonstration sites from the EU project ALTERFOR - Alternative models and robust decision-making for future forest management

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Introduction to the reader

This document contains suggested management prescriptions for the Irish alternative Forest Management Models (aFMMs) – developed for Ireland's western peatland forests. The target groups are forest owners with blanket peat stands who are interested in expanding the provision of ecosystem services from their forest and manage their forest without the use of fertiliser. These aFMMs were not exclusively developed for Coillte sites, but also private forest owners with blanket peat forests. Current and prospective forest owners considering afforestation should read the following documents by the Irish Forest Service:

- *Afforestation Grant and Premium Scheme 2014-2020* (Forest Service, 2015a).
- *Environmental Requirements for Afforestation* (Forest Service, 2016a).
- *Land Types for Afforestation* (Forest Service, 2016b).
- *Native Woodland Establishment GPC9 & GPC10 - Silvicultural Standards* (Forest Service, 2015b).

This document assumes the reader has a prerequisite knowledge about trees used in Irish forestry. We would suggest the following two sources to learn about tree species:

- *A Guide to Forest Tree Species Selection and Silviculture in Ireland* (Horgan et al., 2003)
- *Irish Forest Species* on the Forest Service website for Forestry Publication (Forest Service, 2020)

This document contains starts with a background that explains the need for the aFMMs and the thought process behind their development. The next section describes the management prescriptions for the aFMMs, including the associated costs, followed by a presentation of demonstration sites where these aFMMs have been established in Ireland. Excerpts of the aFMM yield tables are included towards the end, followed by a list of references.

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Background

When the Irish afforestation programme was initiated in the early 20th century, it was decided that only land that was not suitable for agriculture should be afforested (Gray, 1963). Afforestation was largely driven by the need for a national timber supply and to create jobs in disadvantaged rural areas (Neeson, 1991). Thus, large areas of blanket bog were afforested using intensive drainage methods and extensive fertiliser application (Renou-Wilson & Byrne, 2015), resulting in over 30% of Irish forestry being located on blanket bogs along the western seaboard (Forest Service, 2013). Today, blanket bog forestry is seen in a different light, with questions being asked about its sustainability and viability. Interviews were held with forestry stakeholders between November 2016 and January 2017, getting their opinions about their ideas of what an ideal forest consist of, their preferences for ES provision levels, and any conflicts they perceive in the current forest policies (Juerges & Krott, 2017). Some of the key findings were:

- Forest managers indicated that forests on blanket bogs often have poor timber quality and managing some of these sites results in a net cost.
- Environmental NGOs prefer to see natural blanket bog and native woodlands instead of exotic conifer plantations.
- Anglers and other water quality stakeholders were concerned about the effect of eutrophication and siltation on salmon stocks and Freshwater Pearl Mussels (FPMs) in catchments dominated by forests on peat soils.

The main objective when developing aFMMs was to find less intensive management systems, to avoid using fertilisers, and to focus more on the environmental aspects of forest management. Thus, the aFMMs were designed to tackle the abovementioned issues and conflicts, provide higher levels of ES supplies and a more preferred mix of them, and be feasible for forest management to establish in terms of having a low establishment cost. Job creation is no longer a priority in forestry on peat soils; instead, other social values such as tourism, angling, and hillwalking are today important services that were taken into consideration when developing the aFMMs. The aFMMs were developed without pushing the limits of available silvicultural knowledge or going far outside of current forest policy. The main objectives behind each of the aFMMs that were developed were:

- To have less intensively managed blanket bog forests, by planting lodgepole pine in a range of low-stocking densities, and by thinning current lodgepole pine stands to a lower stocking density than used in standard practices.
- To increase sawlog output, timber quality, and broadleaves in the landscape by planting mixtures of Sitka spruce and downy birch, with the birch acting as a nurse species.
- To restore blanket bogs to their natural condition.

Management prescriptions

Lodgepole pine fibre – 1,600-2,000 stem ha^{-1}

Lodgepole pine planted at 1,600 stems ha^{-1} offers a low-intensity management option for blanket peat sites. Following clearfelling of the previous stand, the site is replanted using uniform spacing and a lower stocking than the regular 2,500 stems ha^{-1}. Uniformity in spacing is important as this will ensure equal development of these trees destined to produce pulpwood. In practice, a density of 2,000 stems ha^{-1} or 1,800 stems ha^{-1} can be used, with a 10% expected seedling mortality in the first 4 years. Small differences in productivity could determine the planting density, as well as what the Forest Service will approve. It seems Coillte will settle on planting 2,000 stems ha^{-1}, and they have made it a company policy that low YC areas are now categorised for wood fibre production, rather than quality log production. The Forest Service have to accept the reforestation stocking at felling license application for wood fibre production.

The aFMM does not require any management interventions between planting and clearfelling, although a few site visits might be necessary to assess stand development. Clearfelling can be expected around the age 50-60, but assessment of windthrow damage on the site might be necessary and result in an earlier clearfelling. One issue might be large branches during clearfelling, but harvesting heads might develop in the decades until these sites are clearfelled.

A rough recommended productivity is Sitka spruce (SS) Yield class (YC) range for this aFMM is 8-20, but preferably SS YC 16 and below. The cost of establishment is estimated at €1,689 ha^{-1} for the 1,600 stems density, €1,900 ha^{-1} for the 1,800 stems ha^{-1} stocking, and €2,111 ha^{-1} for the 2,000 stems ha^{-1} stocking.

Lodgepole pine biodiversity – 1,100 stems ha^{-1}

Lodgepole pine planted at 1,100 stems ha^{-1} offers a cheap reforestation alternative that should be utilised to extract existing valuable timber on the site, or to transition the stand to a more natural, low-stocked forest, or both. Establishment of the stand should be done by creating an intimate mixture of planted group of trees, separated by open area. Normal planting density (i.e. 2,500 stems ha^{-1}) should be used in the groups to allow more than half the site to effectively be open space. The exact planting pattern and size of groups should be varied until the best approach to promote regeneration of native plants, shrubs, and trees can be determined.

Following plantation there should be no further management interventions. However, future naturally regenerating lodgepole pine should be removed if native trees and shrubs colonise the site. There may also be issues with rhododendron (*Rhododendron ponticum*) creeping into the site. If rhododendron is present in the area it will require management, and the best option might be to refrain from establishing this aFMM.

The establishment cost is estimated at €1,161 ha^{-1}, and the aFMM is mostly suited to low-productivity sites that are no longer financially profitable to manage, sort of SS YC 14 and below. This aFMM could be established behind aquatic setbacks to enhance water protection and the natural aesthetics of the landscape.

Nephin thin

A Nephin thin site can be established by heavily thinning an existing lodgepole pine dominated stand. Somewhere between 63-75% of trees should be thinned between age 26-50, and the around 450-600 stems ha^{-1} should remain after the treatment. After the heavy thin, the stand should be left to develop freely, and it is beneficial if the stand is on a fairly windfirm site. Issues with this aFMM

include that rhododendron can move into the site and take over before native ground vegetation has had a chance to establish on the site.

Regarding costs the only costs are for felling, extraction, and transportation of the thinned trees, but when these logs are sold the transition to Nephin thin will likely result in a net profit. Management costs could be incurred for removing rhododendron. Natural regeneration of other tree species than lodgepole pine should be left on site.

Modified Kronoberg

The first step in implementing the Modified Kronoberg (MKB) aFMM on blanket peat is to find suitable sites. Peat depth is a major factor affecting site productivity and crop survival. The BOGFOR project established Sitka spruce-birch mixtures on cutaway peat sites with a 0.3-0.6 m peat depth. Thus, expert recommendation is that the MKB aFMM should be limited to blanket peat sites with peat no deeper than 0.5 m.

Once suitable sites are found, the MKB management starts with planting a mixture of 54% Sitka spruce and 46% downy birch in alternating rows, with some double rows of Sitka spruce, at almost 2 by 2 m spacing, resulting in 2,500 trees ha^{-1}. After reforestation, three thinnings are applied at ages 21, 27, and 34, and the stand is eligible for clearfelling at age 40 (Table 1). The first thinning only harvests birch, while all the remaining birch and some of the Sitka spruce are harvested in the second thinning. The third thinning only removes some Sitka spruce trees, and all remaining Sitka spruce trees are removed in the clearfelling.

The reforestation cost for the MKB aFMM was calculated by summing half the cost of planting one hectare of Sitka spruce and half the cost of planting one hectare of birch, totalling €2,965 ha^{-1}. The site productivity can vary based on soil conditions, but sites with an estimated SS YC of at least 16 should be used to establish this aFMM.

Table 1. Overview of the management prescriptions for the Modified Kronoberg System

Prescription	Age	Downy birch	Sitka spruce
Planting	0	1,146 stems/ha planted	1,354 stems/ha planted
Thinning 1	21	Thinned from 1,161 to 506 stems/ha	Unthinned, 1,280 stems/ha
Thinning 2	27	Birch harvested; all 506 stems/ha removed	Thinned from 1,280 to 1,101 stems/ha
Thinning 3	34	-	Thinned from 1,101 to 536 stems/ha
Clearfell	40	-	Sitka spruce harvested; all 536 stems/ha removed

Bog restoration

Bog restoration is the process of removing the existing forest and blocking drains, in order to raise the water table so the site becomes water saturated and a suitable site for *Sphagnum* mosses and other bog vegetation. Suitable sites for bog restoration involve areas with environmental policy designations (Natua2000), sites that have low YC, and sites where certain *Sphagnum* mosses and other indicator plant species are already present. The presence of typical bog vegetation is an important factor in determining if the site has potential to support a rare habitat type (Neville, 2018). Additionally, the historic afforestation establishment methods are important as it indicates the degree of disturbance to the site and how extensive the drain-filling operation will be. It is important to establish permanent plots on the site in order to assess the progress of recolonization by bog species. Removal of naturally regenerating species (mainly seeds from the previous forest

crop) might be necessary and can cost around €500 ha^{-1}. Restoration of blanket bogs in Ireland costs around €2,000 ha^{-1} and tend to be lower if the site is flat.

The previous tree crop can be harvested as commercial timber, but some bog restoration sites have utilised fell-to-waste since the ground was too wet to support heavy machinery without causing excessive peat damage through rutting.

Demonstration sites

Lodgepole pine fibre –2,000 stem ha^{-1}

Location: eastern edge of Finnaun forest estate, Cloosh Valley Forest, Co. Galway.

Figure 1. Demonstration site for low-stocked lodgepole pine for biomass, roughly located within the yellow square.

The demonstration site is 81.81 ha in size and is composed of two adjacent stands. The stands are divided by a road, along which there are several wind turbines.

The previous crop species was lodgepole pine and Sitka spruce, with a productivity of Sitka Spruce Yield Class (SS YC) 10 - 12 (YC 8 -10 for lodgepole pine). The main harvest assortment from the Sitka spruce was only pallet wood, so the performance was not good enough to produce sawlogs. New policies and best management practices has made fertilisation ineligible on this site, so planting lodgepole pine at a lower stocking was the best option. Alternatives considered were to retain the existing stand indefinitely, but the site was deemed productive enough to support a crop of low-stocked lodgepole pine. Bog restoration was considered, but the site had shallow peat over rocky outcrop, and generally deep peat is necessary to restore valuable bog complexes. Additionally, removing the forest requires an equal area of forest to be established elsewhere, and acquiring new land for afforestation is an expensive investment. Thus, the target site has generally lower YC with shallower peat, that produce a biomass crop with as little initial investment as possible. The demonstration site was burnt in the Cloosh fire of May 2017.

The previous crop was harvested full pole and extracted, with no following windrowing after. All the dead branches remained on ground, and planting was done wherever the suitable and brash free space. The site was planted in 2019, with a stocking of 2,000 plants per hectare, using lodgepole pine bare-root seedlings. The site is located on deep peat and has no special protection or designation. Coillte expects that 10% seedling mortality within four years, leaving 1,800 stems ha^{-1}, which will ensure sufficient forest cover. Clearfell is expected at around 50 - 60 years. Some issues with using

lower stockings is that the Forest Service has not issues clear guidelines whether planting 1,800 stems ha^{-1} with 10% seedling mortality in four years would fulfil the reforestation requirements or not. Planting at lower stockings could this result in higher maintenance costs to ensure forest cover.

Coillte anticipates that this management option will be expanded on large western peatland forest areas, especially since demand for biomass is likely to increase in the future. The management system has the added benefit that open area in the forest increase biodiversity in the landscape.

The main issues at establishment is that there is generally much weevil on the sites where low stocked is considered, so bare root stock with higher root collar diameter is often required. Planting immediately after clearfelling is necessary to ensure that the seedlings grows thicker before weevils emerge after two years. Coillte use an integrated pest management by using insecticides, but more and more of these chemicals are banned from use and there are no weevil reducing nematodes suitable for Irish conditions.

A similar survival issue is blanket bog inherently poor conditions, i.e. waterlogging and nutrient deficiency. Although peat depth affects survival, studies have found that the depth can vary a lot on the same site, requiring extensive surveying to determine the actual depth profile.

Lodgepole pine biodiversity – 1,100 stems ha^{-1}

To date, no demonstration site has been established at this density. Success will likely depend on the rate of rhododendron colonisation.

Nephin thin – Wild Nephin, Co. Mayo

Location: South of Bellacorrick and north of Newport, Co Mayo

Figure 2. Aerial view of a Nephin Thin FMM.

The site is roughly 97 ha in size, comprised of two stands and was afforested by double mould board ploughing of virgin blanket peat in 1977 and planted with lodgepole pine, south coastal.

Productivity of the site was measured to lodgepole pine YC 10, which corresponds to SS YC 12-14. No previous thinning had been done before the demonstration site was heavily thinned in 2015 and 2017, at the ages of 38 and 40, respectively. Both stands had around 1,800 trees ha^{-1} at the time of thinning, and the thinning operation uniformly removed 75% of the stems, leaving around 450 stems ha^{-1}.

The decision to heavily thin was based on the premise that opening up the canopy would be beneficial for ground vegetation and stand aesthetics. The stands are on very deep peat and this was the deciding factor as it was assumed that stability would not be an issue - the entire site sways on the peat, reducing the possibility of windblow. The main justification for this was based on the concepts of the wilderness project which morphed into the Wild Nephin project.

This site was established as a transition area to wilderness where increase light would improve floral biodiversity on the site. However, this is very much a pilot project and opening the canopy and increased light has caused rhododendron (*Rhododendron ponticum*) to creep in.

There were signs of lodgepole pine naturally regenerating, but those saplings tend to get wiped out due to a) heavy frost, resulting in frost heave where the roots are pushed up and exposed to the air and die, and b) weevil attacks killing saplings. Thus, overall regeneration is not happening on the

demonstration site. Some of the mature trees on site have snapped halfway up the stem, indicating the site is actually windthrow stable.

Another 100 ha of Nephin thin was planned in the same area, but since rhododendron was observed to invade the heavily thinned stands the additional planned thinnings were cancelled. No more Nephin thin will be done until more time has passed, allowing forest managers to assess the development in the stands were already thinned.

One perceived benefit of this aFMM is that some timber can be salvaged, but since it is pulpwood, the millgate price is marginal to negative. However, opening up the forest canopy increases aesthetics, but how biodiversity is improved remains to be seen by assessing this demonstration site.

Modified Kronoberg – Blackwater production area, Shannonbridge, Co. Offaly

The test site was established in 2000 on previous industrial cutaway peat (milled peat, mainly *Phragmites*) and is thus an afforested site. The afforestation was a part of the BOGFOR project that investigated the potential to afforest decommissioned industrial cutaway peats. Although this site is not located on blanket peat, this demonstration site is the closes thing existing in Ireland.

Planting was done in alternating rows of Sitka spruce (*Picea sitchensis*) and Downy birch (*Betula pubescens*), at 2,500 trees ha^{-1}, in a 50:50 mix using a 2 by 2 m spacing. Both the birch and spruce seedlings were bare-root stock, with the Sitka being a 2+1 transplanted seedling, and the birch being 1U1 undercut seedling. In total six treatments were established at the test site, but alternative 2 below is the one most likely to be utilised for the MKB aFMM. In the alternatives where spruce was planted after the birch (i.e. alternatives 3-4), the spruce showed signs of suppression by the birch. Alternative 1, pure Sitka spruce stand showed signs of stunted growth and nutrient deficiency symptoms.

1. Pure Sitka spruce.
2. Alternative lines of Sitka spruce and birch planted at the same time (in the year 2000).
3. Alternate lines of birch and Sitka spruce, but the spruce was planted 2 years after the birch.
4. Alternative line of birch and Sitka spruce, with spruce planted 4 years after birch.
5. One line of birch and 2 lines of Sitka spruce planted at the same time.
6. One line of birch and 3 lines of Sitka spruce planted at the same time

To date, no thinning has been done in the 50:50 mix of Sitka spruce and birch (Alternative 2), but the next thinning will remove one line of birch from centre of each bay with some selective thinning of larger birch (i.e. negative selection). The post-thin birch stocking should be maintained to ca 600 trees ha^{-1}. Thinning of Sitka spruce should be delayed.

Assessment of the stands overall development and response to thinning will determine when and how the future thinnings and the clearfelling will be done. Due to uncertainty, it is likely that the management schedule will differ from the idea MKB thinning schedule.

Figure 3. Aerial view of the MKB demonstration site (in yellow box).

Bog restoration - Emlaghdauroe, The Twelve Bens, Co. Galway

The Emlaghdauroe demonstration site is located on the southwestern slopes of Ben Gleninsky, on the southern edge of the Twelve Bens mountain range in the Connemara region of Co. Galway. The site is surrounded by the Twelve Bens/Garraun Special Area of Conservation (SAC) and the area with restored bog will be subsumed into the SAC once restoration has been shown to be successful. In total, the site is 90.3 ha in size and was restored as a part of the EU LIFE project LIFE02 NAT/Ire/8490, which restored around 2,000 ha of blanket bog in Ireland.

Prior to restoration, the site could be divided in to two parts. Below 200 m altitude there was an area of lodgepole pine (>8 m tall). Above 200 m altitude was a large unplanted area, dominated by heath vegetation and rocky outcrops. Upslope from the planted area there is wet heath vegetation, dominated by purple moor-grass (*Molinia caerulea*) and ling heather (*Calluna vulgaris*). Further upslope, this vegetation community grades into dry/montane heath dominated by ling heather (*Calluna vulgaris*), containing plant species such as clubmoss (*Huperzia selago*), bilberry (*Vaccinium myrtillus*), juniper (*Juniperus communis*) and bearberry (*Arctostaphylos uva-ursi*).

Emlaghdauroe was partly chosen as a demonstration site since areas of montane heath habitat are relatively rare in Ireland. The site will serve as a good demonstration of how many similar conifer plantations in Connemara can be managed for environmental benefits.

The management interventions used to restore the bog was to remove the commercial conifer crop using machines and blocking the artificial drains using a combination of plastic piling and peat. A smaller and wetter site was manually felled to waste, since machine tracks would cause too much damage to the soil. The conifer plantation was felled in April 2003, and by 2006 extensive bog vegetation had taken over the site.

Due to the dense canopy of the previous lodgepole pine crop, there were very few species of ground vegetation still on site. Narrow strips of Molinia dominated vegetation persisted in unplanted ride lines, and besides sparse mosses (*Hypnum cupressiforme, Sphagnum capillifolium, Polytrichum commune*), the ground was covered in needles.

Recolonization by regenerating blanket bog vegetation has been a relatively slow process, but recolonization has taken place. *Juncus effusus* has developed extensively in sloping areas and/or areas subject to flushing by flowing surface waters. The other parts of the site are currently dominated by *Molinia caerulea* and the moss *Hypnum cupressiforme*.

Besides the relatively slow recolonization, there have not been any issues or downsides with restoring this site. The bog restoration has resulted in environmental benefits through restoring and increasing the area of this rare habitat type. Additionally, the site now sequesters carbon in the peat, and by removing forest sites that result in a financial loss when managed, there are few drawbacks to bog restoration once the work has been done.

Figure 4. Emlaghdauroe boardwalk

Figure 5. Aerial view on the Emlaghdauroe bog restoration site.

Yield tables

Due to space limitations, yield tables are only presented for the yield classes where the aFMMs are likely to be planted and on a 5-year basis. Lodgepole pine established at 2,500 stems ha^{-1} is included for reference.

Lodgepole pine: Normal - 2,500 stems ha^{-1}

YC	Age	Top height (m)	Diameter (cm)	Trees (ha^{-1})	Volume (m^3 ha^{-1})	Average tree (m^3)
12	0	0.0	0	2500	0	0.00
12	20	11.3	14	2189	149	0.07
12	25	14.6	16	2009	249	0.12
12	30	17.5	18	1751	344	0.20
12	35	20.0	20	1523	425	0.28
12	40	22.2	21	1349	495	0.37
12	45	24.2	23	1219	559	0.46
12	50	26.0	24	1118	617	0.55
12	55	27.7	25	1035	669	0.65
12	60	29.3	26	967	716	0.74
14	0	0.0	0	2500	0	0.00
14	20	11.3	14	2189	149	0.07
14	25	14.6	16	2009	249	0.12
14	30	17.5	18	1751	344	0.20
14	35	20.0	20	1523	425	0.28
14	40	22.2	21	1349	495	0.37
14	45	24.2	23	1219	559	0.46
14	50	26.0	24	1118	617	0.55
14	55	27.7	25	1035	669	0.65
14	60	29.3	26	967	716	0.74

Lodgepole pine: Fibre - 1,600 stems ha^{-1}

YC	Age	Top height (m)	Diameter (cm)	Trees (ha^{-1})	Volume (m^3 ha^{-1})	Average tree (m^3)
8	0	0.0	0	1600	0	0.00
8	25	11.2	14	1389	109	0.08
8	30	12.9	16	1291	164	0.13
8	35	14.5	19	1189	216	0.18
8	40	15.8	21	1085	262	0.24
8	45	17.0	23	984	302	0.31
8	50	18.0	25	887	336	0.38
8	55	18.9	27	796	362	0.46
8	60	19.7	29	712	383	0.54
10	0	0.0	0	1600	0	0.00
10	25	12.2	15	1328	146	0.11
10	30	14.0	18	1215	206	0.17
10	35	15.6	21	1100	259	0.24
10	40	16.9	23	988	304	0.31
10	45	18.1	25	880	341	0.39
10	50	19.0	27	780	369	0.47
10	55	19.9	29	687	390	0.57
10	60	20.6	32	604	403	0.67
12	0	0.0	0	1600	0	0.00
12	20	11.3	14	1401	118	0.08
12	25	13.4	17	1275	187	0.15
12	30	15.3	20	1143	250	0.22
12	35	16.8	22	1013	302	0.30
12	40	18.1	25	890	344	0.39
12	45	19.2	27	775	376	0.48
12	50	20.1	30	672	397	0.59
12	55	20.8	33	580	409	0.71
12	60	21.5	35	498	413	0.83

Lodgepole pine: Biodiversity - 1,100 stems ha^{-1}

YC	Age	Top height (m)	Diameter (cm)	Trees (ha^{-1})	Volume (m^3 ha^{-1})	Average tree (m^3)
8	0	0.0	0	1100	0	0.00
8	25	11.2	14	959	77	0.08
8	30	12.9	17	895	123	0.14
8	35	14.5	20	827	168	0.20
8	40	15.8	22	758	209	0.28
8	45	17.0	25	690	245	0.36
8	50	18.0	27	625	275	0.44
8	55	18.9	29	563	299	0.53
8	60	19.7	31	505	317	0.63
10	0	0.0	0	1100	0	0.00
10	25	12.2	16	909	107	0.12
10	30	14.0	19	835	158	0.19
10	35	15.6	22	760	205	0.27
10	40	16.9	25	685	246	0.36
10	45	18.1	27	613	279	0.45
10	50	19.0	30	545	304	0.56
10	55	19.9	32	483	322	0.67
10	60	20.6	35	426	332	0.78
12	0	0.0	0	1100	0	0.00
12	20	11.3	14	963	82	0.09
12	25	13.4	18	881	140	0.16
12	30	15.3	21	794	195	0.25
12	35	16.8	24	707	242	0.34
12	40	18.1	27	624	280	0.45
12	45	19.2	30	546	309	0.57
12	50	20.1	33	476	327	0.69

Lodgepole pine: Nephin thin

YC	Age	Top height (m)	Diameter (cm)	Trees (ha^{-1})	Volume (m^3 ha^{-1})	Average tree (m^3)
6	40	12.3	17	498	67	0.13
6	45	13.5	20	475	91	0.19
6	50	14.6	22	450	115	0.26
6	55	15.5	25	425	137	0.32
6	60	16.4	27	399	158	0.40
8	40	15.8	25	418	138	0.33
8	45	17.0	28	383	165	0.43
8	50	18.0	31	348	187	0.54
8	55	18.9	34	316	204	0.65
8	60	19.7	37	285	214	0.75
10	40	16.9	28	383	167	0.44
10	45	18.1	31	345	191	0.55
10	50	19.0	35	309	208	0.67
10	55	19.9	38	275	218	0.79
12	40	18.1	31	356	192	0.54
12	45	19.2	34	314	212	0.67
12	50	20.1	38	275	222	0.81

Modified Kronoberg

	Maincrop after thinning						Harvest				Before thinning						
Age	SPP	DBH (cm)	H (m)	BA (m^2/ha)	Vol m^3/ha	Tree/ha	BA (m^2/ha)	Vol m^3/ha	Tree/ha	vol/tree	DBH (cm)	H (m)	BA (m^2/ha)	Vol m^3/ha	Tree/ha	Cum.vol. m^3/ha	MAI m^3/ha/yr
16	Total	9.3	5.5	20.6	67	2530										67	4.2
	BI	11.5	6.3	13.3	47	1161										47	2.9
	SS	7.7	4.8	7.3	21	1369										21	1.3
21	Total	11.5	8.7	21.9	111	1845	17.3	105	595	0.16	13.2	9.3	39.2	216	2440	216	10.3
	BI	13.1	9.7	7.5	41	565	17.3	105	595	0.16	15.6	10.4	24.8	146	1161	146	7.0
	SS	11.1	8.4	14.4	70	1280					11.1	8.4	14.4	70	1280	70	3.3
27	Total	17.2	11.1	27.7	169	1101	14.7	82	685	0.12	16.3	10.7	42.4	251	1786	356	13.2
	BI						14.1	79	506	0.16	18.4	11.3	14.1	79	506	184	6.8
	SS	17.2	11.1	27.7	169	1101	0.6	3	179	0.01	15.7	10.5	28.4	172	1280	172	6.4
34	Total	28.8	16.0	35.1	274	536	14.9	107	565	0.19	23.3	14.6	50.0	382	1101	569	16.7
	BI															184	5.4
	SS	28.8	16.0	35.1	274	536	14.9	107	565	0.19	23.3	14.6	50.0	382	1101	384	11.3
40	Total	36.6	19.6	56.3	501	536	56.3	501	536	0.94						795	19.9
	BI															184	4.6
	SS	36.6	19.6	56.3	501	536	56.3	501	536	0.94						611	15.3

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